

Assessment of Industrial Gas Industry & Addendum to the same report covering modules on India Industrial Gases with market size & associated positioning statement & Peer Profile released in Mumbai in June / 2026

INOX Air Products

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Macroeconomic Overview of the Global & Indian Economy

Overview of the Global Economy

Review and Outlook of Global GDP

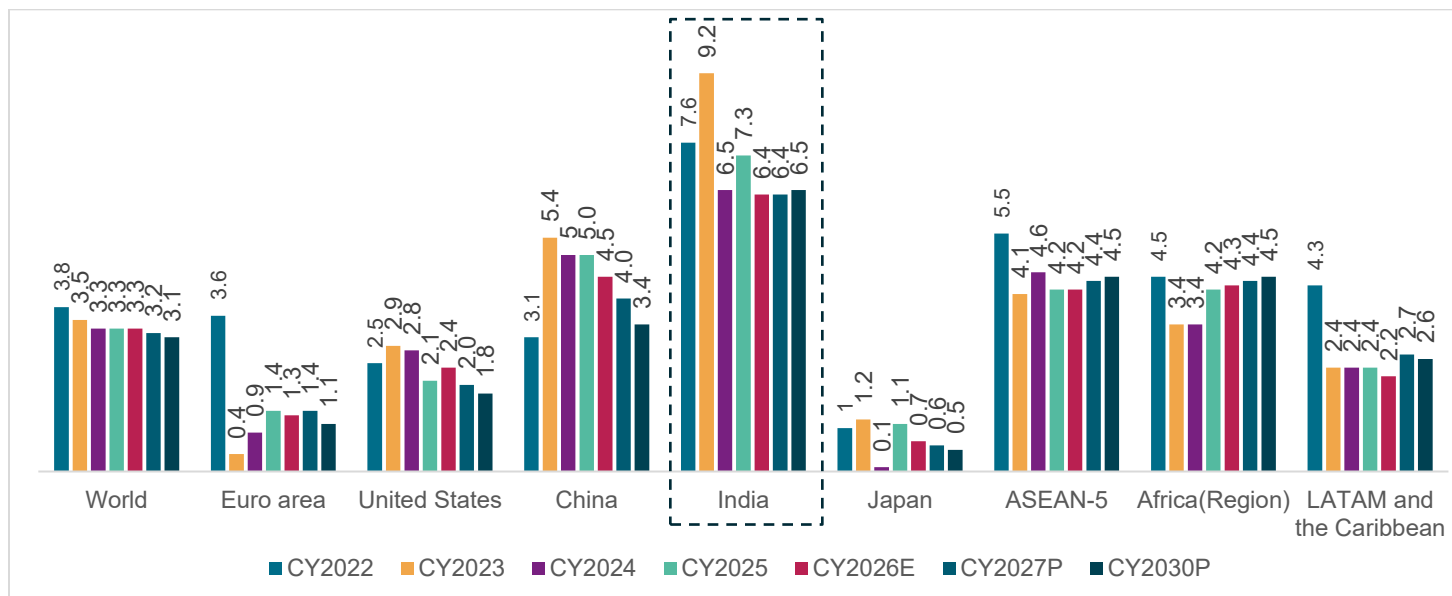
Global economic growth is estimated to have remained resilient in calendar year 2025, with advanced economies showing steady albeit slightly slower growth (1.8% in CY2024, vs 1.7% in CY2025).

The global growth pace is estimated to be steady at 3.3% in CY2026 and 3.2% in CY2027 according to IMF's World Economic Outlook January 2026 estimates. Trade policy challenges are being countered by investments in tech (like AI), government support, and adaptable businesses, which are expected to help to keep things on track. The effects of tariffs and uncertainty are expected to fade going ahead.

Growth in advanced economies (like US, UK, Euro area, Japan) is projected to remain stable (1.7% in CY2025 to 1.8% in CY2026 and 1.7% in CY2027) with the support of fiscal policy as well as lower policy rate. Further, the adverse effects of elevated trade barriers are expected to diminish over the period.

In emerging markets and developing economies (like ASEAN countries, Africa region, LATAM) growth is expected to slow down (4.4% in CY2025 vs 4.2% in CY2026 and 4.1% in CY2027), with pronounced downgrades for countries affected most by recent trade measures. The growth outlook is projected to be relatively more stable for India, despite global environment uncertainty. The projected steady expansion of the economy is expected to be supported by private consumption, particularly in rural areas.

GDP growth (% y-o-y) of key economies



Note: On Calendar Year (CY) basis

* Euro area comprises 19 member countries of the EU, * ASEAN-5 (Indonesia, Malaysia, The Philippines, Singapore, and Thailand)

* Africa (Region) -GDP numbers based on IMF WEO -October 2025 outlook

Source: International Monetary Fund (IMF); World Economic Outlook (WEO) – January 2026 update, Crisil Intelligence

India to be the fastest growing large economy

- The Indian economy has demonstrated its resilience so far in fiscal 2026, with the growth inflation mix improving despite a challenging and uncertain global environment. Major factors contributed towards growth are lower than expected impact of the US tariff, domestic monetary, supporting government policies such as tax cuts to increase spending and sustained global growth driven by heavy investments in the artificial intelligence ecosystem particularly in the US.
- The first advance estimate (FAE) of National Statistics Office (NSO) projects India's GDP growth 7.4% in fiscal 2026 from 6.5% in fiscal 2025. The growth has been primarily driven by strong momentum in manufacturing and construction. Additionally private final consumption expenditure (PFCE) remained above the decadal trend of 6.1% despite the high base year and it is supported by tax relief, rate cuts by Reserve Bank of India (RBI), direct benefit transfer (which have crossed Rs 4 lakh crore) and low inflation.
- Exports growth remained strong because of frontloading of merchandise exports in anticipation of tariffs in the first half of the fiscal 2026 and robust service exports.
- On the supply side gross value added (GVA) growth is projected to strengthen to 7.3% in fiscal 2026 compared to 6.4% in fiscal 2025, due to strong growth in manufacturing and service sectors.
- Nominal GDP growth, on the other hand is estimated to be softer at 8% in fiscal 2026 compared to 9.8% in fiscal 2025. NSO estimates softer GDP growth in the second half of fiscal 2026 at 6.8% compared with 8% in the first half of fiscal 2026. The gap between real and nominal GDP growth estimates at 0.6%, is at its lowest level in 2011-12 series. The lower nominal GDP growth puts some pressure on deficit targets as these are measured as a percentage of nominal GDP.
- CRISIL expects India's gross domestic product (GDP) growth to moderate to 6.7% in fiscal 2027 from the NSO first advance estimate of 7.4% for fiscal 2026, weighed down by diminishing advantages from statistical factors, such as fading impact of a low deflator.
- GDP growth is expected to normalise towards the decadal trend. It is expected to get support from healthy consumption, a supportive monetary policy, the US-India trade deal, a mild pick-up in private investment, and low crude oil prices.
- CRISIL expects CPI inflation to rise to 5% in fiscal 2027 from an estimated 2.5% in fiscal 2026 as food inflation is expected to normalise and it is anticipated that RBI will maintain the current policy rates, considering the recent increase in inflation.

Overview of the Indian Economy

Review of GDP growth over fiscals 2019-2025 and Outlook for fiscal 2026

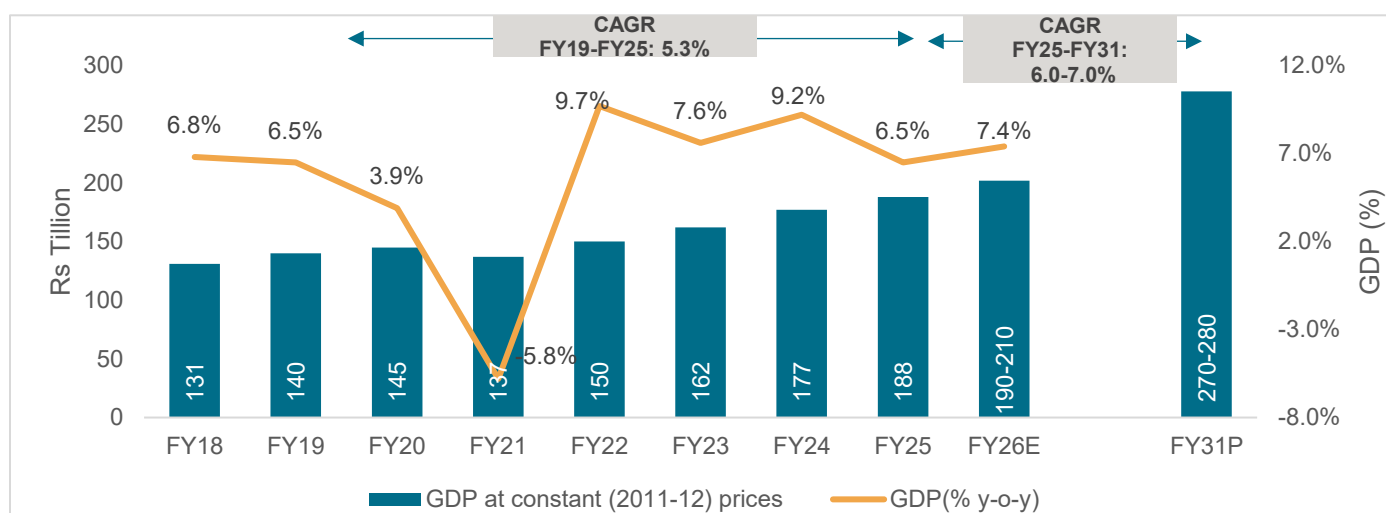
According to the IMF's January 2026 database, India has become the fourth-largest economy in the world surpassing Japan. At present, it is the fastest-growing major economy, outpacing its global peers.

The Indian economy logged a 5.3% CAGR between fiscals 2020 and 2025, driven by benign crude oil prices, soft interest rates and a low current account deficit. However high growth and low inflation have redefined the growth momentum in fiscal 2026. Inflation remains below the lower tolerance level; unemployment is on declining trajectory and export performance continues to improve. Further, the financial environment remains supportive, with readily available credit and low interest rates. Also, the domestic demand remains strong supported by robust private consumption.

According to the National Statistics Office's (NSO) First advance estimates (FAE), India's GDP is projected to grow at 7.4% in fiscal 2026 compared to 6.5% in fiscal 2025. The real GDP growth is projected to be 6.7% for fiscal 2027. Growth projection is slightly higher than the pre-pandemic decadal trend rate of 6.6% is expected to be supported by healthy consumption, supportive monetary policy, low crude oil prices and mild pick up in private investment.

Private consumption has witnessed a slight moderation, but it continues to remain robust, driven by several supportive factors. These includes tax relief measures, recent rate cuts by RBI, substantial direct benefit transfers and the positive impact of low inflation. Moreover, healthy monsoon is expected to support the agriculture sector and rural incomes. Robust agricultural production on the back of the favourable monsoon will help keep food inflation in check, which will free up household budgets for discretionary spending.

India's GDP growth trend and outlook



Note: FY26E- E Estimated P – projected

Source: National Statistical Office (NSO), IMF, Crisil Intelligence estimates

After strong GDP growth in the fiscals 2023-2025, GDP growth is estimated to remain steady at 6.5% in fiscal 2026, however given the risks in global turmoil. GDP growth hit a five-quarter high of 7.8% in the first quarter of fiscal 2026, up from 7.4% in fiscal 2025 for the same period. The nominal GDP growth slowed down to 8.8% in the first quarter of fiscal 2026 from 10.8% in the fourth quarter of fiscal 2025. As inflation eased and borrowing costs decreased, it gave significant boost to consumer spending. Domestic private consumption growth strengthened despite a high base effect, boosting both manufacturing and services. Higher government spending in the first quarter contributed to a sharp rise in government consumption expenditure and healthy fixed investment growth. Export growth was fueled by the front-loading of goods exported in anticipation of higher US tariffs. On the supply side, gross value added (GVA) rose to 7.6% in the first quarter of fiscal 2026 from 6.8% in the fourth quarter of fiscal 2025. Services and manufacturing saw a significant rise in growth. A lower deflator benefited both these sectors. Growth in mining, construction and electricity slowed due to an early onset of the southwest monsoon. Agriculture growth softened compared to the previous quarter but stayed at its quarterly decadal trend.

Crisil Intelligence estimates GDP growth to remain steady at 6.5% in fiscal 2026 with downside risks. The tariff moves and shifting global supply chains will keep domestic private corporate sector investment cautious in the fiscal 2026. However, tailwinds are expected to support growth in India. A healthy monsoon, benign inflation, the Reserve Bank of India's (RBI) rate cuts, and tax relief by government are expected to strengthen domestic consumer demand.

CRISIL Intelligence expects the GDP growth momentum to continue over the long-term horizon and projects the economy to clock a CAGR of 6-7% between fiscals 2026 and 2031.

India to remain a global outperformer

India's growth is expected to outperform other emerging and advance economies in the medium run. Its steady growth momentum will be accelerated by resilient domestic demand, with rural consumption gaining momentum, rise in urban spending and private investment increasing at a faster rate. We expect GDP growth to average 6-7% between fiscals 2026 and 2031, compared with 3.3% globally as estimated by the IMF. By fiscal 2030, India is projected to become the world's third-largest economy with a projected GDP of US\$7.3 trillion.

Key factors impacting the business environment:

- Strong domestic demand is expected to drive India's growth over peer economies in the medium term
- Investment prospects are considered optimistic, given the government's capital expenditure (capex) push, the progress of the Production Linked Incentive (PLI) scheme, healthier corporate balance sheets and a well-capitalised banking sector, with low non-performing assets
- The government's future capex is expected to be supported by tax buoyancy, simplified tax structures with lower rates, reassessment of the tariff structures and digitalisation of the tax filing process
- The medium-term growth is anticipated to be bolstered by increased capital spending on infrastructure and asset development projects, thereby translating into enhanced growth multipliers

Key highlights of Union Budget Fiscal 2026-27

- The government plans to significantly ramp up public capital expenditure, aiming to reach Rs. 12.2 lakh crore by the fiscal 2027. This substantial increase in public investment is expected to drive growth, create jobs, and improve the country's infrastructure.
- The revised tax slabs as well as increased tax rebate limit under the new tax regime, announced during the previous budget, have been maintained, continuing to support middle class consumption.
- The agriculture sector contributes significantly to rural economy, employing 55% of the population. The Union Budget 2026-27 focuses on four pillars for strengthening agriculture, enhancing productivity, improving quality, building climate resilience and supporting sustained farmer income.
- To encourage private sector participation in infrastructure development, the government will establish an Infrastructure Risk Guarantee Fund. This fund will provide a safety net for private developers, mitigating risks associated with infrastructure projects during the development and construction phases.
- India Semiconductor Mission (ISM) 2.0- A new initiative to boost semiconductor production, focusing on equipment and materials, design, and supply chain development.
- The Electronics Components Manufacturing Scheme outlay increased to Rs. 40,000 crore.
- Dedicated Rare Earth Corridors to be established in Odisha, Kerala, Andhra Pradesh and Tamil Nadu to promote mining, processing, research and manufacturing.

- The Ministry of Road Transport and Highways is expected to receive the highest capex allocation (Rs 2.9 lakh crore) followed by the Ministry of Railways (Rs 2.8 lakh crore), rising 8.1% (vs 4.7% in fiscal 2025) and 10.3% (vs 0% in fiscal 2025) respectively, next fiscal, reflecting continued commitment to create infrastructure. The two ministries are cumulatively expected to have a 46.3.% share in capex fiscal 2026.
- The Self-Reliant India Fund will receive an additional allocation of Rs. 2,000 crore. This fund will continue to provide vital support to micro-enterprises, ensuring they have access to the risk capital needed to sustain and grow their businesses.

Trend in inflation

Inflation based on the Consumer Price Index (CPI) averaged 2.5% in the Apr-Dec period of fiscal 2026, closer to the lower end of the RBI's target range of 2-6%. Inflation (CPI) inched up to 1.3% in December 2025 compared to 0.7% in November 2025.

CPI averaged 0.8% in the third quarter of fiscal 2026 compared with 1.7% in the previous quarter, staying below the RBI's target range for second consecutive quarter. Low food prices and goods and service tax (GST) rate cuts led to the broad-based softness in inflation in December 2025. Core inflation continued to be driven by the sustained surge in gold and silver prices. Within this, goods recorded lower inflation than services, as former benefitted more from the GST cuts.

The food and beverages category remained in deflation for the fourth consecutive month as of December 2025. However, the decline narrowed (-1.8% in December 2025 vs -2.8% in November 2025), given that the base effect is beginning to fade, particularly for vegetables and pulses. Sequentially, prices gained momentum. Food prices rose 0.8% m-o-m on a seasonally adjusted basis. The deflation in vegetables, pulses and spices narrowed while inflation accelerated for eggs, meat and fish, milk and sugar. That said, falling inflation in cereals, edible oils, and prepared meals, snacks and sweets capped the rise in food inflation.

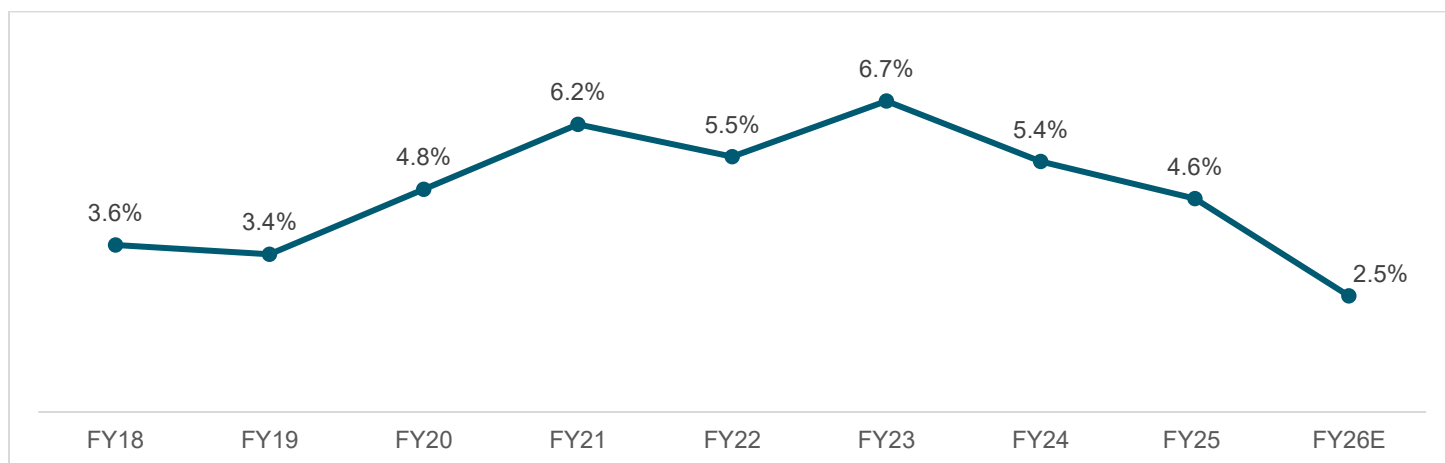
GST cuts helped ease the prices of packaged food items, driving down inflation in prepared meals, snacks and sweets (3.5% in December 2025 vs 3.7% in November 2025). Non-alcoholic beverages fell as well (2.4% in December 2025 vs 2.9% in November 2025).

Core inflation excluding gold saw lower inflation of 2.2% averaged compared with services (3.1%). GST cuts have benefited goods more than services. Most of the items saw falling inflation in December 2025. Transport and communication saw the lowest inflation (0.8% in December 2025 vs 0.9% in November 2025) benefitting from lower crude prices.

Overall, it appears that most household items such as FMCG and clothing and footwear, large electronics and automobiles saw quicker pass-through of the GST benefits. FMCG inflation softened to 2.7% in December 2025 from 3% in November 2025, clothing and footwear (1.4% in December 2025 vs 1.5% in November 2025), large electronics saw deflation to -2.7% from -2.5%.

Inflation picked up in the non-food category (1.2% in December 2025 vs 0.7% in November 2025) as the pace of price rise accelerated in the primary non-foods category (2.9% in December 2025 vs 2.3% in November 2025) and manufactured products, excluding food (2.0% in December 2025 vs 1.5% in November 2025).

CPI trendline



E- Estimated

Source: Ministry of Statistics and Programme Implementation (MOSPI), RBI, CRISIL Intelligence

Inflation based on wholesale Price Index (WPI) inflation contracted by 1.2% in October 2025 from 0.1% in September 2025, driven by a decline in the prices of primary articles and easing inflation in manufactured products. The WPI inflation rate for fuel and power deflation stayed steady.

Within the primary articles category, deflation in crude petroleum and natural gas -7.5% in October 2025 (vs -3.8% in September 2025) widened due to deeper deflation in crude petroleum prices -13.6% in October 2025 (vs 7.4% in September 2025). Domestic wholesale crude oil prices have been declining since August 2024, in line with the on-year decline in Brent prices.

Meanwhile, deflation in the fuel and power segment was steady in October 2025(-2.6% vs -2.6%). Within this, deflation eased in mineral oils (-2.2% vs -3.6%) but widened in electricity (-5.8% vs -1.3%), even as coal prices remained unchanged (0.4%).

The WPI for manufactured goods, which accounts for approximately one third of the overall WPI basket, eased to 1.5% in October 2025 from 2.3% in September 2025.

CRISIL WPI input-output ratio remained unchanged at 0.95 in October 2025 as there was month on month decline in both input (by 0.5%) and output prices (by 2.0%). Lower input prices were driven by declining wheat, energy inputs (specifically crude petroleum and natural gas) and manufacturing of non-metallic mineral products. Lower output prices reflected a decline in food output (vegetables and fruits) and automobile and motorcycle manufacturing.

Outlook on inflation

CPI inflation has been low in the first half of fiscal 2026, averaging 2.2%. A sharper than expected fall in food inflation, expectations of healthy food supplies for the rest of the fiscal, benign global crude prices and the GST rate cut on mass consumption items have all contributed. CRISIL Intelligence expects CPI inflation to be an average of 2.5% in fiscal 2026 significantly lower than 4.6% in fiscal 2025.

While monsoon pattern seems identical to fiscal 2025 (above-normal at 8% above long period average), there was greater incidence of excess rains in major kharif crop-producing states in fiscal 2026. This could affect incoming Kharif arrivals from October 2025, though food prices remain in check so far. Nevertheless, adequate reservoir and groundwater levels bode well for rabi output. Inflation is expected to remain benign on the back of low crude prices (expected at \$62-67 per barrel in

fiscal 2026). The Goods and Services Tax (GST) rationalization will have a one-off softening impact on retail prices, though it will depend on the speed of the pass-through.

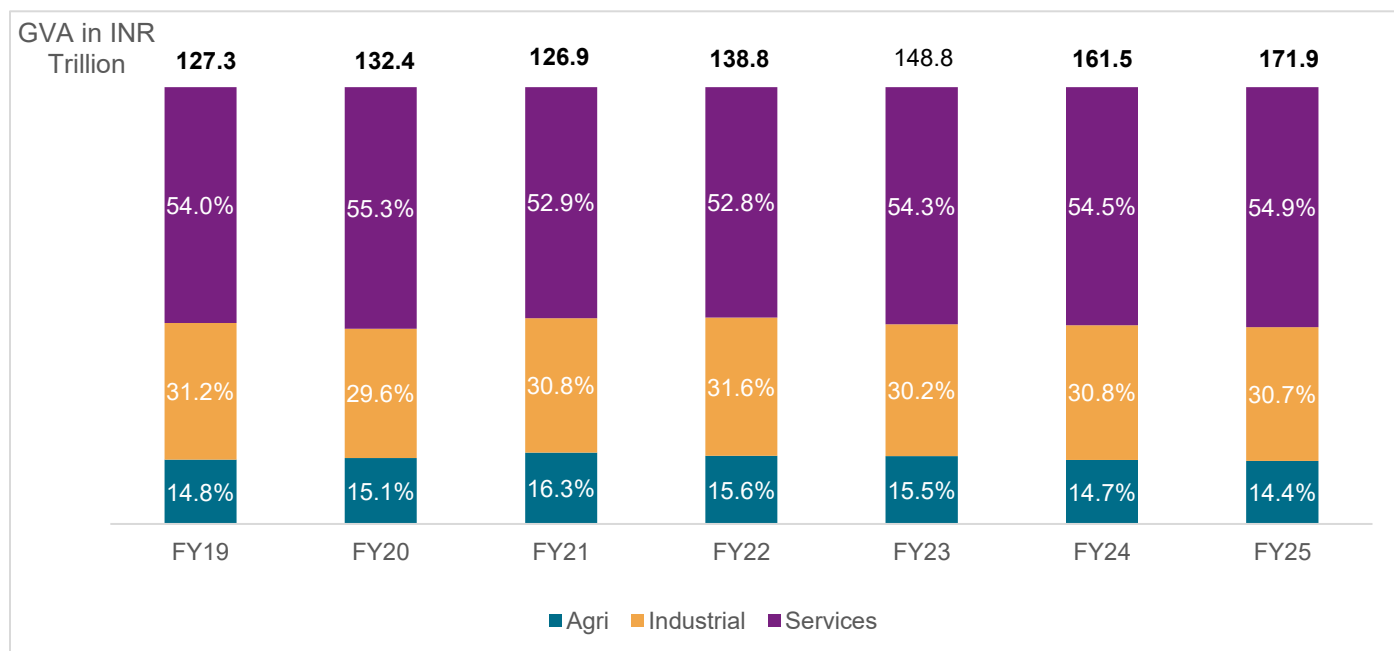
The low inflation environment is expected to provide space for monetary easing. CRISIL Intelligence expects the RBI to cut rates by another 25-bps in CY2025.

Review of key factors impacting the Business environment

India transition to the world's fourth largest economy and fastest growing among major economies has been on the back of services, industry and agriculture sectors thriving. In fiscal 2020, the service sector accounted for 55.3% share of India's GVA vs 54.0% in fiscal 2019. However, in fiscal 2021, its share had dipped to 52.9%, owing to the onset of the pandemic. The pandemic and subsequent lockdown adversely impacted the economy in fiscal 2021. The agriculture GVA (gross value added) at constant prices expanded during the fiscal 2021, while the services and industrial sectors GVA contracted. In fiscal 2022, agriculture GVA rose by 4.6% and the industrial sector by 12.2%, from the low base of fiscal 2021, whereas the service sector grew 9.2%. This primarily supported a 9.4% rise in total GVA in fiscal 2022.

Agriculture GVA continued to grow at 6.3% in fiscal 2023. The industrial sector grew at a relatively moderate pace of 2.5% in fiscal 2023 contracting its share in total GVA, Services which clocked the fastest 10.3% y-o-y growth during the year, saw its share expanding. Trade, hotels, transport, and communication services (THTC) saw strong year-on-year growth of 12% in fiscal 2023

Share of sector in GVA at constant prices



Source: RBI; CRISIL Intelligence

The Agri sector witnessed a growth of 2.7% year-on-year in fiscal 2024, thereby contributing to 14.7% of the GVA. The services sector provided a thrust to the economy with 11% growth and 54.5% GVA share while the industry sector maintained its share.

GVA growth was 6.4% in fiscal 2025 compared with 8.6% in fiscal 2024 led by slowing growth in industry- 5.9% in fiscal 2025 compared to 10.8% in previous fiscal year. Services which contributed ~55% in total GVA in fiscal 2025 grew by 7.2%

compared to 9.0% in fiscal 2024. However, growth in agriculture picked up 4.6% in fiscal 2025 compared to 2.7% in the previous fiscal year. Higher growth in agriculture and allied activities was driven by healthy kharif output and increase in Rabi crop acreage.

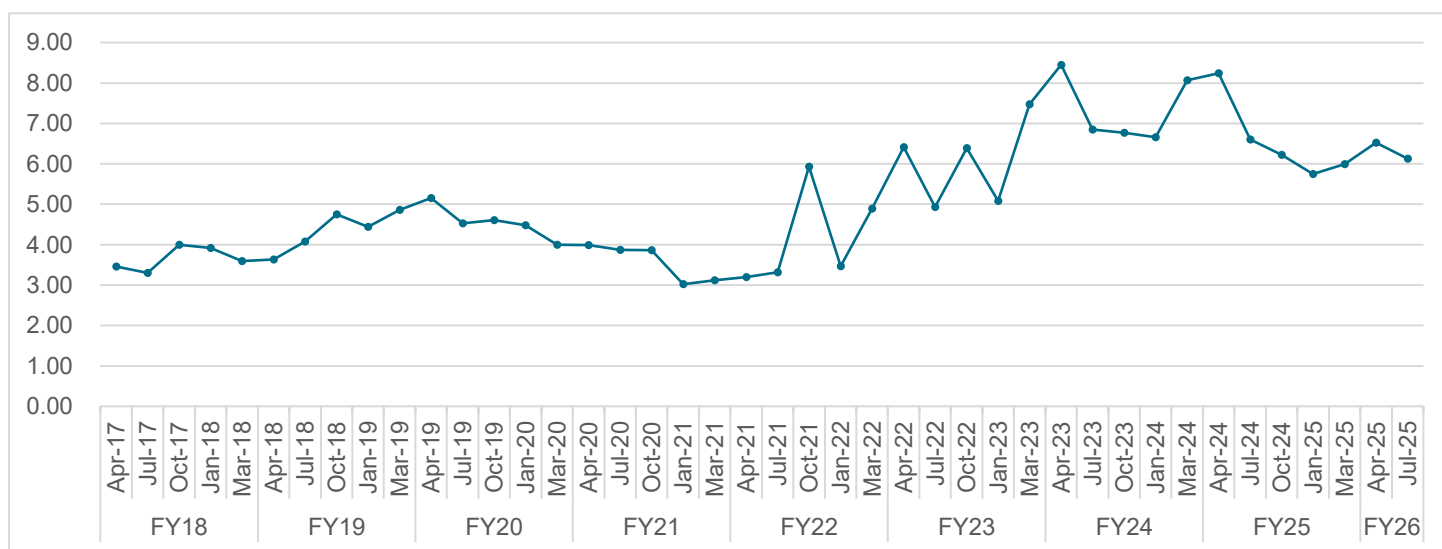
Among the major producing sectors, the highest growth in fiscal 2025 was construction services, at 9.4% year-on-year. Public administration and defense services grew at a healthy pace of 8.9% during fiscal 2025.

The global trend shift towards more protectionist policies, the budget faces an additional challenge of supporting sectors impacted by the tariff-induced situation and accelerating economic reforms to enhance India's growth potential and mitigate external risks.

Electricity market prices in India

Power demand is closely linked to GDP growth where historically power consumption largely follows economic cycles. In fiscal 2025, power demand surged 4.2% on year to 1,695 billion units (BU). This growth comes on the back of three consecutive high growth years starting fiscal 2022 leading to an addition of 315 BU over the period. In fiscal 2026, Crisil Intelligence estimates power demand to increase by 1-3% on year to 1,710-1,730 BU. India's installed generation capacity, which stood at 382 GW at the end of fiscal 2021 reached 475 GW in fiscal 2025 on the back of healthy renewable capacity additions (including solar, wind, hybrid, and other renewable sources). In fiscal 2026, Crisil Intelligence estimates renewable energy to account for 37-42% of the installed capacity, up from 25% in fiscal 2021, whereas coal-based capacity is expected to have tapered to 38-43% over the same period from 53% in fiscal 2021. Renewable capacity is projected to be 470-480 GW in fiscal 2031 on the back of strong renewable capacity additions over fiscals 2026-31. According to CERC by fiscal 2031, RE capacity is projected to account for 50-55% of the installed capacity of 885-895 GW. As the country shifts its focus away from fossil generation, coal's share in installed capacity is projected to decline to 25-30% by fiscal 2031 from 40-45% in fiscal 2026.

Monthly Weighted Average Prices of traded power (Rs/ KWh):



Source: Central Electricity Regulatory Commission (CERC), Crisil Intelligence

The all-India average cost of supply increased from Rs 3.40/kWh in 2008-09 to Rs 7.24/kWh in 2023-24. According to Central Electricity Regulatory Commission (CERC), the electricity tariffs charged by the DISCOMs are not cost-reflective for various reasons. These tariffs for residential and agricultural consumers are subsidized by overcharging industrial and

commercial users. The DISCOMs sell electricity below cost or provide for free/subsidized rates for agriculture and domestic consumers.

Impact of GDP on Industrial Gases Segment

The industrial gases industry in India, which includes the production and distribution of oxygen, nitrogen, hydrogen, argon and carbon dioxide, is closely aligned with trends in GDP, particularly growth driven by the manufacturing sector. As the economy expands, industrial production across sectors such as steel, metals, chemicals, fertilizers, automotive, electronics and engineering typically rises, leading to higher consumption of industrial gases that are integral to production processes. These gases are widely used in applications such as combustion, cutting and welding, inerting, blanketing, heat treatment and various chemical synthesis processes.

Manufacturing-intensive sectors such as steel and non-ferrous metals are significant consumers of oxygen and nitrogen for smelting and refining operations, and their expansion is often associated with broader economic growth. Similarly, increased activity in chemicals, oil and gas, and pharmaceuticals supports demand for hydrogen and specialty gases used in processing, purification and research applications. Economic growth also tends to encourage fresh capital investment and capacity additions in manufacturing, which can result in new on-site gas installations and long-term supply arrangements. Thus, the growth of industrial gas industry is directly related to the GDP growth. The rising industrial output as indicated by the growing GDP and manufacturing GVA drives the demand for industrial gas across sectors, since the industrial gases are primarily inputs in production across manufacturing value chains.

Over the past five years (Fiscals 2021-2025), the industrial gases sector in India has grown at an average rate nearly twice (~2x) that of the country's GDP. GDP influences the industrial gases segment primarily by changing manufacturing output and investment appetite. In the short term, GDP-driven manufacturing swings alter volumes and utilization levels. In the medium term, GDP expectations shape industrial capex, which determines the pipeline of high-value onsite gas projects and long-lived infrastructure investments. Thus, sustained GDP growth, particularly when supported by industrial and manufacturing expansion, supports stable and scalable demand for the industrial gases segment.

Review of the Index of Industrial Production (IIP)

Growth in the Index of Industrial Production (IIP) accelerated for the second straight month to a 26-month high of 7.8% on-year in December 2025, compared with an upwardly revised 7.2% in November 2025, driven by robust consumer demand. Domestic consumption benefitted from Goods and Services Tax (GST) rationalisation, while export-oriented sectors took a hit from United States (US) tariffs.

On a sectoral basis, mining and electricity were drivers of higher IIP growth in December 2025, while manufacturing growth moderated a tad within manufacturing, GST rationalisation benefitted sectors such as food products and automobiles, but export-oriented sectors such as wearing apparel and textiles saw IIP growth moderate.

As per the use-based classification, growth was driven by primary goods and the consumer sectors. Primary goods output growth saw the sharpest growth compared to November 2025 within the industrial and investment sectors. Growth in mining hit an 18-month high of 6.8% in December 2025 vs 5.8% in November 2025. Electricity growth turned positive after two months of degrowth (6.3% vs -1.5%). Core sector data indicates electricity production rose 5.3% in December 2025, compared with a decline of 1.5% in November 2025. Growth in coke and refined petroleum products, an export-oriented sector, turned negative (-0.4% vs 0.4%)

Infrastructure and construction goods continued to clock double-digit growth, though slower than the previous month. While growth accelerated in basic metals (12.7% vs 11.3%), it softened in non-metallic mineral products (12% vs 12.7%). Softer

growth in capital goods was led by fabricated metal products (8.1% vs 11.6%), while growth in machinery and equipment was largely stable (7.5% vs 7.6%)

The weakness in export-oriented sectors is in line with the trade data released by the Ministry of Commerce and Industry. In December 2025, India's merchandise exports rose a mere 1.9% on-year

Cumulatively, the consumer sectors (consumer durables and consumer non-durables) saw growth accelerate to 9.8% in December 2025 from 9.3% in November 2025.

Impact of key events on India's Manufacturing sector

Increased focus on foreign trade agreement

India is actively negotiating and reviewing bilateral trade agreements with major global economies to boost its trade prospects.

India signed a trade and economic partnership agreement with the European Free Trade Association (EFTA) on March 10, 2024, and the India-UAE bilateral investment treaty came into effect on August 31, 2024. It is also in the process of reviewing its 2009 trade agreement with the Association of Southeast Asian Nations (ASEAN) to make it more equitable and aligned with current economic realities.

India and the UK signed a landmark FTA in July 2025 to improve bilateral trade and investment flows. The agreement is expected to double trade between the two nations—currently valued ~USD 60 billion—by 2030. Under the deal, India will gain near-complete duty-free access for its exports to the UK, especially in key sectors, such as textiles, gems and jewellery, engineering goods and processed foods. In return, the UK will benefit from phased tariff reductions on high-value goods such as automobiles, Scotch whisky, medical devices and premium food products. The FTA also introduces streamlined customs procedures and a special mobility pathway for Indian professionals.

Beyond goods trade, the agreement includes provisions on digital trade, services, intellectual property and government procurement. A key highlight is the social security pact that exempts Indian professionals from double contributions for up to three years, benefiting around 75,000 workers. The deal is also aligned with sustainability and ESG goals, featuring cooperation on clean energy and green technology. The India-UK FTA is a strategic milestone that strengthens India's trade diversification strategy, complements the supply chain diversification trend and reinforces its position in global supply chains.

India -EU (European Union) Free Trade Agreement (FTA)

The India-EU FTA, also known as the Broad-based Trade and Investment Agreement (BTIA), aims to liberalise trade in goods, services and investment between India and the 27-member European Union. The negotiations were launched in CY2007, but progress was slow due to various challenges and disagreements.

On 17th June 2022, the European Union relaunched negotiations with India for FTA. The negotiations for the India-EU FTA have made significant progress and concluded on 27th January 2026. The FTA covers 25% of global GDP and targets to double bilateral trade to USD 250 billion within a decade. The trade deal will potentially support the manufacturing and service sectors between India and the EU. Reduction of over 90% of tariffs is expected to double EU goods exports to India.

The India-EU FTA is expected to have a notable impact on trade and investment between the two regions. According to Industry estimates, the agreement could increase bilateral trade by up to 20% and attract significant investment into India. Overall, the India-EU FTA has the potential to be a game-changer for trade and investment between the two regions.

United States (US)-India Bilateral Trade Agreement

US and India announced framework for an interim trade agreement in February 2026, affirming countries' commitment to the broader U.S.-India Bilateral Trade Agreement (BTA) negotiations launched in February 2025, which will include additional market access commitments and support more resilient supply chains.

The Interim agreement between the US and India showcase a common commitment to reciprocal and balanced trade based on mutual interest and concrete outcomes.

Under this interim agreement, India will eliminate or reduce tariffs on all U.S. industrial goods and a wide range of U.S. food and agricultural products.

India intends to purchase \$500 billion of U.S. energy products, aircraft and aircraft parts, precious metals, technology products, and coking coal over the next 5 years. India and the United States will significantly increase trade in technology products, including Graphics Processing Units (GPUs) and other goods used in data centres, and expand joint technology cooperation.

The US will apply a reciprocal tariff rate of 18% on originating goods of India, including textile and apparel, leather and footwear, plastic and rubber, organic chemicals, home décor, artisanal products, and certain machinery, and, subject to the successful conclusion of the Interim Agreement, will remove the reciprocal tariff on a wide range of goods including generic pharmaceuticals, gems and diamonds, and aircraft parts. India will also receive a preferential tariff rate quota for automotive parts.

The United States and India agree to strengthen economic security alignment to enhance supply chain resilience and innovation through complementary actions to address non-market policies of third parties, as well as cooperation on inbound and outbound investment reviews and export controls.

India-UK Free Trade Agreement (FTA)

- The India-UK FTA is more of a medium to long-term opportunity: India UK signed a comprehensive economic and trade agreement (CETA) on July 24, 2025. The FTA deal aims to significantly boost trade by removing tariffs and lowering barriers for many goods and services.
- The FTA opens trade opportunities for domestic companies in manufacturing and service sector. With the agreement potentially having multiplier effect on exports over the long run.
- The total goods and services trade between the UK and India was over \$45 billion in 2024, with India's exports to the UK at ~\$28 billion and imports from the UK at ~\$18 billion.
- Other key commodities benefiting from this immediate duty-free access are products of plant and animal origin, marine products and a wide range of chemicals.
- The UK has granted access to nearly 99% of Indian goods, with 80% of the goods covered duty-free from the day of implementation. Goods such as textiles, food and jewellery will become duty free.
- India will lower tariffs on 90% of UK's goods including medical devices and automobiles

India is a competitive market, and it is growing steadily as a supplier to the UK, although it accounts for only ~2% share of UK imports at present. With the lowered/ eliminated tariff duty by the UK under the CETA, India is expected to become far more competitive in the UK market especially compared to other Asian countries.

Overview of Government policies and trends

Lowering supply chain dependency on China

India including other nations are actively pursuing strategies to reduce supply chain dependency on China in the wake of pandemic and growing geo-political tensions.

This includes diversifying the supply chain by sourcing inputs from various countries with a goal of reducing the risk of relying on a single country. Furthermore, India is also trying to strengthen the domestic manufacturing environment through various policy initiatives. Key strategies adopted by India to diversify the supply chain includes:

Foreign investments: India is attracting multi-national companies those who are actively seeking to diversify their manufacturing bases away from China. Government is aiding these companies in terms of tax benefits and incentive schemes. India has also published new policies on FDI to attract investments from various countries across sectors.

- **Domestic manufacturing:** Government is pushing domestic companies to develop products locally and bring certain level of localization in the products, thereby reduce dependence on China. This involves introduction of initiatives and schemes like Make in India, Atmanirbhar Bharat, China plus one, PMP and PLI.
- **Trade diversification:** India is actively engaging in trade pacts and FTAs to diversify its trade partners. Strengthening trade ties with developing and developed economies offers alternatives to sourcing goods and technology.

To reduce the dependency on China and prepare for potential future supply chain challenges, 14 nations under the Indo-Pacific Economic Framework (IPEF), including the United States, Japan, and India, have reached an agreement aimed at augmenting supply chain resilience and diversification. The agreement involves sharing information with each other and coordinating responses during the time of crises. Under the agreement, the participating countries would establish an IPEF supply chain council, supply chain crisis response network, and labor rights advisory network that will provide a framework to strengthen supply chains and prevent potential disruptions.

Driven by geopolitical shifts and rising tariffs, several MNCs are investing heavily in India to diversify production and build it as an export base,

- Apple now manufactures about ~14% of its iPhones in India, aiming 26% within a few years, via partners like Foxconn and Tata electronics.
- Walmart has boosted sourcing from India across categories like toys, apparel and electronics.
- Vietnam based Vinfast has planned to invest Rs 4,000 crore in the next 5 years and have started construction of their EV manufacturing facility in Tamil Nadu.

Together, these points highlight India's growing strength as a global manufacturing and export hub.

Atmanirbhar Bharat Campaign

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

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

PLI scheme provides boosts to industrial investments in the short-to-medium term.

The PLI scheme's primary objective is to make manufacturing in India globally competitive by removing sectoral obstacles, creating economies of scale and ensuring efficiency. It is designed to create a complete component ecosystem in India and make the country an integral part of the global supply chain. The PLI scheme is a time-bound incentive scheme by the government which rewards companies in the 5-15% range of their annual revenue based on the companies meeting pre-decided targets for incremental production and/or exports and capex over a base year. The stronger-than-expected pick-up

in demand and larger companies gaining share over smaller companies led to revival of capex in fiscal 2022. The rise in fiscal 2024 was on account of the expansion plans underway by India Inc.

PLI scheme provides boost to industrial investments in the short-to-medium term. The PLI scheme aims to make India's manufacturing globally competitive by removing sectoral obstacles and creating economies of scale. The scheme, implemented from 2022 to 2029, has already shown significant results:

- ~Rs 2 lakh crore in realised investments across 14 sectors as of September-2025
- Rs 18.7 lakh crore in revenue generated
- ~12.6 lakh jobs created directly and indirectly

The scheme provides time-bound incentives to companies, rewarding them 5-15% of their annual revenue for achieving pre-decided targets for production, exports and capital expenditure. The scheme has led to a revival in capital expenditure and is expected to boost economic growth and create more employment opportunities.

The automobile and auto component sector saw a sharp increase in the allocation in the past few years—from Rs 2.63 crore in fiscal 2024 to Rs 346.87 crore in fiscal 2025 to Rs 2,818.85 crore for fiscal 2026.

The Union budget 2026-27 increased the PLI scheme allocation for automobile and auto component to Rs 5,939.87 crore, a major rise from the revised 2025-26 estimates of Rs 2,091.26 crore. This surge supports 82 approved applicants in accelerating manufacturing and advanced automotive technology (AAT) and EVs.

Budgeted incentives for each sector under the PLI scheme

Sector	Segment	FY26 Revised Estimates (RE) (Rs crore)	FY27 Budget Estimates (BE) (Rs crore)
Electronics	Electronic manufacturing and hardware	6,960	1,345
Pharma	Pharmaceuticals	2,300	2,250
Automobile	Advance chemistry cell (ACC) battery	13	86
	Automobiles and auto components	2,091	5,940
Textile	Textile	400	405
White goods	Air conditioners and LED lights	304	1004
Steel	Specialty steel	193	380

Source: PIB, budget documents, Crisil Intelligence

PLI Auto scheme promotes manufacturing of advanced automotive technology vehicles and components. It attracted Rs 35,657 crore in investment and created 48,974 jobs till September 2025.

Key drivers for economic growth

Robust growth keeps policy rates on pause

The repo rate cuts by the Monetary Policy Committee (MPC) of the Reserve Bank of India (RBI), have supported lower interest rates in the economy. The MPC has kept rates unchanged at 5.50% for the repo rate, maintaining a 'neutral' stance.

- GDP growth surpassed expectations at 7.8% in the first quarter of fiscal 2026 leading to an upward revision of growth projection to 6.8% for fiscal 2026. Meanwhile, the MPC has lowered its inflation forecast to 2.6%, citing faster than expected declines driven by GST cuts. The committee noted potential downside risks to GDP growth in the latter half of fiscal 2026 due to US tariffs on Indian exports, although GST rationalization may mitigate some impacts.
- The MPC also acknowledged that GDP growth would face more downside risks in the second half of fiscal 2026 due to US tariffs on Indian exports, though the rationalization of GST will partially offset the overall impact.
- The MPC revised its inflation forecast based on the Consumer Price Index (CPI) downwards by 50 basis points (bps) to 2.6% for fiscal 2026, with risks evenly balanced. The committee revised its forecast for real GDP growth upwards by 30 bps to 6.8% for this fiscal, viewing risks as evenly balanced

Spending on roads to remain elevated

The road's capex growth to normalize to 6% CAGR between fiscal 2024-26. The progress of national highways in India has been remarkable over the past decade, with significant growth in terms of length and infrastructure development.

- The length of national highways has increased 60% from 91,287 km in 2014 to 1,46,195 km as of March 2026. This expansion demonstrates the government's efforts to improve the transportation network.
- Furthermore, the development of four-lane and above national highways has multiplied more than 2.5-fold to ~48,000 km.
- The government has announced plans to develop 20,000 km of high-speed corridors (HSCs) over the next 5-6 years. It aims to establish a 50,000 km-long HSC network by 2040.
- Annual national highway construction data reveals the share of four-lane, and more highways have increased steadily, from 28% in fiscal 2019 to 44% in fiscal 2025, while the share of two-lane highways has decreased from 56% to 36%. This trend indicates more focus on developing broader highways.

The Pradhan Mantri Gramin Sadak Yojana (PMGSY), a long-running rural road construction program initiated in 2000, aims to provide all-weather road connectivity to unconnected habitations.

To date, a total of 7.97 lakh kilometers of roads have been sanctioned under the scheme. Building on this momentum, Phase IV of PMGSY was sanctioned in September 2024, with an ambitious plan to construct 62,500 kilometers of new roads at a total investment of Rs 70,125 crore, further expanding rural road connectivity and bridging the infrastructure gap in rural areas.

India boasts the highest population of young people

- The global population of youth (generally between 15 and 24 years), which stood at 1.3 billion in 2024, is projected to continue to grow slowly, reaching a peak of 1.4 billion in the early 2030s as per world population prospects 2024.
- In around 75% of countries and areas in this group, the share of the population at working ages (between 20 and 64 years) will continue to increase more rapidly than the total population over the next 30 years, providing an opportunity for accelerated economic growth on a per capita basis.

- According to the United Nation Population Fund (UNFPA's) State of World Population Report 2024 the worldwide population recorded 8.11 billion in 2024. Out of the world's total population, 25% is between 0-14 years, 65% is between the ages of 15 and 64 years, which is considered the working population of a country, and 10% above 65 years. Apart from this, about 11% of the population is between 10-19 years of age, and 17% are between 10-24 years (Generation Z). People under the age of 25 account for more than 40% of the population as of CY2024.
- For developed regions, the working population age between 15-64 accounts 64% while in less developed region it contributes around 65% and least developed region contributes 58% in CY2024. The working population in Asia pacific region is around 68%.
- In Asian countries, India surpasses China by a slight margin at 1.44 billion in CY2024 and becomes the most populous country in the world. 24% of India's total population is between 0-14 years, 68% is between the ages of 15 and 64 years, which is considered the working population of a country, and 7% above 65 years. Apart from this, about 17% of the population is between 10-19 years of age, and 18% are between 10-24 years. People aged under 25 year account for 40% of the population.
- China, which recorded 1.42 billion population in CY2024. 16% of China's total population is between 0-14 years, 69% is between the ages of 15 and 64 years, which is considered the working population of a country, and 14% above 65 years. Apart from this, about 12% of the population is between 10-19 years of age, and 26% are between 10-24 years. People aged under 25 accounts 30% of the population.
- Similarly, 11% of Japan's total population is between 0-14 years, 58% is between the ages of 15 and 64 years, which is considered the working population of a country, and 30% above 65 years. Apart from this, about 9% of the population is between 10-19 years of age, and 13% are between 10-24 years. People aged under 25 years account for 22% of the population. The median age for Japan is nearly 49 years. The median age for United Kingdom is 40 years and the median age for United State is 38 years.
- India's median age is about 28 years, and it has largest working population among major global economies. It is expected to add ~70 million to the workforce (15-64 age group) by 2030. This benefit allows greater engagement in productive labour, thus bolstering national income. India's youthful demographic not only strengthens the country's competitive edge in the services and manufacturing sectors but also unlocks the spending potential of a young population towards discretionary expenses. The working/young population has significantly impacted India's growth in the past few years majorly in the IT, manufacturing, and service sectors. This is in line with past progress of economies like Japan and China where the young population has fueled economic development. India's young population is embracing new technologies and ideas which is expected to further boost the industries like technology, manufacturing, healthcare, and infrastructure.

Review and outlook of Global Industrial Gases Industry

Introduction to industrial gases

Industrial gases comprise high-purity chemical elements and compounds that are manufactured through air separation, reforming, purification, compression, and/or liquefaction processes, and supplied to industrial, medical, and commercial end users. These gases function as process inputs, reaction feedstocks, protective/inert atmospheres, and energy vectors, and are therefore integral to the operation of critical value chains spanning healthcare, refining, metals, food processing, and electronics manufacturing. In parallel, industrial gases are material to industrial decarbonisation pathways, including the deployment of low-carbon hydrogen, oxygen-enhanced combustion to improve thermal efficiency and reduce emissions, and the facilitation of carbon capture solutions, particularly in hard-to-abate sectors such as steel, cement, glass, and waste treatment.

Below are the major industrial gases and their applications

Industrial Gas	Major industries/applications
Oxygen	Steel, healthcare, manufacturing, chemical, pharmaceutical, paper & pulp, oil & gas, etc.
Nitrogen	Chemicals, oil & gas, food & beverage, steel and other metal manufacturing, electrical and electronics, mining, pharmaceutical, etc.
Hydrogen	Chemicals, oil & gas, steel, power industry, glass etc.
Argon	Electrical & electronics, steel, healthcare, automotive, aerospace, chemicals, etc
Carbon dioxide (CO ₂)	Beverage carbonation, modified-atmosphere packaging, pH control/water treatment uses etc
Helium	Cryogenics and cooling (e.g., superconducting systems), leak detection, specialty manufacturing, and controlled atmospheres

Review and outlook for global industrial gases market

The global industrial gases market is undergoing robust expansion, propelled by escalating demand across a diverse array of end-use sectors, including manufacturing, healthcare, and energy. This growth is primarily attributed to the increasing utilization of industrial gases in applications such as welding, cutting, metal fabrication, inerting, and chemical synthesis. Additionally, the rise in urbanization and the growing participation of women in the workforce are contributing to heightened demand for industrial gases within the food and beverage sector, particularly as the consumption of ready-to-cook, confectionery, and frozen food products continues to rise.

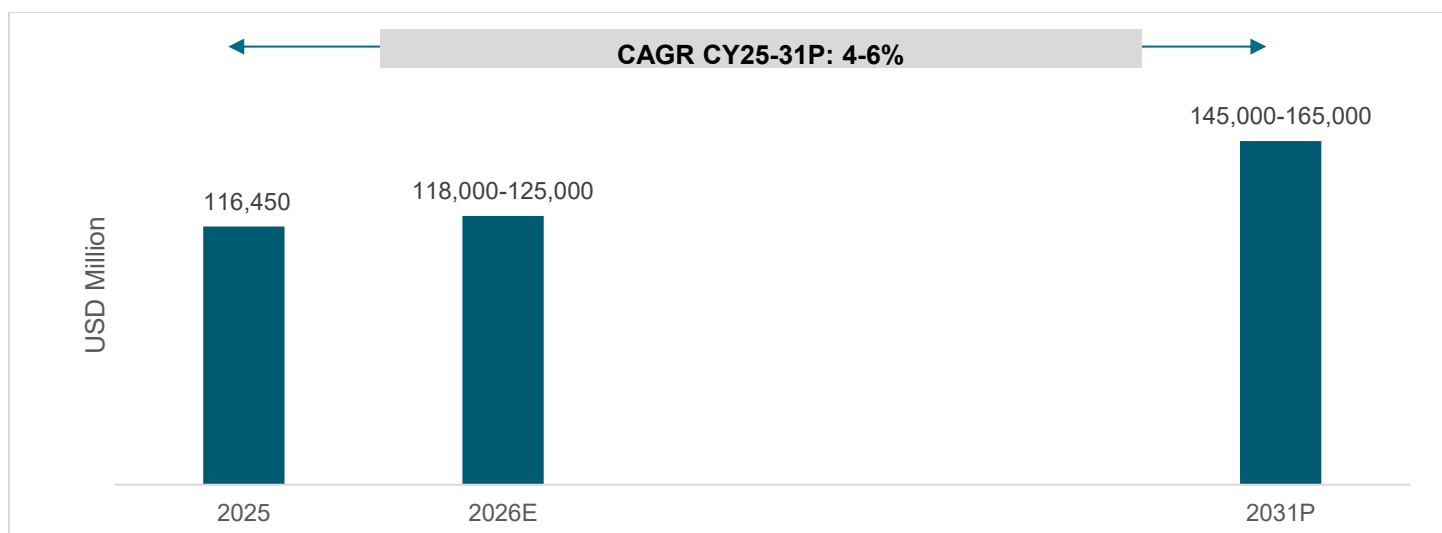
The market is also witnessing a notable shift toward the adoption of specialty gases, which are essential for high-technology applications in industries such as electronics, pharmaceuticals, and biotechnology. Market expansion is further supported by the ongoing scaling of global manufacturing capacities, sustained infrastructure development, and the increasing complexity of industrial processes that necessitate higher gas purity, stricter specification controls, and reliable supply

continuity. Technological advancements, including the development of more efficient gas production and distribution systems, are also playing a significant role in supporting market growth.

In the electronics and advanced manufacturing sectors, the continued expansion of semiconductor, display, and photovoltaic supply chains is driving demand for ultra-high-purity gases and specialty chemicals, which are critical for processes such as etching, deposition, and maintaining controlled-atmosphere environments where even minimal contamination can adversely affect production yields. In the chemicals and energy sectors, the demand for hydrogen and other process gases is increasing in line with refining requirements, petrochemical production, and gradual investments in lower-carbon technologies, while carbon dioxide continues to be widely used in food processing, packaging, and various industrial applications.

At the micro level, market performance is influenced by capacity planning, plant reliability, contract structures, logistics efficiency, and the energy intensity of operations. Since production is capital intensive and often energy dependent, fluctuations in input costs and unplanned supply interruptions can materially impact profitability. The ability of suppliers to manage long term contracts, optimize asset utilization, and ensure localized production close to end users has become increasingly critical, particularly as customers demand higher reliability, shorter lead times, and cost stability in an environment of tightening margins. At the macro level, the market is shaped by global economic conditions, geopolitical stability, and regulatory and environmental policies. Ongoing wars and geopolitical tensions in the Middle East, Eastern Europe, and other strategically important regions have contributed to volatility in energy prices, disruptions in global trade routes, and uncertainty in industrial investment decisions. These conflicts, along with sanctions and shifting trade alliances, directly affect production economics and cross border supply chains.

Global Industrial Gases Market Size, CY25-31P (By value)



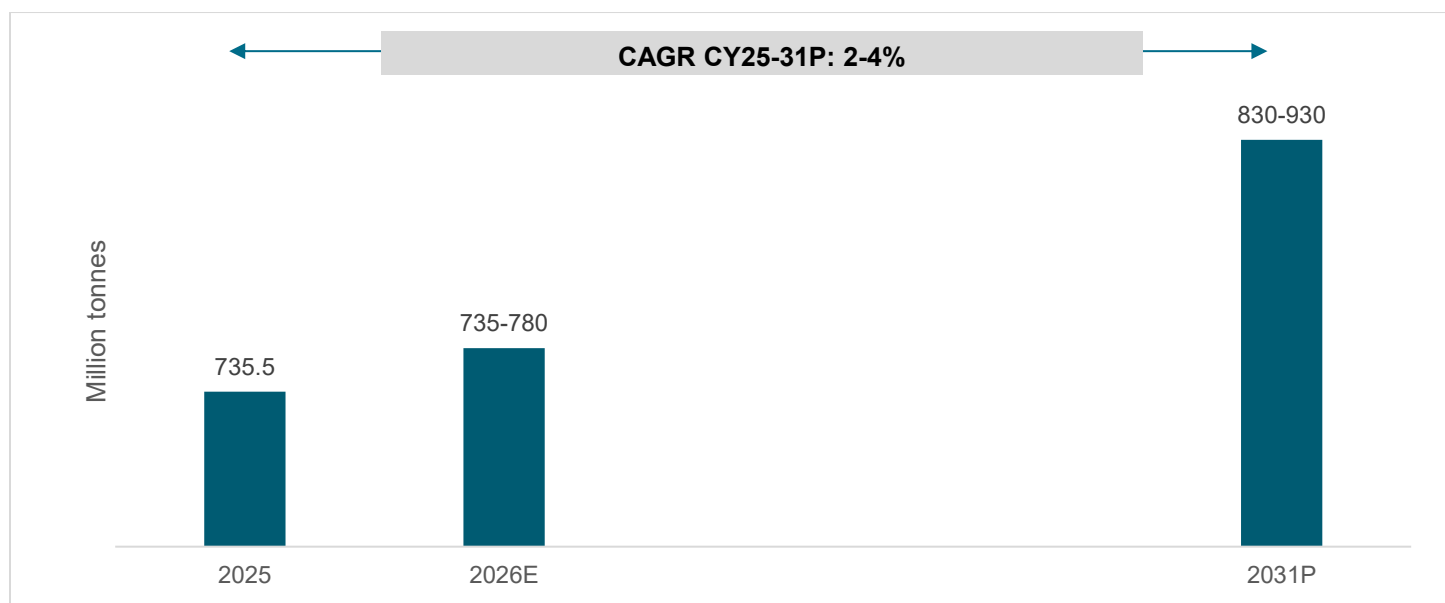
Note: This study covers the industrial-gases market, which includes all gases produced and supplied for industrial, manufacturing, medical, scientific, and welding uses. Further, revenue derived from design, supply, installation, and commissioning of large air-separation units (ASUs) or projects for nitrogen plants, PSA plants, and gas distribution/storage systems are not included in this market sizing

Source: Nexdigm

In terms of growth prospects, the market is projected to grow with a CAGR of 4-6% between CY2025 and CY2031. This growth will be supported by strong end-use industries and capacity augmentation by leading gas suppliers. Demand for industrial gases is expected to rise from USD 116,450 million in CY2025 to USD 145,000-165,000 million by CY2031, driven primarily by the steel, chemical, healthcare, and electronics sectors. Sustained industrial activity driven by the growing demand from rising sectors including the data centers, aerospace and CCUS are expected to drive the market further. Overall, the global industrial gases market is well-positioned for sustained, broad-based growth, driven by ongoing industrial

expansion, rising technical standards, and the growing indispensability of gases in high-value manufacturing and essential services. Although the rate of growth may fluctuate by region and industry cycle, the long-term outlook remains positive, supported by persistent demand from healthcare and electronics, continued urban and industrial development, and the ongoing modernization of energy and chemical value chains.

Global Industrial Gases Market Size, CY25-31P (By volume)



Source: Nexdigm

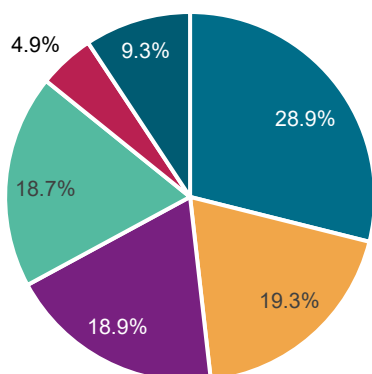
Volume growth remained steady and predictable, reflecting the non-discretionary nature of consumption, while value growth exhibited greater sensitivity to energy costs, inflation, and contract pricing dynamics. Overall, the market outlook through 2031 remains resilient and fundamentals driven. While volume growth is expected to remain steady and closely correlated with global industrial production, value growth is likely to accelerate due to improved pricing discipline, long-term contractual structures, and greater emphasis on supply reliability amid geopolitical and energy market uncertainty. These factors position the global industrial gases market for sustained and stable expansion through the end of the decade.

Market split by gas type

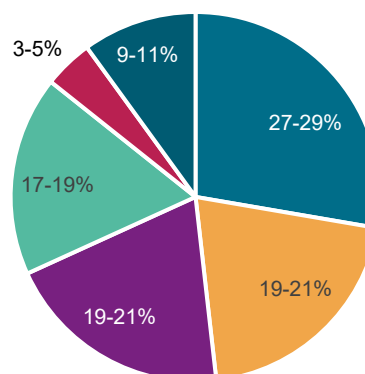
The global industrial gases market is a diverse and dynamic industry, comprising a wide range of gases used across multiple end-use sectors including steel, refining, chemicals, healthcare, electronics, food processing, and energy. Nitrogen, hydrogen, oxygen, and carbon dioxide together account for nearly 86% of total market value, indicating a strong concentration in high-volume, process-integrated gases, while specialty and niche gases contribute the remaining share through higher value-added applications.

Market split by Gas Type (CY2025 – CY2031P) – by value

CY2025



CY3031 P



■ Nitrogen ■ Hydrogen ■ Oxygen ■ Carbon Dioxide ■ Argon ■ Other gases - Methane, Ammonia, Acetylene, & other rare gases

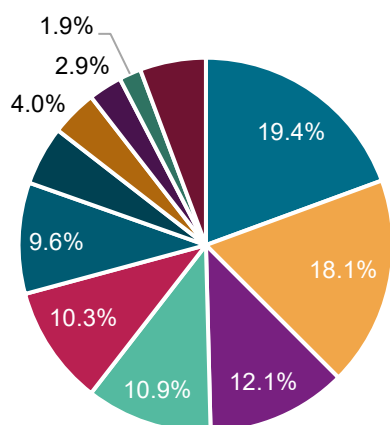
Source: Nexdigm

Market split by application

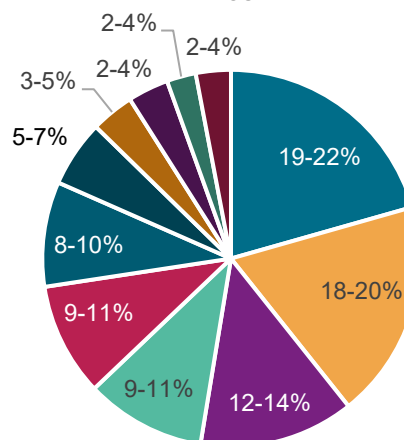
The global industrial gases market is diversified across a wide range of end-user industries, with bulk demand primarily driven by iron & steel, oil refining, chemicals, and healthcare. These sectors rely heavily on oxygen, nitrogen, hydrogen, and argon for core production processes. Manufacturing-led industries, healthcare, and advanced technology sectors further contribute to overall demand, enhancing diversification and long-term growth visibility.

Market split by application type (CY2025 – CY2031P) – by value

CY2025



CY2031P



- Chemicals
- Oil and Gas
- Electrical and Electronics
- Aerospace and Defence
- Steel and Other Metal Manufacturing
- Manufacturing
- Infrastructure
- Others
- Healthcare
- Food and Beverage
- Pharmaceuticals

Source: Nexdigm

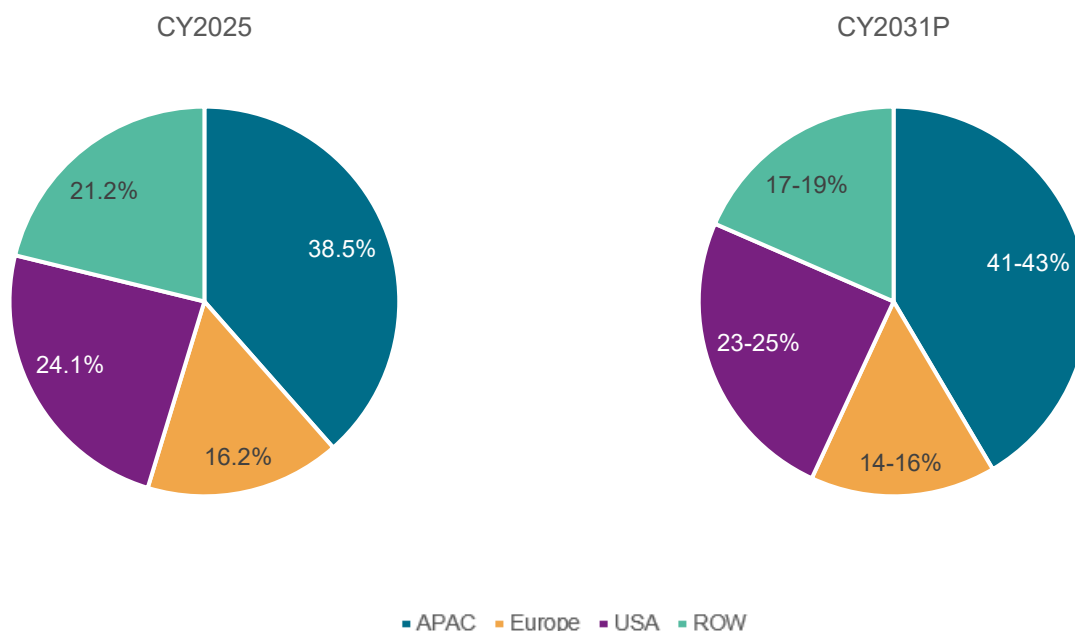
- **Chemicals:** The chemicals and petrochemicals industry accounts for 19.4% of global industrial gas value in CY2025. Hydrogen is widely used as a feedstock in ammonia and methanol production, oxygen supports oxidation reactions and process efficiency, and nitrogen is applied for inerting reactors and storage systems to maintain safety.
- **Steel and other metal manufacturing:** The iron and steel industry accounts for 18.1% of global industrial gas value in CY2025, given the intensity of gas usage across primary and secondary steelmaking processes. Oxygen is extensively used in blast furnaces and basic oxygen furnaces to remove impurities and improve combustion efficiency. Nitrogen and argon are applied in purging, inerting, and secondary refining to enhance metallurgical quality and homogeneity.
- **Healthcare:** The healthcare sector accounts for 12.1% of global industrial gas value in CY2025, driven by medical oxygen used in respiratory therapy and intensive care. Nitrous oxide and carbon dioxide are used in anesthesia and minimally invasive surgical procedures. This segment requires strict quality control and uninterrupted supply infrastructure.
- **Oil and gas:** The oil and gas sector contributes 10.9% of global industrial gas value in CY2025, primarily driven by hydrogen consumption in hydrotreating, hydrocracking, and desulfurization processes to meet stringent fuel standards. Nitrogen supports blanketing and purging operations for safety, while oxygen is used in regeneration and combustion applications.
- **Manufacturing:** The manufacturing sector accounts for 10.3% of the global industrial gas value in CY2025, benefits from automation, reshoring of industrial production, and growth in fabrication-intensive industries.
- **Food and beverages:** The Food and beverages sector accounts for 9.6% of the global industrial gas value in CY2025, the industry continues to expand alongside global packaged food production and cold chain investments, particularly in emerging markets.
- **Electrical and electronics:** The segment is being driven by major semiconductor fabrication projects, where high-purity gases are critical for chip manufacturing and assembly. Governments are actively supporting these investments through subsidy programs and localization initiatives, strengthening long-term demand.
- Infrastructure-related investments reflect expansion of onsite air separation units, hydrogen production facilities, storage terminals, and pipeline networks supporting large industrial corridors and energy transition hubs.

Overall, the 2025 application mix highlights a market that is not only diversified but increasingly investment led. Global capital expenditure in refining, chemicals, semiconductors, green hydrogen, steel modernization, and healthcare infrastructure is strengthening long-term contracted supply models. This project-driven demand base enhances revenue visibility and reinforces the industrial gases market's resilience across economic cycles.

Market split by geography

The global industrial gases market in 2025 demonstrates a well-balanced geographic distribution, reflecting the alignment of gas demand with industrial production intensity, energy infrastructure, and capital investment cycles. Asia-Pacific (APAC) accounts for 38.5% of global market value at USD 44.8 billion, Europe contributes 16.2% at USD 18.9 billion, USA (dominant region in the Americas) contributes 24.1% at USD 28.1 billion while the Rest of the World (ROW) collectively represents the a share at 21.2% or USD 24.7 billion. This distribution underscores the industry's dual dependence on high-growth emerging economies and mature, capital-intensive industrial markets.

Market Split by Key Geographies (CY2025-CY2031P) – by value:



Source: Nexdigm

Asia Pacific: APAC is the fastest-growing regional market, driven by rapid industrialization, urban development, and expanding manufacturing value chains. China and India anchor incremental demand through steel, chemicals, refining, construction-linked fabrication, and increasingly through electronics and specialty gas consumption. Across North Asia and Southeast Asia, the build-out of semiconductor, display, and photovoltaic ecosystems is a major catalyst for ultra-high-purity and specialty gases, where suppliers compete on purity assurance, supply redundancy, and localized production capabilities. India and Southeast Asia are emerging as high-growth pockets due to infrastructure development, new refinery projects, and semiconductor manufacturing investments. The region is also central to global energy transition investments, including hydrogen hubs, battery manufacturing facilities, and advanced materials production. APAC's growth profile is also shaped by aggressive capacity additions in basic materials and chemicals, creating sustained need for oxygen, nitrogen, argon, and hydrogen.

USA: The USA (major market in Americas) represent a mature, high-value industrial gases market characterized by entrenched large-volume customers and a strong shift toward on-site supply models (e.g., air separation units and hydrogen plants) serving refining, chemicals, metals, and large manufacturing sites. In the United States, demand is supported by healthcare oxygen requirements, resilient packaged-gas consumption across general manufacturing, and continued investments tied to electronics manufacturing expansion and broader industrial modernization. The region also shows increasing emphasis on hydrogen and decarbonization-linked projects (e.g., refinery optimization, low-carbon hydrogen pilots, and carbon management initiatives), which can translate into new long-term supply contracts.

Europe: Europe is a technically advanced but underpinned by stringent environmental and safety requirements and a high installed base of industrial gas infrastructure. Demand is concentrated in healthcare, chemicals, food and beverage, metals, and advanced manufacturing, with increasing pull from high-purity applications in pharmaceuticals, laboratories, and electronics. Regional dynamics are strongly influenced by energy-price volatility and decarbonization policy, which affect operating economics for energy-intensive production assets such as air separation units and hydrogen facilities. As a result, suppliers are prioritizing efficiency upgrades, network optimization, and long-term contracting strategies. Europe is also an important region for low-carbon hydrogen development, where policy support and industrial clusters are shaping new project pipelines, although permitting timelines, power pricing, and offtake certainty remain key determinants of execution speed. According to European Industrial Gases Association (EIGA) Production of industrial gases in the EU is heavily concentrated in a few countries. Germany is the largest producer for nearly all major gases followed by France, which is a key player in nitrogen and rare gases. Italy, Belgium and the Netherlands, which contribute significantly to nitrogen, oxygen, hydrogen, and carbon dioxide output. Spain and Poland are also relevant producers, particularly for carbon dioxide and rare gases.

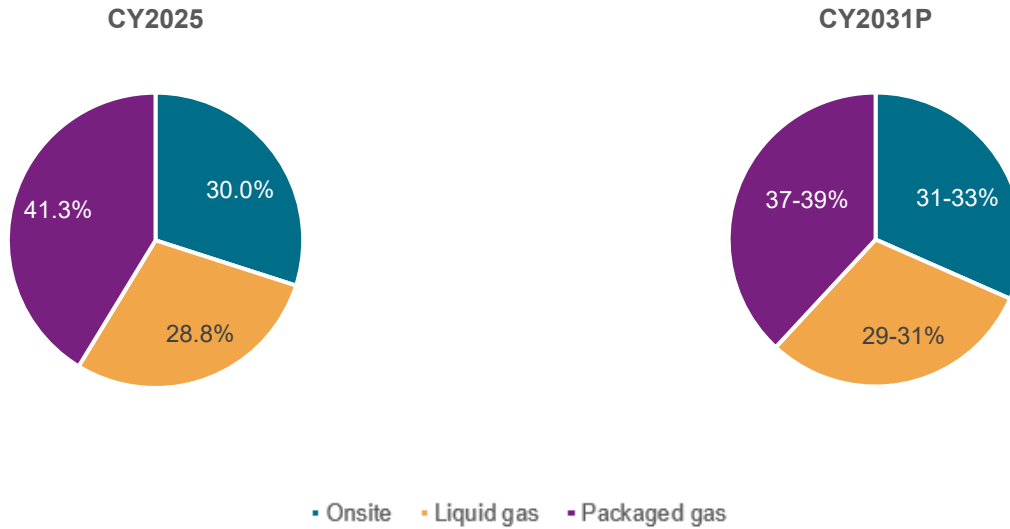
Rest of the World: RoW—comprising the Middle East, Africa, Latin America, and parts of world—presents a highly diverse opportunity set. The Middle East is anchored by large-scale refining, petrochemicals, and metals projects, supporting sizable demand for oxygen, nitrogen, and hydrogen, often structured around mega on-site plants and long-term supply agreements. In Africa, growth is generally tied to mining, healthcare capacity buildout, and industrialization in selected hubs, but market development can be constrained by logistics complexity, infrastructure gaps, and reliance on cylinder distribution for smaller customers. Latin America is comparatively more cyclical, with growth linked to mining, metals, energy projects, and infrastructure development, and it often relies more heavily on merchant liquid and packaged distribution outside major industrial corridors. Other RoW markets vary widely in maturity, with demand shaped by local industrial policy, energy availability, import dependence for equipment and specialty gases, and the pace of investment in manufacturing and healthcare systems.

Overall, the regional split highlights a structurally diversified global market. APAC drives volume-led growth, Europe advances value-led transformation through sustainability initiatives, and ROW anchors demand through energy and capital-intensive industrial investments. This geographic balance enhances resilience and provides multiple growth levers for the global industrial gases industry through the remainder of the decade.

Market split by businesses

The global industrial gases market can be segmented based on the nature of the business model into On-site (Build-Own-Operate or BOO), Liquid Gases (Merchant), and Packaged Gases. Each segment differs in terms of capital intensity, customer profile, revenue visibility, logistics complexity, and margin structure.

Market Split by businesses (CY2025-CY2031P) – by value:



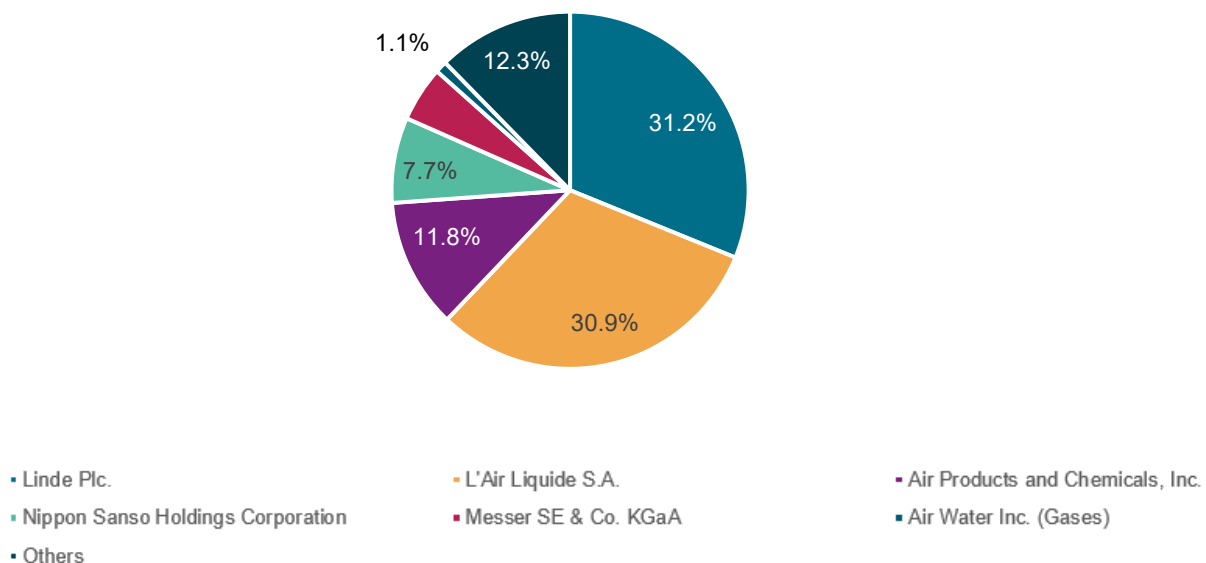
Source: Nexdigm

Global Competitive Landscape

Globally, the leading manufacturers of industrial gases are Linde, Air Liquide, Air Products, Taiyo Nippon Sanso, Messer, Air Water, etc. A few major businesses dominate a consolidated market owing to the industry's high capital requirements, substantial technological competence, and stringent regulatory standards.

The global industrial gases market in CY2025 remains highly consolidated at the top, with Linde plc, L'Air Liquide S.A. and Air Products jointly commanding ~74% of total global market share. This dominance reflects their scale advantage, technological leadership, diversified geographic presence, and long-term onsite contract portfolios that create high entry barriers. These companies benefit from strong pricing discipline, integrated pipeline ecosystems, and multi-decade customer relationships across major industrial clusters worldwide.

Market Split by Industry Players, CY2025:



Source: Nexdigm

Linde Plc., holding 31.2% of the global market in CY2025, maintains its leadership through disciplined capital allocation and a strong portfolio of large onsite and pipeline projects. L’Air Liquide S.A., with a closely matched 30.9% share, benefits from its balanced exposure across Europe, North America, and Asia-Pacific, along with strong innovation capabilities. Air Products and Chemicals, Inc., accounting for 11.8% of the global market, has the greatest proportion of total sales in the on-site mode of supply, extensive pipeline networks in key industrial clusters globally, and higher proportion of total sales to electronics/semiconductor applications. Nippon Sanso Holdings Corporation, with a 7.7% market share, leverages strong capabilities in electronics-related and high-purity gas segments, supported by its footprint across Japan, Southeast Asia, and North America.

Messer SE & Co. KGaA, holding 5.0%, has strengthened its global standing following major asset acquisitions and regional capacity expansions in Europe, the Americas, and Asia. Air Water Inc. (Gases segment), with 1.1% share, maintains a strong domestic base in Japan while selectively expanding overseas.

The remaining 12.3% of the global industrial gases market is distributed among a fragmented group of regional and mid-sized players operating across China, India, the Middle East, Europe, and the Americas. Notable contributors include Yingde Gases, Hangzhou Oxygen (Hangyang), Inox Air Products, Gulf Cryo, SOL Group, and Airgas. These players typically compete through localized production assets, merchant distribution networks, engineering capabilities, and regional industrial integration. While individually smaller than global majors, collectively they form a significant competitive layer, particularly in fast-growing emerging markets and specialized industrial clusters.

Overall, the competitive landscape reflects a structurally concentrated market with competition driven by technological capability, execution track record, customer relationships, and global operating scale.

Key Growth Drivers

Rising Global Industrial Energy Consumption

Industry remains the largest energy consuming sector globally. According to the International Energy Agency, industry accounted for approximately 37% of total global final energy consumption in 2022. Energy intensive sectors such as steel, chemicals, refining, cement, and manufacturing rely heavily on industrial gases for combustion, processing, inerting, and chemical reactions. This structural energy demand directly supports long term gas consumption. Global crude steel production reached about 1.9 billion tonnes in 2023 according to the World Steel Association. Steelmaking requires significant oxygen usage in basic oxygen furnaces. Similarly, refining capacity continues to expand in Asia and the Middle East, supporting hydrogen demand for hydrocracking and desulfurization. Sustained industrial output therefore creates a stable base for global gas demand growth.

Expansion of Hydrogen and Energy Transition Investments

Hydrogen is central to global decarbonization strategies. The International Energy Agency reports that global hydrogen demand reached approximately 95 Mn tonnes in 2022, primarily used in refining and ammonia production. Governments worldwide have announced more than 50 national hydrogen strategies, reflecting long term policy commitment toward low carbon hydrogen production.

The IEA further indicates that low emissions hydrogen production capacity could increase multiple times by 2030 from projects already announced or under construction, although some face delays. Countries such as Germany, the United States, Japan, and Saudi Arabia are investing billions of dollars in hydrogen hubs, electrolyzers, and carbon capture infrastructure. These investments directly expand industrial gas production and distribution infrastructure globally.

Semiconductor and Electronics Manufacturing Growth

High purity gases are essential for semiconductor fabrication. According to the Semiconductor Industry Association, global semiconductor sales reached approximately USD 627.6 billion in 2024. Each fabrication facility requires ultra high purity nitrogen, hydrogen, and specialty gases under tightly controlled conditions, supporting long term onsite supply contracts.

Government supported manufacturing programs are accelerating this growth. The United States CHIPS and Science Act allocate over USD 50 billion to boost domestic semiconductor manufacturing. The European Union has also launched the European Chips Act to strengthen regional chip production.¹¹ New fabrication plants across the United States, Taiwan, South Korea, Japan, and Europe create sustained demand for specialty and bulk industrial gases.

Growing Healthcare Infrastructure and Medical Oxygen Demand

Medical gases remain a structurally resilient demand segment. The World Health Organization estimates that during the COVID 19 pandemic, global oxygen demand in low- and middle-income countries increased more than five-fold at peak periods. This led to significant investment in oxygen generation plants and hospital pipeline systems.

Healthcare spending continues to rise globally. According to the World Bank, global health expenditure represents roughly 10% of global GDP. Aging populations in Europe, Japan, and North America and expanding healthcare access in Asia and Africa support long term demand for medical oxygen, nitrous oxide, and other healthcare related gases.

Review and outlook of Indian Industrial Gases Industry

Overview of Industrial Gases

Industrial gases are a vital component of modern manufacturing. These gases play a crucial role in various applications across multiple sectors, including manufacturing, healthcare, energy, food, and beverages, and automotive. These gases are utilized in diverse forms, such as pure gases, gas mixtures, and liquid gases, depending on specific requirements. The industry encompasses a range of gases, including oxygen, nitrogen, argon, carbon dioxide, and hydrogen, which are employed in numerous industrial applications, including welding and metal cutting, chemical synthesis, refining, food processing, and packaging. The industrial gas industry has experienced significant growth, driven by technological advancements and the development of new applications. The sector comprises bulk gases (oxygen, nitrogen, hydrogen, argon, and carbon dioxide) and high-purity and specialty gases like helium, argon, etc for precision applications, such as semiconductors, pharmaceuticals, and laboratory research. The Indian industrial gases industry plays a critical role in supporting various end-use sectors, including metal manufacturing, oil and gas, electronics, healthcare and pharmaceuticals, chemicals, and food and beverage processing.

The demand for industrial gases is closely tied to macroeconomic indicators, including manufacturing output, infrastructure growth, energy consumption, and regulatory standards. The healthcare industry has witnessed a structural increase in oxygen consumption since 2020, driven by enhancements in medical infrastructure. The food and beverages sector utilizes substantial volumes of carbon dioxide and nitrogen for carbonation, freezing, modified-atmosphere packaging, and quality preservation. Furthermore, hydrogen, nitrogen, and oxygen serve as raw materials for chemical producers in the manufacture of ammonia, methanol, ethylene oxide, and refinery desulfurization. The climate transition has driven investments in green hydrogen, solar cells for renewable energy, carbon capture using carbon dioxide, and next-generation air separation units (ASUs) with reduced energy consumption. The expansion of the semiconductor and electronics industries, driven by artificial intelligence (AI), 5G, electric vehicles (EVs), and advanced chip fabrication, has accelerated global demand for high-purity gases and rare gases, such as neon, xenon, and krypton. Important initiatives like the National Oxygen Supply Program and the Pradhan Mantri Jan Arogya Yojana (PMJAY) have aided in the establishment of new oxygen plants, the renovation of existing facilities, and the promotion of investment and involvement from the private sector.

Industrial gases have evolved from being commodity inputs to strategic enablers of clean energy transitions, advanced manufacturing ecosystems, and resilient healthcare systems. With rapid industrialization in India, increasing global decarbonization commitments, and growing specialty gas requirements, the sector is poised for sustained long-term growth, driven by both traditional industries and emerging technological demand. The Indian industrial gases industry is closely linked to the country's GDP growth, which drives higher demand across end-use segments and encourages increased investment and technological innovation. Consequently, overall economic expansion acts as a key catalyst for the sustained growth and development of the country's industrial gases sector.

Furthermore, the sector serves as an essential, always-on input across sectors that must maintain continuous operations. This structural demand profile makes the industry fundamentally non-cyclical and baseline consumption remains anchored to safety requirements and regulated continuity of supply that cannot be deferred. The other defining characteristic of industrial gases is their complete lack of substitutes. Oxygen is indispensable for combustion, metallurgy, and medical therapy; nitrogen prevents fires and product degradation through inerting; argon is essential for welding and specialty metallurgy and CO₂ plays irreplaceable roles in carbonation, refrigeration, and processing. The lack of alternatives creates a demand characterized by exceptional resilience and immunity to competitive displacement or technological substitution. The sector is also fundamentally insulated from AI disruption although AI may optimize efficiency in value chain.

Compared to regional and subscale players, national-level industrial gas suppliers with dense production and distribution networks are structurally better positioned to control transportation costs, maintain high service reliability and support customers operating across multiple locations, creating a sustained competitive advantage.

Industrial Gases Supply

Industrial gases are distributed either as compressed or liquefied products, with the choice of transport method—cylinders, bulk road or rail tankers, ISO tank containers, or pipelines—depending largely on the required volume and distance to the end user. Compressed gases are stored in high-pressure steel or composite cylinders and tube trailers, typically at pressures more than 100 bar, and are delivered by road. For liquefied and cryogenic gases such as liquid oxygen, nitrogen, argon, carbon dioxide, and LNG, insulated, vacuum-jacketed tankers and portable tanks are used to maintain extremely low temperatures and keep the gases in liquid form. Adherence to strict safety standards, such as India's PESO regulations, is critical to prevent leaks, fires, or contamination.

Pipelines: For industrial clusters with large, steady demand, gases like oxygen, nitrogen, hydrogen, and synthesis gas are supplied directly from central production facilities to users via dedicated pipeline networks. While pipeline infrastructure requires significant upfront investment, it provides reliable, cost-effective long-term supply, making it ideal for large-scale consumers such as petrochemical plants, refineries, and steel or chemical manufacturing facilities. On-site production is also typically supported by short pipeline delivery.

On-site Generation: Another major supply method involves installing dedicated gas generation plants at the customer's location. This approach, often under a build-own-operate (BOO) model, allows continuous, on-demand production and direct delivery of gases like oxygen, nitrogen, argon, or hydrogen via short pipelines. It is particularly suited for large, consistent users in sectors such as steel, chemicals, refineries, and electronics, with the industrial gas provider responsible for plant operation and the customer supplying utilities and land.

The on-site supply model operates under long-term take-or-pay contracts, typically ranging from 10 to 20 years, providing revenue visibility and earnings stability. Contractual minimum offtake commitments support predictable cash flows and reduce volume risk. As production facilities are integrated within or adjacent to customer premises and supply is undertaken through dedicated pipelines, the model significantly reduces logistics and transportation costs. On-site arrangements generally support stable margin profiles due to embedded infrastructure and contractual pricing frameworks.

Tankers/Containers: Bulk delivery involves transporting gases in cryogenic tankers to customer sites, where they are stored in large, insulated tanks. Cylindrical tanks/containers are commonly used for regional distribution of both compressed and cryogenic gases in trucks/rails, offering flexibility for supplying multiple customers. For higher volumes and longer distances, ISO tank containers are shipped by rail or heavy trucks, enabling efficient bulk movement from production plants to distribution terminals or large clients. INOX Air Products' logistics and supply chain infrastructure includes a fleet of 739 cryogenic tankers as of March 2026, is the largest in India, enabling efficient merchant gas distribution across the country. INOX Air Products operate India's largest fleet of cryogenic tankers with 739 as of March 2026, travelling a distance of 39 million kilometers in fiscal 2026. This logistics and production infrastructure is a significant competitive advantage in the merchant business, enabling the company to serve customers efficiently and reliably across India's diverse geography. Company deployed India's first LNG fuelled cryogenic tanker for supplying cryogenic liquids, with an aim of reducing logistics emissions.

Cylinders: Smaller-scale users, such as hospitals, laboratories, and small manufacturing units, receive gases in high-pressure cylinders, typically filled at 100 to 300 bar and transported by standard delivery vehicles. For larger, but still portable, requirements, tube trailer trucks equipped with several long, high-pressure cylinders are used to deliver large quantities.

In India, the combination of containers and cylinders accounts for a significant share of industrial gas supply. For medium-to large-scale users who need large quantities but do not have the continuous demand to justify on-site generation, bulk containers and tankers offer a cost-effective solution. For specialized or smaller-scale requirements, cylinders remain popular due to their flexibility and ease of transport and storage, allowing users to avoid the capital expenditure associated with bulk storage or on-site production systems.

Gas application matrix

Sector	Key Gases Used	Application
Iron Making	Oxygen, Nitrogen	Oxygen enrichment in blast furnaces, inerting, stirring and refining, melting, heating for iron and steel
Steel Making	Oxygen, Argon, Nitrogen	Oxygen for decarburization (BOF), Argon for stirring/refining, Nitrogen for inerting, oxygen enrichment applications
Stainless Steel Making	Argon, Oxygen, Nitrogen	Argon–oxygen decarburization (AOD), refining, melting, heating for non-ferrous metals production, hot isostatic pressing
Steel Processing (Heat Treatment)	Nitrogen, Hydrogen	Atmosphere control, carburizing, nitriding, hardening, cryotreating, heat treating applications
Steel Processing (Cutting/Welding/Annealing)	Oxygen, Nitrogen, Argon, CO ₂ , Mixed gases	Annealing, cutting, gouging, laser processing, plasma cutting, welding, cladding/hardfacing
Metallurgy	Argon, Helium, Nitrogen	Powder metal atomization, plasma spraying, quenching, sintering
Semiconductors	Nitrogen, Hydrogen, Argon, WF ₆ , NF ₃ , CF ₄ , Silane	Atmosphere control, brazing, IC packaging, assembly/test, etching, cleaning
Solar PV Cells	Nitrogen, Hydrogen, Silane, Ammonia	Photovoltaic cell manufacturing
F&B – Freezing	Nitrogen, CO ₂	Cryogenic freezing, crust hardening, fermentation, pathogen intervention
F&B – Chilling	Nitrogen	Cryogenic chilling, cooling, process temperature control
F&B – Carbonation	CO ₂	Bottling/canning, carbonation, supercritical CO ₂ extraction
F&B-Others	CO ₂ , Nitrogen	Controlled atmosphere storage, inerting/blanketing, MAP packaging, sparging, pH control, whipping/aeration, wine production, hydrogenation of oils/fats
Refining & Chemicals	Hydrogen, Oxygen, Nitrogen	Hydrogenation, hydroprocessing, FCC optimization, catalyst regeneration, cryogenic separation, inerting/blanketing, sulfur removal, wastewater aeration
Clean Energy	Green Hydrogen and its derivatives	Decarbonizing power production, hydrogen fueling for automobiles
Construction	Oxygen, Nitrogen, CO ₂	Concrete pouring/setting, laser processing

Cement and Tile	Oxygen	Kiln and precalciner enrichment, oxygen enrichment applications
Additive Manufacturing (3D Printing)	Argon, Nitrogen, Helium	Atmosphere control, inerting/blanketing, wire arc additive manufacturing, cooling
Oil & Gas – Upstream	Nitrogen, CO ₂ , Helium	Enhanced oil recovery, fracturing, syngas solutions, well completions
Oil & Gas – Downstream	Hydrogen, Oxygen, Nitrogen	Hydroformylation, polymer processing, mineral wool/rockwool production
Automotive Manufacturing	Nitrogen, Argon, CO ₂	Autoclave inerting, brazing, cold spraying, cryogenic cooling, battery production/recycling
Tire Manufacturing	Nitrogen	Autoclave inerting, cryogenic deflashing, tire curing, inerting/blanketing
Healthcare	O ₂ , Nitrous Oxide, Helium, Nitric Oxide	Respiratory oxygen, cryotherapy, cryopreservation, MRI filling
Aerospace	Helium, Nitrogen, Oxygen, Hydrogen	Autoclave inerting, brazing, cold spraying, environmental/low-temp testing, rocket propellant, purging, pressurization
Electronics (Displays, LEDs)	Nitrogen, Hydrogen, Specialty gases	Atmosphere control, brazing, fiber optics, flat panel displays, LED production, inerting/blanketing
Pulp & Paper	Oxygen, CO ₂	Wastewater aeration, vessel drying
Glass Manufacturing	Oxygen, Nitrogen, Hydrogen, Silane	Melting/forming, bubbling, cutting/polishing, inerting/blanketing, heat treating
Mining & Minerals	Oxygen, Nitrogen	Ore processing, recovery, smelting
Pharmaceuticals & Biotech	Oxygen, CO ₂ , Nitrogen, Specialty gases	Cryopreservation, freeze drying, microbial growth control, hydrogenation, inerting/blanketing, packaging, NMR cooling
Agriculture (Controlled Atmospheres)	Nitrogen	Greenhouse atmosphere control, CO ₂ enrichment

Source: INOX Air Products and Crisil Intelligence

Safety and regulatory requirements

The production, storage, and transportation of industrial gases involve hazardous materials that are subject to stringent safety and regulatory frameworks.

Regulatory landscape

The industrial gases sector in India operates within a stringent regulatory framework that ensures the safe production, transportation, storage, and utilization of hazardous gases. This regulatory framework establishes a structured and controlled environment that is essential for the safe and reliable operation of industrial gas facilities.

Regulation / Act	Applicability	Coverage Area	Sustainability
Gas Cylinder Rules, 2016 (Amendment applicable,2025)	Cylinders for oxygen, nitrogen, argon, hydrogen, CO ₂ , LPG, specialty gases	Cylinder manufacturing standards, periodic testing, valve/burst disc specifications, filling limits, labelling, color coding	Ensures safe reuse, testing, and lifecycle management of cylinders, reducing accident-related environmental risks
Static and Mobile Pressure Vessels (Unfired) Rules,2016 (Amendment Rules in 2025)	Cryogenic tanks, bulk gas storage, mobile tankers	Design, fabrication, installation, testing, certification of cryogenic tanks & bulk vessels used for liquid O ₂ , N ₂ , Ar, CO ₂ , LNG, etc.	Promotes safer bulk storage and reduced leakages, minimizing environmental and safety hazards
Factories Act (Industrial safety framework,1948)	Industrial gas plants, filling stations, ASUs	Worker safety, ventilation, handling of toxic/flammable gases, emergency procedures, PPE, hazardous area classification	Enhances occupational health, accident prevention, and safer industrial operations
Manufacture, Storage & Import of Hazardous Chemicals (MSIHC) Rules,1989	Hazardous gases including hydrogen, ammonia	Identification of major accident hazards, risk assessment, on-site emergency plans, worker training	Reduces environmental damage and human exposure from accidental releases
Environmental Protection Guidelines (1986 extended and included in 2022)	Gas plants and cylinder filling units.	Air emissions, noise limits, waste disposal, environmental clearance for large ASUs or hydrogen plants	Core sustainability regulation ensuring emissions control, energy efficiency
Bureau of Indian Standards (BIS) Codes (latest 2023)	Cylinder design, valves, purity standards, industrial safety	IS standards for cylinders (IS 7285), valves (IS 3224), gas purity grades, storage and pipeline guidelines	Standardization improves safety, reduces leakages, and enhances lifecycle sustainability
Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (Amendments Rules, 2024)	ASUs and gas plants generating hazardous waste	Handling, storage, disposal, recycling of hazardous waste	Supports circular economy and prevents soil and water contamination
Carbon Credit Trading Scheme (CCTS), 2023	Large industrial gas producers (future applicability)	Carbon accounting and emission trading	Encourages decarbonization and low-carbon gas production
National Green Hydrogen Mission / Green Hydrogen Policy, 2022	Hydrogen producers, suppliers, storage and transport operators	Incentives for renewable hydrogen production and supply	Promotes clean energy transition and climate sustainability

Draft: Carbon Capture, Utilization and Storage (CCUS) Policy Framework and its Deployment Mechanism in India 2022	CCUS operators	Carbon capture across various end-use industries	Promotes carbon capture and decarbonizing the industrial sector, which is hard to electrify and hard to abate
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The robust governance framework in India plays a vital role in promoting sustainable growth in the industrial gases sector. As the demand for industrial gases continues to rise, driven by growth in manufacturing, healthcare, clean energy, and semiconductors, adherence to PESO norms, BIS standards, and environmental regulations will be crucial. These regulations not only ensure high levels of safety, environmental stewardship, and process discipline among industrial gas producers but also establish national benchmarks for gas purity, infrastructure resilience, and workforce safety. By minimizing industrial accidents and hazardous waste risks, this regulatory ecosystem enhances public safety, strengthens industry reliability, and reinforces national standards for infrastructure integrity and environmental protection.

Industry trends for the industrial gases market in India across focus end-user industries

Outsourcing of gas production and its advantages

Outsourcing of gas production refers to an arrangement where an industrial customer relies on a specialised third-party supplier to install, own, operate, and maintain gas generation facilities, instead of investing in captive production assets. In contrast, captive production involves customers setting up and operating their own air separation or gas generation units within their premises.

Historically, large end-users preferred captive production to ensure supply security and optimise costs at scale. However, a gradual shift toward outsourced models is emerging as customers seek to reduce capital expenditure and improve balance sheet efficiency.

Outsourcing gas production enables industrial customers to avoid significant upfront capital investment in gas generation infrastructure and instead convert such costs into predictable operating expenses. This supports balance sheet efficiency and allows companies to allocate capital toward core manufacturing activities rather than non-core utilities. It also transfers operational, technical, and safety responsibilities to specialised suppliers, reducing execution risk while improving plant reliability and uptime through professional maintenance. In addition, outsourced models offer flexibility to scale gas supply in line with production needs, supporting efficient capacity management and operational focus on core business functions.

Preference for reliable long-term supplier

Industrial gas supply is critical to continuous plant operations, making reliability a key purchasing criterion. Customers increasingly prefer long-term partnerships with suppliers that can ensure uninterrupted supply, consistent purity standards, and strong service support. Long-term contracts provide supply assurance, pricing visibility, and operational stability, strengthening supplier–customer relationships and reducing production risk.

Need for proximity to customer

The economics of industrial gas supply are closely linked to logistics efficiency and delivery reliability. Proximity of production facilities, storage infrastructure, or pipeline networks to customer sites reduces transportation costs, delivery lead times, and the risk of supply interruptions. For high-volume or time-sensitive applications such as steelmaking, healthcare, and electronics manufacturing, close geographic presence supports operational continuity and rapid response to demand.

fluctuations. As a result, suppliers invest in regional production hubs and distributed infrastructure to strengthen customer access and service reliability.

Gestation period for setting up a plant for industrial gases

Setting up a large industrial gas production facility, such as an air separation unit (ASU), typically involves a significant gestation period spanning detailed engineering design, regulatory clearances, civil works, equipment fabrication, installation, and commissioning. For large-scale cryogenic ASUs, which serve steel, chemicals, and other heavy industries, the construction and commissioning phase generally ranges from 18 to 30 months from groundbreaking to operational readiness, depending on project complexity and site conditions. The gestation period for a standalone merchant gas production plant typically ranges from 18 to 36 months for standard projects, though complex or large-scale projects can take longer. Smaller facilities or modular compressed gas plants may have shorter timelines, but larger cryogenic installations often require comprehensive site preparation, infrastructure integration, and extensive testing before commissioning. Given the gestation period ranging from 9 to 30 months associated with engineering, procurement, construction and commissioning for industrial gas players, there may be timing mismatches between the commissioning of facilities and the ramp-up of customer operations. Delays in downstream customer projects, deferment of industrial capacity additions or slower-than-expected growth in end-use sectors may result in temporary under-utilization of newly constructed assets.

Material dependencies for setting up an industrial gas plant and dependencies upon any other country for technology / gas etc.

The establishment of an industrial gas manufacturing plant in India is materially dependent on high-value cryogenic process equipment and select imported components, although overall localization for conventional gases is relatively high.

For air separation units (ASUs) used in oxygen, nitrogen, and argon production, the core cryogenic distillation technology, cold boxes, high-efficiency turbo-expanders, structured packing, and advanced Distributed Control Systems (DCS) are typically supplied by global OEMs such as Linde plc, Air Liquide, Air Products, and Hangyang Group. While civil works, piping, storage bullets, vaporizers, and cylinder cascades are largely fabricated domestically, India remains dependent on imports for large-capacity ASU designs, cryogenic heat exchangers, molecular sieve beds, and process automation software.

For specialty and rare gases, dependence is significantly higher. India does not have natural helium reserves and relies on imports, historically from the United States and Qatar. Neon supply is globally concentrated and has experienced disruption due to geopolitical tensions in Eastern Europe. Calibration mixtures and semiconductor-grade ultra-high purity gases often require imported purification systems and analytical instruments.

In the emerging Green Hydrogen (H₂) segment, dependency is more pronounced. Electrolysers (especially PEM and advanced alkaline systems) and fuel cell stacks are largely imported from Europe and China. Although India has launched production-linked incentive (PLI) schemes under the National Green Hydrogen Mission to localize electrolyser manufacturing, domestic capacity remains nascent, and critical components such as membranes, catalysts (e.g., iridium), and bipolar plates are import-dependent.

Overall, while conventional industrial gases (oxygen, nitrogen, argon) benefit from high domestic fabrication capability and localized Engineering, Procurement, and Construction (EPC) execution, advanced cryogenic process technology, rare gases, high-purity systems, and hydrogen electrolyser technology remain structurally reliant on foreign technology providers and global supply chains.

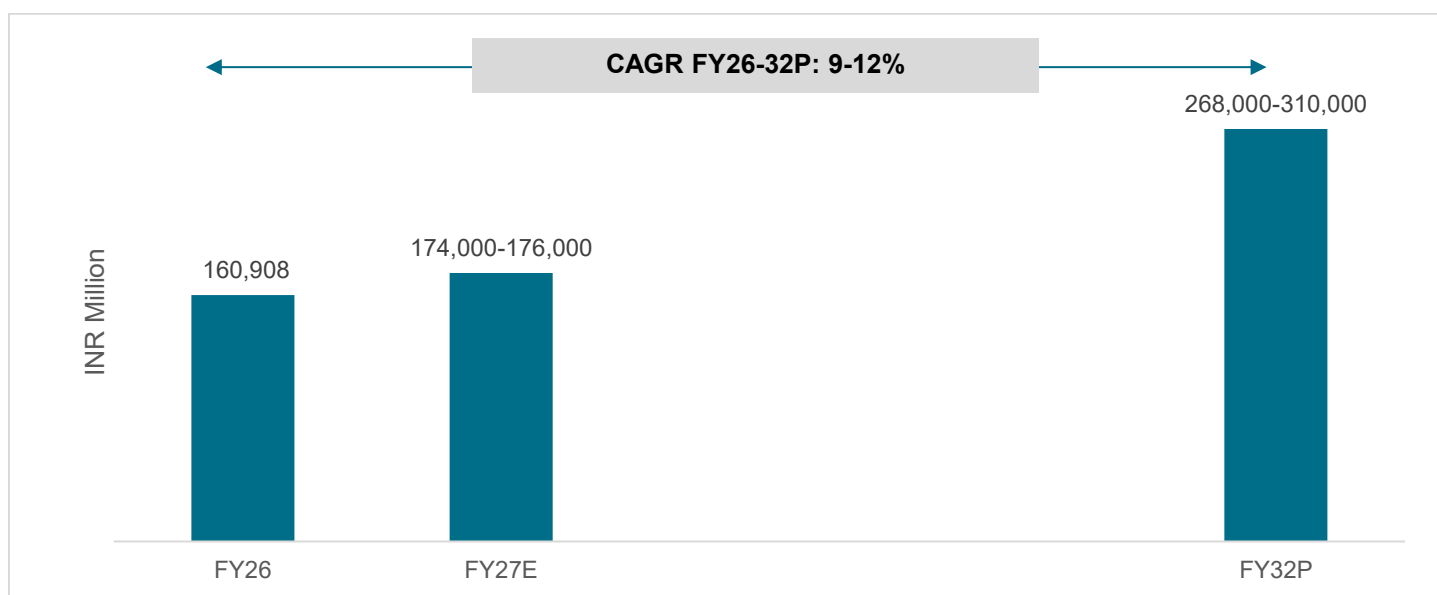
Review and outlook for domestic industrial gases market

The industrial gases market witnessed a sharp rebound in fiscal 2022, posting an exceptional growth as industries reopened after pandemic and oxygen demand remained structurally high. As emergency medical oxygen needs normalized, supply chains stabilized, and industrial activity returned to routine levels, the extraordinary spike decreased. Over the next few years, growth gradually cooled, reflecting a market transitioning from crisis-driven demand to steady, industry growth-related expansion. By fiscal 2025, growth normalized, indicating that the sector moved past volatility and settled into a more sustainable, industrial cycle driven trajectory. This trajectory reflects both the normalization of industrial activity and increasing capacity additions by major gas producers. Key industrial gas players in the industry include INOX Air Products, Linde, Air Liquide, Air Water and Ellenbarrie. INOX Air Products is the largest integrated industrial, medical, electronic and speciality gases company in India by revenue, with a market share of 22.4% as at fiscal 2026.

The industrial gases sector grew in fiscal 2026 with limited impact from West Asia conflict, supported by strong domestic demand from steel, healthcare, manufacturing, and electronics. The escalation of the West Asia conflict in late February 2026 triggered sharp volatility in energy markets during the fourth quarter, increasing logistics costs and tightening the availability of natural gas for India. As a significant portion of India's imported gas is routed through West Asia, disruptions around the Strait of Hormuz and force majeure declarations by certain suppliers prompted the government to prioritize gas allocation for households and critical sectors, while restricting supplies to some industrial users. This created indirect pressure on the industrial gases ecosystem because many downstream gas-consuming industries are being exposed to fluctuations in fuel availability and pricing.

In steel, reduced LNG and LPG availability affected gas-based DRI operations, reheating, and certain stainless-steel processes. In glass, where furnaces require continuous thermal energy and oxygen enrichment, volatile gas prices raised operating cost pressures. The fertilizer segment was particularly vulnerable, as natural gas is the primary feedstock for ammonia and urea production; accordingly, LNG shortages and higher spot prices affected plant utilization, increased subsidy pressure, and constrained downstream fertilizer availability. More broadly, chemicals, petrochemicals, ceramics, and other manufacturing industries faced higher input costs, intermittent gas limitations, and lower utilization rates, which in turn impacted the demand for oxygen, nitrogen, hydrogen, argon, and carbon dioxide. While the West Asia crisis does not alter the long-term structural drivers of industrial gas demand, it creates a near-term impact through higher energy costs, logistics disruptions, and weaker operating rates in end-use industries, affecting both the cost structure and demand volumes of the industrial gas sector.

Overall/TAM Industrial Gases Market Size for India, fiscal 26-32P (by value)



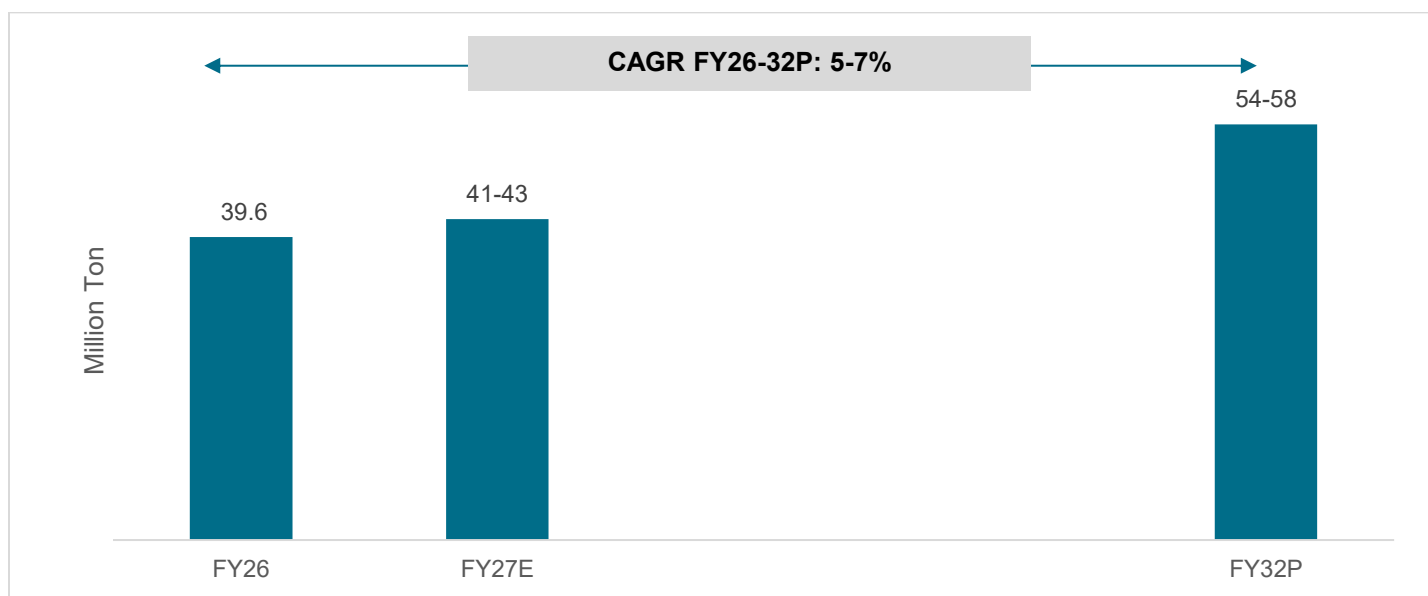
Note:

1. Overall/TAM industrial gas market size includes captive and non-captive industrial gas market.
2. The captive industrial gas market refers to the segment where gases are generated on-site by OEs or companies exclusively for their own internal use. In this model, the company produces industrial gases to meet its specific operational needs and may supply these gases to external customers.
3. The non-captive industrial gas market involves gases produced by industrial gas manufacturers. These gases are supplied in bulk or packaged form or on-site to various customers through different business models.

Source: Nexdigm

The industrial gases market in India is projected to grow at a CAGR of 9-12% during fiscal 2026-FY2032 outperforming global growth. This is supported by government initiatives such as Make in India, policies encouraging import substitution, and rising demand from sectors including steel, pharmaceuticals, manufacturing, defence, chemicals, healthcare, energy, electronics and emerging sectors like hydrogen. In the on-site segment expansion in domestic steel production capacity is expected to drive demand for ASUs.

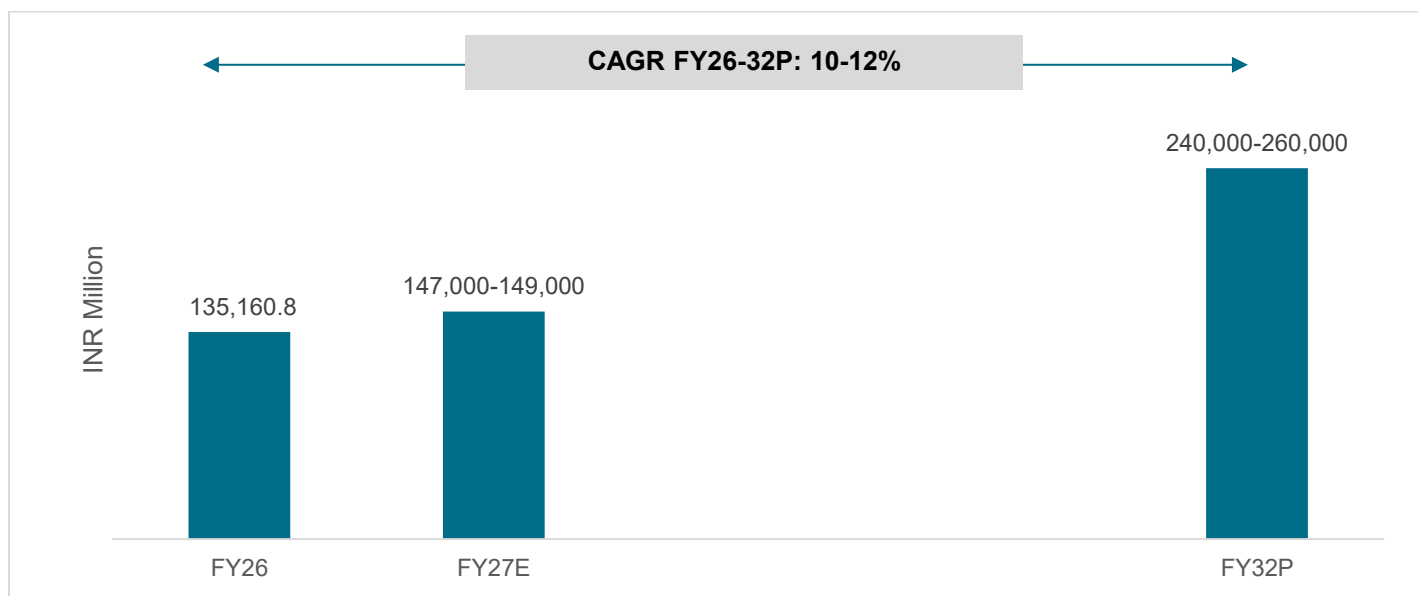
Overall/TAM Industrial Gases Market Size for India, fiscal 26-32P (by volume)



Source: Nexdigm

The Indian industrial gas market comprises a wide range of gases that support critical applications across manufacturing, chemicals, healthcare, metals, energy, and electronics. The market of industrial gases was valued at INR 135,160.8 million in fiscal 2026 driven by rising demand from steel production, pharmaceuticals, electronics manufacturing, and medical oxygen usage. Looking ahead, India's expanding manufacturing ecosystem, government-led infrastructure development, and rising consumption of high-purity gases in healthcare, renewable sector (solar and hydrogen) and semiconductors are expected to rise, sustaining robust market growth through fiscal 2032.

India Non-captive Industrial Gases Market Size, fiscal 26-32P (by value)

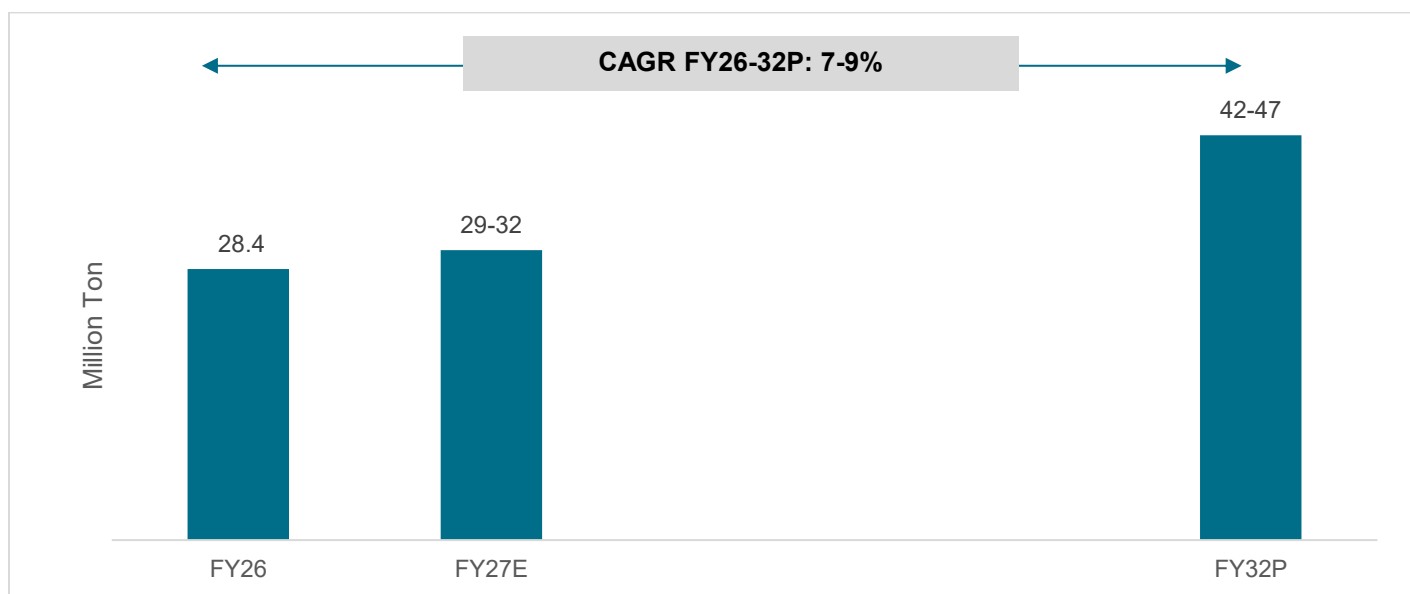


Note:

1. The non-captive industrial gas market involves gases produced by industrial gas manufacturers. These gases are supplied in bulk or packaged form or on-site to various customers through different business models.
2. This study covers the industrial-gases market, which includes all gases produced and supplied for industrial, manufacturing, medical, scientific, and welding uses. Further, revenue derived from design, supply, installation, and commissioning of large air-separation units (ASUs) or projects for nitrogen plants, PSA plants, and gas distribution/storage systems are not included in this market sizing

Source: Nexdigm

India Non-captive Industrial Gases Market Size, fiscal 26-32P (by volume)



Source: Nexdigm

The India industrial gas market is poised for robust growth, supported by rapid industrialization, rising demand for high-purity gases, and large-scale investments across steel, chemicals, semiconductors, healthcare, and advanced manufacturing. Government initiatives such as Make in India, production-linked incentive (PLI) schemes, refinery expansion, and the emergence of green hydrogen are expected to further strengthen consumption of oxygen, nitrogen, hydrogen, and

specialty gases. At the same time, the ongoing West Asia crisis has added a near-term layer of uncertainty through higher energy prices, tighter LNG availability, elevated logistics costs, and periodic disruption to shipping routes linked to the Strait of Hormuz. While these developments do not directly affect industrial gas producers, they do influence key operating cost drivers such as power, fuel, and logistics. They also affect downstream sectors including metals, chemicals, fertilizers, glass, and manufacturing linked industries which remain sensitive to fluctuations in gas and energy availability.

Additionally, the medical gas segment is expected to remain a key growth driver as healthcare infrastructure expands and there is sustained usage of medical oxygen post-pandemic. Sustainability commitments and decarbonization pressures are accelerating investments in green hydrogen, energy-efficient gas production, and lower-emission industrial applications. The market is also being shaped by infrastructure development, improved logistics networks, and wider use of automation and robotics in factories, which support demand for high-purity gases. As a result, the industrial gases market is expected to follow a long-term upward trajectory.

In terms of growth prospects, the market is projected to expand robustly through fiscal 2032, with a CAGR of 10-12% between fiscal 2026 and 2032. The market for industrial gases is expected to rise from INR 135,160.8 million in fiscal 2026 to INR 240,000-260,000 million by fiscal 2032, driven primarily by the steel, chemical, healthcare, and electronics sectors. The growth rate is expected to increase gradually, reflecting sustained industrial activity. This sustained growth will be supported by national manufacturing initiatives and energy-transition measures. Emerging applications, such as rising adoption of green hydrogen, expansion of city gas and natural-gas infrastructure, and stronger investment in solar cell manufacturing, will also accelerate market momentum. As industries move toward cleaner processes, demand for high-purity gases and on-site supply solutions is expected to become mainstream, reinforcing stable multi-year growth through fiscal 2032.

This growth will also be supported by multiple structural demand drivers. Primary among these is the steel sector, which is expected to remain the principal demand anchor, supported by India's National Steel Policy target of 300 million tonnes of installed capacity by fiscal 2030. Green hydrogen represents a significant long-term opportunity, although the scale of adoption remain subject to execution and policy developments. The National Green Hydrogen Mission's target of 5 million tonnes of green hydrogen production per annum by 2030 is expected to create substantial demand for electrolysis equipment, oxygen co-production infrastructure, and high-pressure gas handling and storage systems, where industrial gas companies possess natural technical and operational advantages. Additional growth drivers include –

- healthcare and medical gases, supported by the expansion of Ayushman Bharat and pharmaceutical PLI schemes;
- ultra-high-purity nitrogen and argon for semiconductor fabrication, supported by emerging domestic fabrication capacity;
- carbon dioxide and nitrogen for cold-chain and food-processing applications;
- and specialty gases for research, defence, and advanced manufacturing, all of which are expected to grow from a relatively low base.

The principal risks to this outlook include a prolonged or geographically broader West Asia conflict, which could keep energy prices elevated and weigh on industrial activity in gas-intensive sectors. Apart from these risks, the overall outlook for the industry through fiscal 2032 remains positive, supported by strong demand fundamentals, a diversified end-user base, the emergence of high-value applications, and a policy environment that remains supportive of sectoral expansion.

Market split by gas type (non-captive)

The Indian industrial gases market in fiscal 2026 remains anchored by core bulk gases such as oxygen, nitrogen, hydrogen, and argon. This reflects the country's strong manufacturing backbone, especially in steel, refining, chemicals, and heavy industry. Medical and food-grade applications have kept baseline demand for oxygen and nitrogen structurally higher even after pandemic. Meanwhile, specialty and rare gases are expanding steadily in electronics/solar PV, R&D, and advanced manufacturing, albeit from a smaller base.

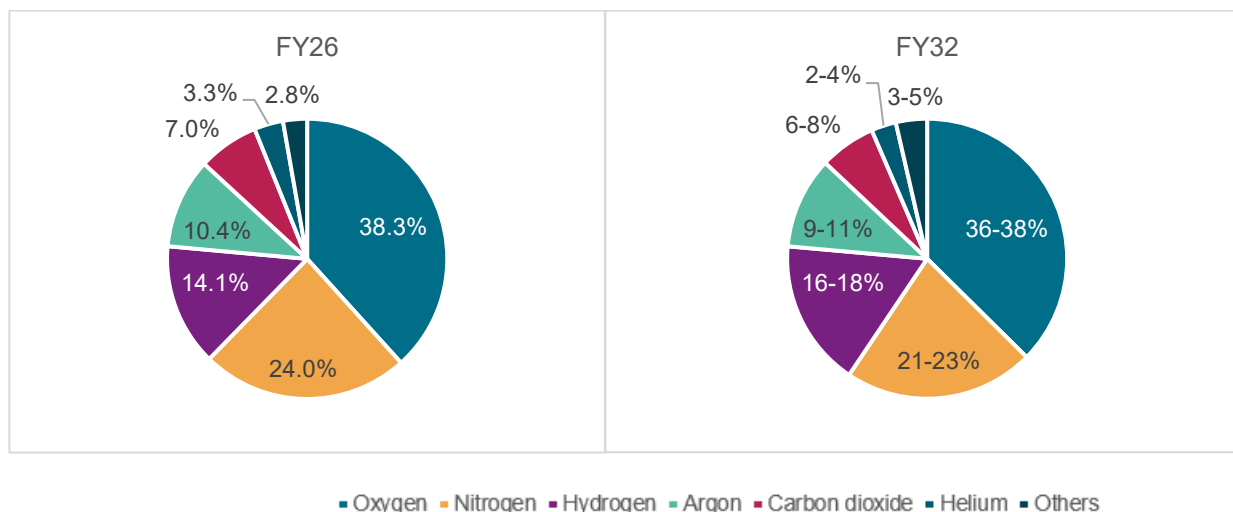
India Industrial Gases Market Size by gas type (by value & volume), fiscal 26 vs 32P

Gas Type	Market Size in INR Million		Growth CAGR (FY26-32P)	Market Size in Million Ton		Growth CAGR (FY26-32P)	Description
	FY26	FY32P		FY26	FY32P		
Oxygen	51,779.1	89,000-95,000	9-11%	13.2	20-22	7-9%	To be primarily driven by steel and healthcare industry. Its mature profile and contract-led pricing result in growth below market average.
Nitrogen	32,463.9	51,000-56,000	8-10%	12.4	17-19	5-7%	Growth to be supported by stable industrial usage in F&B, chemicals, and electronics. High commoditization and on-site generation limit pricing and volume upside.
Hydrogen	19,080.0	39,000-43,000	13-15%	0.2	0.2-0.3	10-12%	Incremental upside from green hydrogen in various applications replacing fossil-based hydrogen and emerging fuel cell applications to lead the demand for hydrogen.
Argon	14,081.4	25,000-28,000	10-12%	0.6	0.8-1.0	7-9%	Shielding gas for welding, metal fabrication, automotive, aerospace, and inerting in electronics and healthcare.
Carbon dioxide	9,488.3	15,000-17,000	8-10%	1.1	1.5-1.7	5-7%	Primarily used in carbonation, freezing and water treatment, F&B, and cold-chain to remain a key demand driver.
Helium	4,524.2	6,500-7,000	6-8%	0.6	0.7-0.8	3-5%	Used in MRI cooling, leak detection, electronics, and specialty applications. Demand to be driven by medical and electronics industry.
Others	3,744.0	8,000-9,000	14-16%	0.4	0.7-0.8	11-13%	Includes specialty gases for solar PV/semiconductors (SiH ₄ , NH ₃ , NF ₃), acetylene for cutting, methane for calibration, and rare gases (Ne, Xe, Kr) for lighting and lasers.

Source: Nexdigm

Note: Others includes Methane, Ammonia, Acetylene, & other rare gases

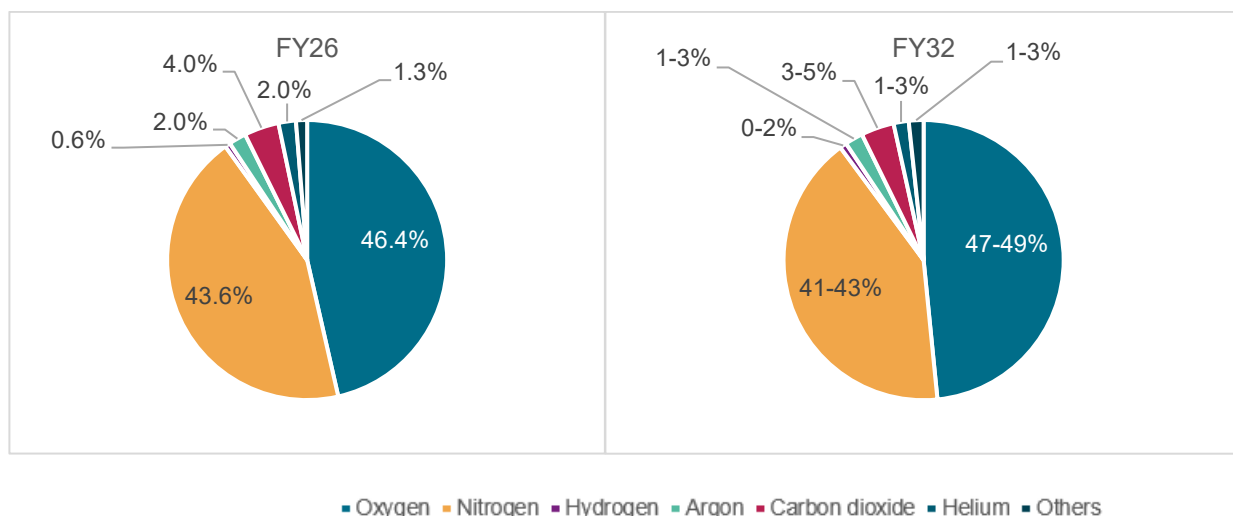
India Industrial Gases Market Size by gas type, share of gases, fiscal 26 vs 32P (by value)



Note: Others include Methane, Ammonia, Acetylene, & other rare gases

Source: Nexdigm

India Industrial Gases Market Size by gas type, share of gases, fiscal 26 vs 32P (by volume)



Source: Nexdigm

Oxygen

Oxygen remains the largest driver, accounting for around 38.3% of the market in fiscal 2026 (by value). This is supported by India's position as the world's second-largest steel producer and continued infrastructure expansion. Oxygen is widely used in blast furnaces, basic oxygen furnaces, metal cutting, glass manufacturing, and pulp and paper. Medical oxygen demand has seen a lasting uplift since fiscal 2021–22, driven by hospital expansion and government-supported on-site oxygen generation programs.

Metals and healthcare sectors are the largest consumers of oxygen. In metals sector, oxygen is utilized to enhance furnace combustion efficiency and improve steel quality during production processes. The healthcare sector accounts for a

substantial share of oxygen demand, with applications in medical purposes such as anesthesia and oxygen therapy. Oxygen is widely used as an oxidizing agent in various chemical production processes and combustion systems, supporting the manufacturing of a range of chemical products. The pharmaceutical industry utilizes oxygen in sterilization, fermentation, and oxidation reactions for synthesizing active pharmaceutical ingredients, as well as in aerobic wastewater treatment. Others include applications in pulp and paper, oil and gas, water, and wastewater treatment.

Growth drivers include:

- Expansion of steel and metal manufacturing, especially in eastern India, drives significant oxygen demand.
- Growth in healthcare infrastructure and increased incidence of respiratory conditions contribute to stable medical oxygen consumption.
- Rising energy and power generation needs, including coal gasification, further support market growth.
- Stringent environmental regulations and cleaner combustion requirements in chemical and petrochemical industries enhance demand for industrial oxygen.

The West Asia conflict, which intensified in late February 2026, disrupted demand across oxygen-intensive end-use sectors such as metals, glass, ceramics, and chemicals. These industries rely on gas-fired furnaces and oxidation reactors, and the spike in LNG prices forced many small and mid-sized players to cut output materially. While healthcare demand remained steady, metals, glass, ceramics, and chemicals weakened in Q4 fiscal 2026. However, full-year oxygen demand growth stayed positive, and the long-term outlook through FY32 is projected to remain strong.

Nitrogen

Nitrogen's broad utility drives its second-largest position with a 24.0% share (by value) in fiscal 2026. It is extensively used for purging and blanketing chemicals and refineries, heat treatment in metals, electronics manufacturing, and across food and beverage applications such as modified atmosphere packaging, flushing, and cryogenic freezing. The growing adoption of on-site PSA nitrogen plants in food processing, aimed at reducing spoilage, continues to support steady volume growth.

Nitrogen finds extensive application in the F&B sector, particularly for freezing, chilling, and modified atmosphere packaging (MAP) to extend shelf life and prevent spoilage. It is also used in preservation processes. The chemicals industry relies on nitrogen for creating inert environments during chemical production, preventing unwanted reactions, and ensuring operational safety and product quality. Nitrogen is also a key component in the synthesis of ammonia for fertilizers. Nitrogen is widely used in steel processing, primarily for its solid solution strengthening effect and its ability to enhance steel's hardenability. It serves as an alloying element and is utilized in processes such as annealing, sintering, and as a protective atmosphere during tempering. The oil and gas industry utilizes nitrogen to increase the well pressure, purge hydrocarbons from pipelines and tanks, and maintain positive pressure to prevent oxygen ingress. Nitrogen injection is also used for enhanced oil recovery and to stimulate flow in depleted reservoirs. Nitrogen is critical in the pharmaceutical industry for creating inert atmospheres in storage tanks, reactors, and packaging, thereby preventing oxidation and degradation of sensitive products. It is also used for purging equipment and reactor cooling in exothermic reactions. Electrical and Electronics sector uses ultra-high purity nitrogen to create inert atmospheres in soldering and reflow processes, preventing oxidation and enhancing solder joint quality. Nitrogen is essential for manufacturing high-quality electronic components. This diversified application base underscores nitrogen's vital role in supporting India's industrial, manufacturing, and technological advancement.

Growth drivers include:

- Rising demand for nitrogenous fertilizers, driven by increased food requirements and crop yield improvements.
- Government policies promote self-sufficiency in fertilizer production, expanding ammonia and urea capacities.

- Shift of manufacturing, pharmaceutical, and chemical supply chains from China to India, supported by cost competitiveness and skilled workforce under various initiatives like Make in India, PLI and others.
- Strong growth in India's agricultural sector and urbanization boosts nitrogen consumption.

Hydrogen

Hydrogen contributes a higher share by value (14.1%) in fiscal 2026 reflecting its high pricing and critical role in refineries and chemicals. Demand is driven by hydrotreating and desulfurization in refineries, where India's capacity is projected to expand from ~258 MMTA toward 300+ MMTA by 2028. Additional demand comes from ammonia and methanol production, with early-stage adoption in steel decarbonization and fuel-cell pilots improving medium-term prospects.

Additionally, hydrogen is employed in various heat treatment processes within this sector. Hydrogen serves as a critical feedstock to produce ammonia in the chemicals segment, which is extensively used in fertilizer manufacturing. Its role in chemical synthesis processes further underscores its importance in this segment. Hydrogen is used for heat treatment, as a fuel in glass melting furnaces, and for turbine cooling in power plants. Hydrogen is essential in refining operations, particularly in processes such as desulphurization of fuels and hydrogenation, which are critical for producing cleaner fuels and facilitating chemical reactions within refineries.

Growth drivers include:

- Government initiatives, including the National Green Hydrogen Mission, are fostering research and commercialization of green hydrogen technologies.
- Decarbonization efforts in energy-intensive sectors such as fertilizers, chemicals, and power are increasing hydrogen adoption.
- Significant investments and collaborations with international partners are accelerating technology development and market expansion.
- The shift towards clean energy and sustainability is driving demand for green hydrogen.
- Emerging applications in automotive, power, and manufacturing are expected to contribute substantially to future market growth.

The West Asia crisis directly affected hydrogen demand in the refinery segment. Disruptions to crude supplies forced some refineries to suspend selected operations, leading to a corresponding decline in hydrogen consumption at impacted units. In addition, the government's March 2026 directive curtailing natural gas supplies to industrial users put further pressure on hydrogen demand across multiple plants. Looking ahead, the clean energy transition could potentially reshape hydrogen demand more fundamentally by fiscal 2032. Under India's National Green Hydrogen Mission, supported by a Rs. 17,490 crore incentive programme through the SIGHT scheme, the country aims to produce 5 million tonnes per annum of green hydrogen by 2030.

Argon

Argon accounts for 10.4% of the market in fiscal 2026 and is firmly established as the primary shielding gas for MIG and TIG welding in automotive, fabrication, aerospace, and general manufacturing. Its demand is supported by rising vehicle production and sustained metal fabrication linked to infrastructure and industrial growth.

Argon is extensively used as a shielding gas in Gas Metal Arc Welding (GMAW), protecting weld pools from atmospheric contamination and ensuring high-quality joins in metal fabrication. The electrical and electronics sector utilizes argon to create controlled environments during semiconductor fabrication, as a filling gas in fluorescent tubes, and to prevent corrosion of tungsten filaments in incandescent bulbs. Argon is also used in the production of solar cells, microchips, and flat panel displays. Gas is essential for producing stainless steel, primarily through the Argon Oxygen Decarburization (AOD) process. Argon creates inert atmospheres during pharmaceutical manufacturing processes to prevent oxidation and

contamination, especially for sensitive active pharmaceutical ingredients. It is also used for blanketing products in vials and ampoules.

Growth drivers include:

- Significant investments in semiconductor and electronics industries drive argon consumption for controlled manufacturing environments.
- Automotive sector expansion, especially in electric vehicles, increases argon use in welding and metal fabrication.
- Government policies, including Production Linked Incentive (PLI) schemes, support growth in automotive, electronics, and healthcare sectors.
- Rapid urbanization and industrialization fuel demand for stainless steel, with argon critical in production

Carbon dioxide

Carbon dioxide, with a 7.0% share in fiscal 2026, is mainly used in beverage carbonation, freezing, welding gas mixtures, and water treatment. It is also connected to the fertilizer value chain as a feedstock for urea. As of fiscal 2026, the demand is still largely driven by traditional industrial and food-grade uses, while carbon capture projects keep CO₂ relevant in policy discussions.

The food and beverage industry is the leading end-use sector for carbon dioxide, primarily utilizing it for carbonation of soft drinks, beer, and sparkling water, as well as in modified atmosphere packaging (MAP) to extend shelf life and preserve product quality. The chemicals industry uses CO₂ directly in the production of urea, methanol, and other chemical products, where it serves as a critical feedstock and process gas. The oil and gas sector utilizes CO₂ mainly for enhanced oil recovery processes, where it is injected into oil reservoirs to improve extraction efficiency. In manufacturing, carbon dioxide is applied as a shielding gas in welding to protect the weld area from atmospheric contamination, and in CO₂ lasers for precision cutting of metals, plastics, and other materials. The pharmaceutical industry employs CO₂ for the extraction of active ingredients, cleaning and sterilizing equipment, and carbonation of certain pharmaceutical solutions.

Growth drivers include:

- Expansion of the food and beverage industry drives demand for carbonation and preservation applications.
- Increased adoption in pharmaceuticals for extraction, sterilization, and solution carbonation supports market growth.
- Rising infrastructure development boosts CO₂ use in concrete curing and welding.
- Enhanced oil recovery techniques in the oil and gas sector further stimulate demand.
- Growing focus on sustainability and circular economy encourages utilization of CO₂ in innovative industrial processes.

Helium and Others

Helium remains a niche but essential gas, contributing 3.3% demand in fiscal 2026. Its primary uses include MRI cooling in healthcare, leak detection, and select electronics and optics applications. Continued investment in healthcare infrastructure and diagnostic imaging supports stable demand. The remaining include other gases such as acetylene for cutting and welding, high-purity ammonia, and methane for electronics and R&D, and rare gases like neon, xenon, and krypton. These are critical for lasers, lighting, lithography, and solar PV manufacturing, closely aligned with India's PLI-driven push in electronics and solar. Though volumes are small today, these gases are strategically important and expected to grow as semiconductors and solar PV manufacturing capacities scale up.

Overall, India's industrial gases market in fiscal 2026 is firmly anchored in bulk gases supporting steel, refining, and manufacturing, with medical and food applications providing durable demand. Specialty and rare gases, while still emerging, are set to play a growing strategic role as electronics, solar, and advanced manufacturing ecosystems mature.

Market split by end-user industries or applications (non-captive)

The Indian industrial gases market is diversified across a broad range of end-user industries, with bulk demand primarily driven by iron & steel, refining, chemicals, and non-ferrous metals, where gases such as oxygen, nitrogen, hydrogen, and argon are integral to core production processes. Manufacturing-led sectors including automobiles, engineering and glass contribute through fabrication, heat treatment, and furnace applications. Healthcare and pharmaceuticals provide stable demand supported by medical oxygen and controlled-environment requirements. At the same time, emerging segments such as solar photovoltaic, electronics and semiconductor manufacturing are increasing their relevance due to their requirement for high-purity and specialty gases. Overall, the market remains anchored in heavy industrial consumption, while advanced manufacturing and healthcare applications are gradually enhancing diversification and long-term growth visibility.

India Industrial Gases Market Size by application (by value & volume), fiscal 26 vs 32P

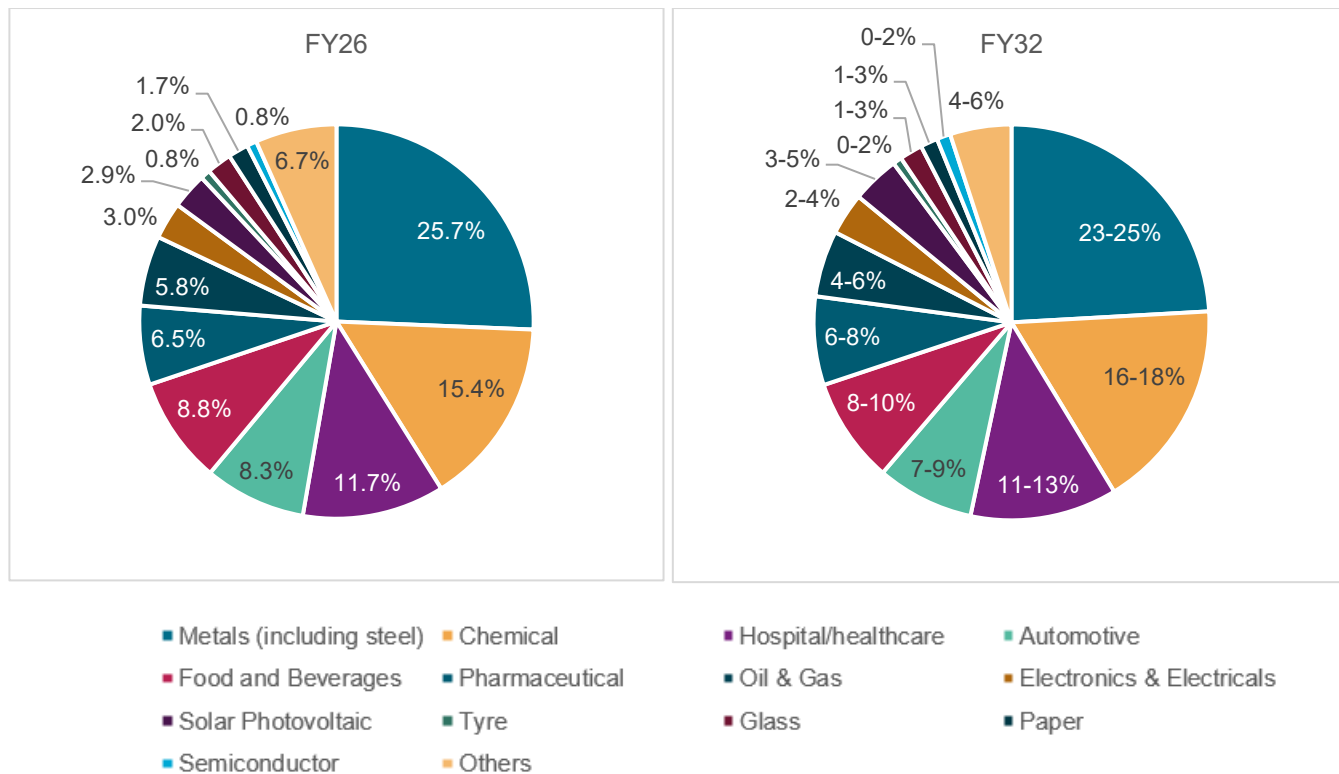
Application	Market Size in INR Million		Growth CAGR (FY26-32P)	Market Size in Million Ton		Growth CAGR (FY26-32P)
	FY26	FY32P		FY26	FY32P	
Metals (including steel)	34,668.7	54,000-60,000	8-10%	11.3	14-16	4-6%
Chemical	20,868.8	38,000-43,000	11-13%	5.3	8.5-9.5	8-10%
Healthcare	15,746.2	28,000-31,000	10-12%	1.8	2.7-3.1	7-9%
Automotive	11,258.9	18,000-20,000	8-10%	1.8	2.4-2.7	5-7%
F&B	11,826.6	20,000-22,000	9-11%	2.1	2.8-3.2	5-7%
Pharmaceutical	8,758.4	16,000-18,000	11-13%	1.5	2.3-2.6	8-10%
Oil & Gas	7,771.7	12,000-14,000	8-10%	1.5	2.0-2.2	5-7%
Electronics	4,081.9	8,000-9,000	12-14%	0.9	1.5-1.7	8-10%
Solar PV	3,973.7	9,000-10,000	15-17%	0.8	1.4-1.6	11-13%
Tyre	1,094.8	1,600-1,800	7-9%	0.2	0.3-0.4	4-6%
Glass	2,757.3	4,400-4,800	8-10%	0.6	0.7-0.8	4-6%
Paper	2,243.7	3,100-3,500	6-8%	0.3	0.3-0.4	4-6%

Semiconductor	1,094.8	2,500-2,800	15-17%	0.1	0.2-0.3	12-14%
Others	9,015.2	11,500-12,500	4-6%	0.2	0.2-0.3	1-3%

Note: Others include Infrastructure, Aerospace and Defense, and small fabrication shops

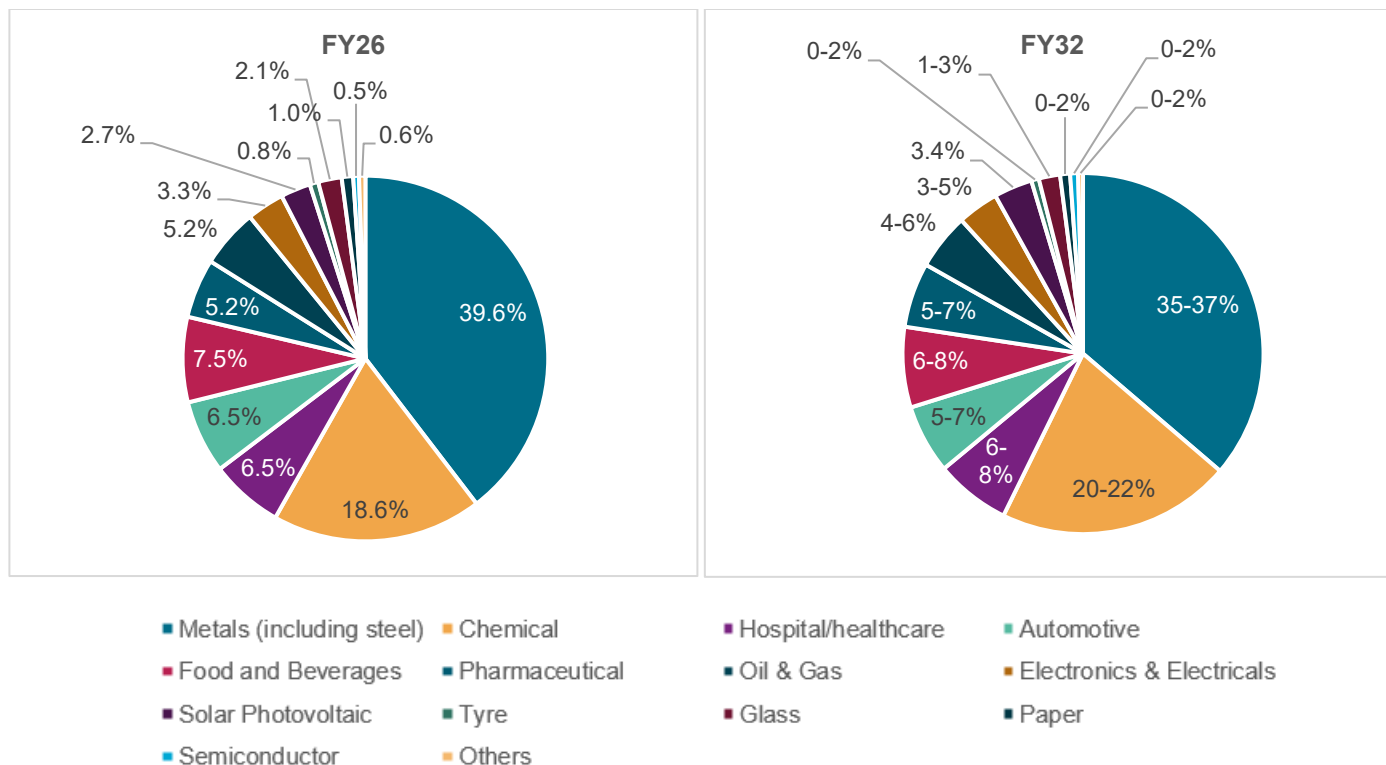
Source: Nexdigm

India Industrial Gases Market Size by end-user industries or applications, fiscal 26 vs 32P (by value)



Source: Nexdigm

India Industrial Gases Market Size by end-user industries or applications, fiscal 26 vs 32P (by volume)



Source: Nexdigm

Metals

Steel and other metal manufacturing contributes 25.7% (by value) of demand for industrial gases in India in fiscal 2026 driven by robust investment in infrastructure development and allied activities. The ongoing West Asia conflict has tightened gas supply and increased freight and energy costs, affecting both demand and supply conditions. Since the escalation began in late February, concerns over supply-side disruptions in oil and gas have added pressure to commodity prices, especially steel. If the conflict persists, it could heighten market uncertainty and further disrupt global supply chains. As a result, the pace of budgeted infrastructure capex spending may depend in part on how the situation evolves.

In the metal segment, INOX Air Products had a market share of 35.5% in fiscal 2026.

Iron and Steel: The iron and steel industry drives the major demand for industrial gases in India, given the intensity of gas usage across primary and secondary steelmaking processes. Oxygen is extensively used in blast furnace and basic oxygen furnace operations to enhance combustion efficiency and productivity, while nitrogen and argon are utilized in purging, inerting and secondary refining processes. In steel manufacturing process, Oxygen is blown into molten pig iron in basic oxygen furnaces to oxidize and remove impurities such as carbon, silicon, manganese, and phosphorus, enabling conversion into refined steel. It also enhances combustion efficiency in blast furnaces and reheating operations. Nitrogen is used for purging and inerting, and also acts as an alloying element contributing to strength and hardenability. Argon is applied in ladle refining for stirring and degassing, improving homogeneity and metallurgical quality.

Non-ferrous metals: The non-ferrous metals segment, including aluminium, copper and zinc, utilizes industrial gases across smelting, refining and downstream processing operations. Oxygen improves combustion efficiency and supports oxidation reactions in furnaces. Nitrogen is widely used for blanketing molten metal to prevent oxidation and contamination. Hydrogen is applied in annealing and heat treatment processes to enhance surface

finish and mechanical properties. Controlled atmospheres are critical in maintaining product quality in continuous high-temperature operations.

Chemicals

The chemical industry accounted for 15.4% (by value) of the industrial gases demand in fiscal 2026. The chemical and petrochemical industries depend on industrial gases as process inputs and for operational safety. Hydrogen is widely used in hydrogenation, hydrocracking and ammonia synthesis. Nitrogen provides inerting and blanketing to mitigate explosion risks in reactors and storage tanks. Oxygen supports oxidation reactions and enhances combustion efficiency. Carbon dioxide is utilized in specific synthesis reactions and downstream applications. These gases are integral to maintaining process efficiency and safety standards.

The petrochemicals sector remains one of the most exposed industries to geopolitical disruption in West Asia, given its direct dependence on imported feedstock and significant trade linkages for final products. India's fertilizer value chain faces significant concentration risk due to its reliance on West Asia for liquefied natural gas (LNG) to make urea as well as for raw materials and finished fertilizers such as urea and diammonium phosphate (DAP). From fiscal 2021 to fiscal 2025, imports supplied about 22% of urea and 52% of DAP on average. Within this, West Asia provided 60–65% of urea and 30–35% of DAP to India, highlighting the region's strategic role. The West Asia conflict has disrupted supply chains, constrained LNG feedstock and escalated costs, impacting the imports of finished fertilizers and domestic production. The supply chain disruption in the chemical and fertilizer industry is expected to impact the demand for industrial gas sector for a short term.

Healthcare

The healthcare sector in India accounts for 11.7% (by value) of the country's industrial gas demand in fiscal 2026, driven by the need for medical-grade gases. The sector is a critical consumer of industrial gases, with oxygen being widely used in respiratory therapy, emergency care, and intensive care units. Additionally, nitrous oxide is used as an anesthetic in surgical and dental procedures, while carbon dioxide is used in laparoscopic surgeries and diagnostic procedures. The supply of medical gases requires a robust and uninterrupted infrastructure, with strict standards for quality. In the healthcare segment, INOX Air Products had a market share of 24.3% in fiscal 2026.

Medical oxygen is one of the fastest-growing segments for India's industrial gas market. Government initiatives to upgrade public hospitals, expand rural healthcare infrastructure, and the post-COVID normalization of medical infrastructure investments continued to drive demand.

Tyre

The tyre industry in India is a significant consumer of industrial gases, accounting for 0.8% (by value) of the country's industrial gas demand in fiscal 2026. The sector relies heavily on gases such as oxygen, nitrogen, and argon for various applications, including tyre manufacturing, testing, and inflation. Oxygen is used for combustion and cutting processes, while nitrogen is used for tyre inflation, curing, and testing. Argon is used in the production of tyre beads and other components. The tyre industry's demand for industrial gases is driven by the need for efficient and high-quality manufacturing processes. In the tyre segment, INOX Air Products had a market share of 54.2% in fiscal 2026 and is the market leader.

Automotive

The automobile manufacturing sector accounts for 8.3% (by value) demand for industrial gases in India in fiscal 2026. Automobile manufacturing utilizes industrial gases in fabrication, assembly, and component manufacturing processes. Argon and shielding gas mixtures are widely used in arc welding and metal fabrication. Oxygen supports cutting and brazing applications. Nitrogen is used in heat treatment, tire inflation, and testing processes. Increased automation and precision manufacturing have strengthened the demand for consistent and high-quality gas supply.

India's broader manufacturing sector including the automotive industry recorded on-year growth in fiscal 2026, although the West Asia crisis has pushed up commodity inflation. Certain headwinds may continue to weigh on industry growth. Retail automotive sentiment could remain impacted by geopolitical uncertainty arising from the West Asia crisis, while rising fuel prices may adversely affect consumer confidence. Further, price hikes undertaken to offset elevated input costs could further impact the industry demand.

Food and Beverage (F&B) Industry

The food and beverage sector has an 8.8% (by value) share in industrial gases demand in India in fiscal 2026. Carbon dioxide is widely used for carbonation in beverages, while nitrogen supports modified atmosphere packaging to enhance shelf life of packaged foods. Cryogenic gases are utilised in freezing and chilling applications to preserve product quality and texture. Stringent food safety standards and quality control requirements make gas purity and traceability important considerations in this segment.

Pharmaceuticals

The pharma industry accounted for 6.5% (by value) of the industrial gases demand for India in fiscal 2026. The pharmaceutical industry uses industrial gases to maintain controlled and sterile manufacturing environments. Nitrogen is used for inerting reactors and preventing oxidation of sensitive compounds. Carbon dioxide supports fermentation and certain formulation processes. Oxygen is used in fermentation processes for antibiotic production. Specialty gases are also used in analytical and quality control instrumentation, where purity is critical.

Oil and Gas

The oil and gas sector has a 5.8% (by value) share in industrial gases demand in India in fiscal 2026. Industrial gases are integral to refining and petrochemical operations, where hydrogen is used in hydrocracking and desulphurisation processes to improve fuel quality and meet environmental norms. Nitrogen is deployed for inerting, purging, leak testing, and enhanced recovery operations, while oxygen supports partial oxidation processes. Reliability of supply is critical in this segment due to the continuous nature of refinery and petrochemical operations, often necessitating on-site or pipeline-based gas solutions.

Electronics

Electronics sector has a 3.0% (by value) share in industrial gases demand in India in fiscal 2026. Electronics and semiconductor manufacturing require ultra-high-purity gases for precision fabrication processes. Nitrogen provides inert atmospheres in cleanrooms and during wafer processing. Hydrogen supports reduction and annealing steps, while rare gases such as argon and neon are used in plasma etching and lithography applications. Specialty gas mixtures are critical in microelectronics fabrication and testing. Even trace impurities can impact yields, making reliability and technical support important. In the electronics segment, INOX Air Products had a market share of 22.4% in fiscal 2026.

Solar: Solar PV sector account for 2.9% (by value) of the market in fiscal 2026. The solar photovoltaic industry relies on high-purity gases to maintain controlled manufacturing environments during wafer, cell, and module production. Nitrogen is extensively used for inerting and purging to avoid contamination during diffusion and deposition stages. Hydrogen is applied in annealing and passivation processes to improve cell efficiency. Specialty gases are used in thin-film deposition and plasma-based treatments. Stringent purity standards make consistent gas quality essential in this segment. In the solar segment, INOX Air Products had a market share of 23.1% in fiscal 2026.

Glass: The Glass industry accounted for 2.0% (by value) of the industrial gases demand for India. The glass manufacturing industry utilizes industrial gases to enhance furnace efficiency and maintain product quality. Oxygen enrichment improves combustion and reduces emissions in melting furnaces. Nitrogen and hydrogen are used to create controlled atmospheres in float glass production, preventing oxidation and surface defects. Specialty gases can also be used in coating and finishing operations. Continuous furnace operations require stable and uninterrupted gas supply. In the glass segment, INOX Air Products had a market share of 40.1% in fiscal 2026.

Semiconductor: The semiconductor sector accounts for 0.8% (by value) of the industrial gases demand for India in fiscal 2026. It relies heavily on ultra-high-purity (UHP) gases to enable contamination-free, tightly controlled environments across front-end wafer fabrication. Nitrogen is widely used for inerting, purging, and as a carrier/blanketing gas to prevent oxidation and particle contamination in process tools. Hydrogen supports key steps such as annealing, surface cleaning/reduction, and forming-gas ambients that help improve interface quality and device performance. Specialty gases are critical inputs for etching (plasma etch chemistries), doping/implant support and diffusion-related steps, and deposition processes (e.g., CVD/ALD precursors) that form precise thin films. Because even trace impurities can impact yield, reliability, and electrical performance, stringent purity standards and consistent gas quality are essential for stable semiconductor production.

Others

Aerospace and Defence: The aerospace and defence sector has marginal share in industrial gases demand in India. High-purity gases such as nitrogen, oxygen, argon, and specialty gas mixtures are used in aircraft manufacturing, propulsion systems, electronics integration and testing applications. Controlled atmospheres are critical during component fabrication and heat treatment processes to maintain material integrity. Given the precision-driven nature of this sector, consistency in gas purity, technical compliance and supply reliability are key competitive parameters.

Market split by supply mode/vertical (non-captive)

The industrial gases market is broadly segmented based on supply mode/vertical into on-site, merchant (bulk), and packaged (cylinder) supply. The choice of supply mode depends primarily on the customer's consumption volume, continuity requirements, integration needs, and capital investment capacity. Large industrial consumers with stable and high-volume requirements typically opt for integrated supply arrangements, while mid-sized and smaller customers rely on transported or packaged formats.

Each supply mode operates under a distinct commercial structure, logistics framework, and customer engagement model. Together, these segments create a diversified revenue mix for industrial gas companies and enable them to cater to a wide spectrum of end-use industries ranging from steel and refining to healthcare, fabrication, and food processing.

Supply Mode/vertical	Market Size in INR Million		Growth CAGR (FY26-32P)	Market Size in Million Ton		Growth CAGR (FY26-32P)
	FY26	FY32P		FY26	FY32P	
On-site	48,982.3	72,000-80,000	7-9%	16.7	22-25	5-7%
Merchant	57,213.6	105,000-120,000	11-13%	9.3	15.0-16.5	8-10%
Packaged	28,965.0	48,000-53,000	9-11%	2.5	3.7-4.2	7-9%

Source: Nexdigm

On-site Supply: Under the on-site model, gas production facilities are installed within or adjacent to the customer's premises and are directly connected through dedicated pipelines. This model is generally adopted by large industrial customers with continuous and predictable demand.

On-site contracts are typically long-term in nature, providing revenue visibility and stable cash flows for suppliers. Due to infrastructure integration and operational interdependence, customer stickiness is high and switching is complex. While this segment is capital-intensive and offers relatively stable margins, it ensures long-term earnings stability and strong return predictability for suppliers.

INOX Air Products is one of the leading players in India in on-site industrial gas supply in terms of installed capacity. Company is one of the India's largest on-site industrial gas suppliers in India in terms of installed capacity, with an existing market share of approximately 17.8% (based on revenue) in fiscal 2026. This share might increase post commissioning capacity in pipeline. Company's on-site business holds a 17.8% market share in India's on-site segment, as of fiscal 2026.

Merchant (Bulk) Supply: The merchant supply mode involves centralized production, with gases transported in liquid form through cryogenic tankers to customer sites. At the customer location, gases are stored in cryogenic tanks and vaporized at the point of use. To optimize costs and ensure timely delivery, merchant operations are structured to primarily serve customers located within a radius of approximately 300 km from liquid manufacturing plants, aimed at reducing transportation costs and enhancing service reliability.

In the Merchant segment organic growth in demand from existing applications and the emergence of new industrial uses is expected to support increased consumption of liquid gases. In particular, demand is expected to be driven by new and emerging applications across sectors such as steel, aluminium, copper, pharmaceuticals, food processing, electronics, tyre and rubber, water treatment and pulp and paper, supported by technologies including oxygen enrichment, hydrogen-based combustion, cryogenic condensation, liquid nitrogen-based freezing and processing, gas-based inerting and cryogenic cooling applications.

Contract tenures in this segment are generally medium-term compared to on-site arrangements, with relatively greater pricing flexibility. Margins are stronger due to distribution value addition, but earnings are more sensitive to plant utilization levels, logistics efficiency, and regional demand conditions. This model balances asset intensity with operational flexibility.

INOX Air Products is the largest and most diversified merchant liquid gas player in India, with a pan-India presence across 28 dedicated liquid gas manufacturing locations and an aggregate production capacity of approximately 5,106 TPD as of March 2026. Their merchant bulk liquid gases business is the largest in India, with an aggregate gas production capacity of approximately 5,106 TPD across 28 dedicated manufacturing locations, and operates at high capacity utilisation levels. In the Merchant business, company held the highest market share at 31.0% as at fiscal 2026. Leading market position in the Merchant segment is further reinforced by the supply reliability afforded by extensive and geographically diversified network of plants, which is a direct consequence of their scale across India. In the event of a plant outage or scheduled maintenance shutdown, company is able to supply customers from alternative locations, ensuring continuity of supply. This level of network redundancy represents an important competitive advantage for customers whose operations depend on uninterrupted gas supply and makes it difficult to replicate for players with limited regional presence.

Company is India's largest and most diversified liquid gas (merchant) manufacturing company, with a 31.0% market share as at fiscal 2026, which might further increase post commissioning of capacities in pipeline.

Packaged (Cylinder) Supply: Packaged supply involves filling gases into cylinders or smaller containers for customers with lower, or specialized requirements. This segment caters to a broad and fragmented customer base including small manufacturing units, laboratories, hospitals, and fabrication workshops.

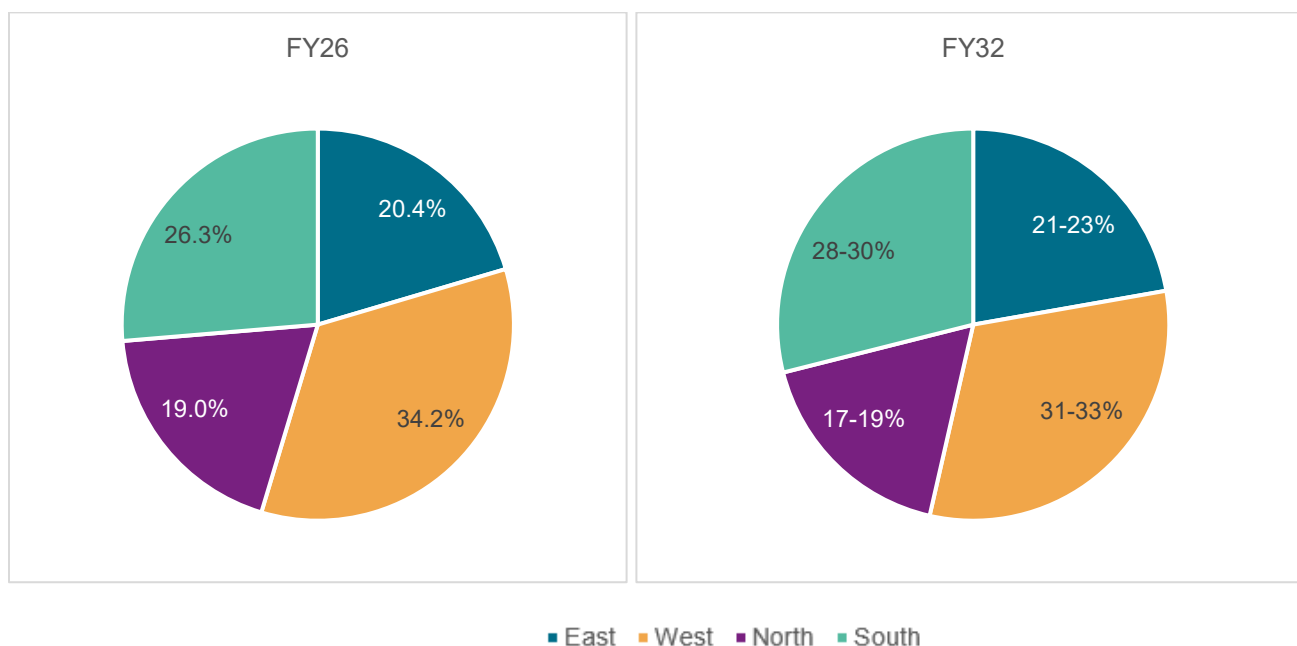
In the packaged & specialty segment demand is expected to be driven by the expansion of India's solar cell manufacturing capacity and the anticipated commissioning of semiconductor manufacturing and outsourced semiconductor assembly and test (OSAT) facilities, which require long-term supply of high-purity and electronic-grade gases under multi-year contracts. A strategic focus on expanding the specialty gases portfolio is essential for industrial gas companies aiming to serve rapidly growing sectors like electronics, solar cell manufacturing, and semiconductors. These segments offer strong growth potential and import substitution opportunities.

Contracts in the packaged segment are usually shorter in duration and transaction-driven in nature. However, this segment is logistics-intensive, working capital-heavy, and geographically constrained due to safety and transportation considerations. Customer retention is driven primarily by service reliability, safety standards, and distributor network strength rather than long-term infrastructure integration.

Market split by key geographies (non-captive)

India's industrial gases market reflects pronounced regional concentration, with demand largely tracking the geographic distribution of heavy industries, petrochemical and refining hubs, and fast-forming manufacturing clusters. Consumption patterns across regions are therefore shaped by differences in industrial base composition, customer scale (tonnage vs merchant vs packaged), and the pace of new capacity additions.

India Industrial Gases Market split by key geographies, fiscal 26 vs 32P (by value)



Source: Nexdigm

West: Western India represents the largest industrial gases market in India in both value and volume terms, driven by a dense cluster of refineries, petrochemical complexes, steel processing units, and chemical manufacturing hubs.

States such as Gujarat and Maharashtra anchor demand through large-scale oxygen, nitrogen, hydrogen, and specialty gas consumption, particularly from refining and petrochemicals, where on-site supply models (such as air separation units and hydrogen plants) are widely deployed. The presence of integrated industrial clusters (e.g., Dahej, Hazira, Jamnagar) further drives high-volume, continuous gas demand supported by long-term supply contracts.

The region also benefits from strong infrastructure, port connectivity, and proximity to export-oriented industries, reinforcing its leadership in both bulk and high-value gas consumption.

South: Southern India is the second-largest market by value, supported by a diversified industrial base including electronics, automotive, pharmaceuticals, and specialty chemicals.

States such as Tamil Nadu, Karnataka, and Telangana contribute significantly to demand for high-purity and specialty gases, particularly in electronics manufacturing, healthcare, and R&D-driven industries. The region has also emerged as a key hub for semiconductor, display, and electronics ecosystem development, which is driving incremental demand for ultra-high purity gases.

While volume consumption is relatively moderate compared to western and eastern India, the higher share of specialty gases results in a stronger value contribution.

East: Eastern India accounts for a significant share of industrial gas volumes, primarily driven by the concentration of steel, metals, mining, and heavy industries in states such as Odisha, Jharkhand, and West Bengal.

The region's demand is largely skewed toward bulk gases such as oxygen and nitrogen, used extensively in steelmaking and allied processes. As a result, while volume share is relatively high, the value share remains lower compared to southern India due to limited penetration of specialty and high-margin gases.

Upcoming investments in steel capacity expansion, downstream metal processing, and infrastructure development are expected to sustain demand growth in this region.

North: Northern India represents the smallest share of the industrial gases market in both value and volume terms, reflecting a relatively lower concentration of heavy industrial clusters.

Demand is supported by fertilizers, glass, food processing, healthcare, and general manufacturing, along with a growing base of packaged gas consumption. The region is also witnessing gradual growth in electronics manufacturing and infrastructure development, which could drive incremental demand for both bulk and specialty gases.

However, compared to other regions, the absence of large-scale petrochemical and steel hubs limits overall consumption intensity.

Growth drivers and challenges

Growth in end-use industries

The industrial gases market in India is experiencing robust growth, driven primarily by expansion in end-use industries such as steel, pharmaceuticals, petrochemicals, healthcare, and manufacturing, among others. The Indian industrial gases market reflects a highly diversified demand base, with consumption distributed across heavy industries, process industries, healthcare, and emerging high-technology sectors.

- In the metals and steel industry, oxygen-intensive processes such as basic oxygen steelmaking, along with argon-based refining and nitrogen for cooling and inerting, continue to drive large volumes. While India's steel industry has historically dominated gas demand, the landscape is gradually shifting as downstream industries scale up.
- Chemical sector drives the consumption of hydrogen and nitrogen in ammonia-urea production, methanol synthesis, and petrochemical feedstock processing. As India expands its chemical and petrochemical capacity, this segment continues to show strong structural demand.
- Healthcare has become a major consumer post-2020 as hospitals across the country built long-term oxygen infrastructure. Medical oxygen usage has now stabilized at a structurally elevated baseline, supplemented by nitrous oxide for anaesthesia and helium for MRI operations.
- The automotive industry is driven by welding gases used in vehicle body fabrication, nitrogen for pressure testing, and hydrogen in emerging EV-related fuel-cell applications. The sector's ongoing shift toward new energy vehicles (EVs, CNG, LNG and Hydrogen) is gradually reshaping its gas consumption profile.
- The F&B sector continues to rely heavily on nitrogen for modified-atmosphere packaging and CO₂ for carbonation, freezing, and preservation processes. This segment benefits from India's fast-growing packaged food and cold-chain logistics ecosystem.
- The pharmaceutical sector uses nitrogen for sterile packaging, CO₂ for controlled environment processes, and oxygen in fermentation and biotech drug production. Rising biologics manufacturing is expected to gradually increase high-purity gas consumption.
- Specialized gases play a crucial role in electronic device production. Nitrogen creates an oxygen-free environment for semiconductor manufacturing, while argon is used for precision-etching and coating tiny material layers.

Growth of various end-use industries

Industry	Historic Growth	Growth Forecast	Demand Trend for Industrial Gases
Semiconductor	21.0% CY20-24	14-16% CY24-30P	++
Solar PV (module)	63.0% FY20-25	12-14% FY25-30P	+
Automotive	3.7% FY20-25	7-9% FY25-31P	+
Chemicals (commodity chemicals)	~5.0% FY20-25	6-8% FY26-31P	=
Electronics	9.2% FY21-25	5-7% FY25-30P	=
F&B	13.2% FY23-25	14-16% FY25-29P	++
Glass	17.0% FY20-25	12-14% FY25-27P	=
Hospitals/healthcare delivery	9.2% FY20-25	9-11% FY25-28P	+
Metals (Steel)	12.5% FY21-25	7-9% FY25-30P	=
Paper	4.9% FY20-25	4-6% FY25-27P	=
Pharmaceutical	8.6% FY20-25	8-10% FY25-27P	=
Oil & Gas	1.9% CY19-24	2-4% CY24-30P	=
Tyre	12.2% FY22-25	5-7% FY25-30P	=

Note: ++ High, + medium, = no impact/stagnant, - low

Source: CRISIL Intelligence

India's demand for industrial gases continues to rise, driven by the expansion of core sectors such as steel, refining, chemicals, and cement, under the government's manufacturing-driven growth agenda. The steel sector alone accounts for a significant portion of oxygen consumption, supported by rapid growth in crude steel output and new blast-furnace and Direct Reduction Iron (DRI) capacity additions.

The chemicals and petrochemicals industries further drive demand for nitrogen and hydrogen through substantial investments in crackers, fertilizers, and specialty chemical projects. Meanwhile, the automotive, metals fabrication, food processing, pharmaceuticals, and electronics manufacturing sectors are scaling up, creating steady requirements for high-purity nitrogen, carbon dioxide (CO₂), argon, and specialty gases.

India's rapidly growing healthcare infrastructure sustains strong demand for medical oxygen and nitrous oxide, while infrastructure and engineering projects boost consumption of welding gases. Collectively, these sectors are strengthening the long-term demand profile for industrial gases in India, supporting sustained capacity expansions by gas producers.

Global Supply Chain Realignments and Manufacturing Shift

The industrial gases sector is increasingly influenced by global supply chain realignments, particularly the adoption of the China+1 strategy by manufacturers across steel, electronics, chemicals, automotive, and semiconductor industries. As companies reduce reliance on single-country manufacturing bases, India is emerging as a preferred destination for new production capacity due to its cost competitiveness, policy support, and growing domestic market. This shift is directly benefiting industrial gas suppliers since steel plants, semiconductor fabs, chemical plants, and electronics facilities require long-term gas supply contracts, pipeline networks, on-site gas production and captive air separation units.

Impact of Global Trade Policies and Geopolitical Conflicts

Global developments such as US tariff policies and trade restrictions have had indirect but material impacts on the industrial gases sector. US tariffs on Indian exports create short-term headwinds but accelerate localization of supply chains. This shift benefits industrial gas players as Indian manufacturers expand domestic capacity, requiring reliable gas supply. Tariffs on steel, chemicals, and high-technology equipment have reshaped global manufacturing flows, accelerated regionalization of production, and increased domestic manufacturing activity in countries such as India, thereby supporting higher industrial gas demand.

Additionally, the Russia-Ukraine conflict has disrupted natural gas supply and pricing in Europe, leading to elevated global energy costs. This has affected the input economics of energy-intensive processes such as hydrogen production and air separation units, reinforcing the strategic importance of energy efficiency, alternative feedstocks, and the accelerated adoption of green hydrogen within the industrial gases industry.

Adoption of Green Hydrogen

India's adoption of green hydrogen is emerging as a pivotal trend influencing the industrial gases landscape, blending environmental goals with long-term energy strategy. The Government of India has officially launched the National Green Hydrogen Mission to scale green hydrogen production, electrolyser manufacturing, and promote use of green hydrogen across sectors such as refining, fertilizers, steel, and chemicals. The mission aims to reduce carbon intensity, enable cleaner feedstocks for industrial processes, and stimulate demand for hydrogen as a low-carbon industrial gas.

Green hydrogen adoption is attracting both public investment and private partnerships, with plans for gigawatt-scale electrolyser capacity and renewable energy linkages to produce electrolytic hydrogen without fossil fuels. This shift is expected to gradually transform traditional industrial gas demand patterns, increasing the use of hydrogen not just in fuel cells or mobility, but also in high-temperature industrial processes, refinery desulphurisation, and as a feedstock in ammonia and methanol production. By diversifying gas portfolios and reducing dependence on fossil-derived hydrogen, India's industrial sectors are positioning hydrogen as a strategic driver of future gas consumption and decarbonisation.

Natural Gas Infrastructure Consumption

The expansion of natural gas infrastructure across India is creating new demand avenues for industrial gases, particularly nitrogen. As the country continues to build out City Gas Distribution (CGD) networks, Liquefied Natural Gas (LNG) import and regasification terminals, and cross-country pipelines, associated gas-handling requirement including purging, leak testing, and inerting are increasing for industrial users, refineries, and processing plants. These networks are spreading into new states and municipalities, extending cleaner fuel access to manufacturing clusters that historically relied heavily on liquid fuels.

Energy policy reforms and investment in pipeline connectivity are positioning natural gas as a transitional fuel for Indian industries, which in turn stimulates industrial gas consumption for compression, safety systems, and process support. With large-scale infrastructure such as the Dharamtar–Jagdishpur pipeline project and expanding CGD licenses under regulatory frameworks, industrial gases like nitrogen and hydrogen are becoming critical service inputs for safe, efficient, and compliant natural gas operations. This infrastructure push supports broader decarbonisation and energy diversification goals, making natural gas expansion a key driver of sustained demand in the industrial gases market.

Growth in Solar Industry

India's rapid solar photovoltaic (PV) industry growth is emerging as an important indirect driver of industrial gas demand, particularly for speciality and high-purity gases. Solar cell manufacturing processes rely on controlled atmospheres, deposition technologies, and chamber cleaning applications that require gases such as nitrogen, hydrogen, silane, and ammonia. As India broadens its solar manufacturing base under national incentives like production-linked schemes, the expanding assembly lines are increasing the consumption of these precision gases.

Government support for large-scale solar capacity and associated electronics ecosystems has increased investments in solar PV value chains like wafer production, thin-film modules, and advanced cell technologies. As these facilities scale up, demand for high-purity gas supplies for etching, doping, and thermal treatments follows suit. The alignment of renewable energy goals with manufacturing competitiveness positions industrial gases as strategic inputs in India's solar sector expansion and broader energy transition agenda.

Impact of PLI on industrial gases market

The Production Linked Incentive (PLI) schemes introduced by the Government of India have accelerated investments across key manufacturing sectors such as electronics, specialty steel, pharmaceuticals, automotive and advanced chemistry cells. The expansion of domestic manufacturing capacities under these schemes has led to incremental demand for industrial gases including oxygen, nitrogen, hydrogen, argon and specialty gases.

Greenfield manufacturing facilities established under PLI typically require integrated gas supply solutions, including on-site air separation units, bulk liquid supply and packaged gases, thereby creating opportunities for long-term supply contracts. Sectors such as electronics and semiconductor manufacturing also drive demand for ultra-high purity and specialty gases, supporting value-added product growth for industrial gas companies.

Further, the focus on localization, import substitution and capacity expansion under the PLI framework enhances capital expenditure visibility in core industrial clusters, indirectly strengthening demand stability and long-term growth prospects for the industrial gases industry.

Barriers to entry

The industrial gases industry is characterised by significant entry barriers, including high capital investment requirements for air separation units and distribution infrastructure, specialised engineering expertise, and strict regulatory compliance obligations. Establishing a reliable logistics network and building customer trust require long-term operational experience and scale. The industry also exhibits high customer stickiness, particularly in respect of large on-site customers where

gases are supplied through dedicated pipeline infrastructure pursuant to long-term contracts, typically extending up to 15–20 years. Such integrated supply arrangements make supplier substitution operationally complex and commercially challenging. Additionally, the prevalence of long-term contracts with incumbent suppliers limits immediate market access for new entrants. Furthermore, customers are highly selective in choosing new suppliers for industrial gases due to the critical role these gases play in the overall manufacturing process across industries, and the high costs and risks associated with switching suppliers, especially where product reliability and uninterrupted supply is critical. These structural barriers tend to favour established players with financial strength, technical capabilities, and extensive customer relationships.

Competitive pricing

While reliability and safety are critical, competitive pricing remains an important decision factor, particularly for high-volume industrial consumers. Customers evaluate suppliers based on total cost of ownership, which includes production efficiency, logistics optimisation, service quality, and uptime reliability in addition to pricing. Given that the production of industrial gases involves energy-intensive processes such as air separation, compression and purification, electricity and fuel costs constitute a significant portion of overall operating expenses. As a result, fluctuations in energy prices whether driven by geopolitical developments, supply-demand dynamics or seasonal factors can directly impact production costs and supplier margins. Suppliers that achieve scale efficiencies, optimise distribution networks, and maintain high asset utilisation are better positioned to offer competitive pricing while preserving margins. Accordingly, the ability to secure stable power arrangements, enter into long-term energy procurement contracts and invest in energy-efficient technologies becomes an important competitive differentiator in managing cost structures and sustaining pricing competitiveness.

Policy impact on Liquid Medical Oxygen infra in India (National Oxygen Supply Program, Oxygen Express)

Medical oxygen is a critical component of healthcare delivery, essential for surgical procedures, emergency care and the treatment of respiratory illnesses. The COVID-19 pandemic emphasized the importance of establishing resilient medical oxygen production, storage and distribution infrastructure across the country.

In response, the Government of India implemented several targeted initiatives to augment domestic oxygen capacity and strengthen supply chains. These included financial and policy support under the National Oxygen Stewardship Programme (NOSP), which focused on ensuring adequate availability, rational utilization and monitoring of medical oxygen across healthcare facilities. Complementary measures facilitated the installation of Pressure Swing Adsorption (PSA) oxygen generation plants in hospitals, expansion and modernization of existing liquid medical oxygen (LMO) production units, and greater private sector participation.

Programs such as the Pradhan Mantri Jan Arogya Yojana (PMJAY) and funding support through the PM CARES Fund contributed to the establishment of medical oxygen plants at district and tertiary care hospitals. Regulatory facilitation, including expedited approvals and streamlined licensing processes during the pandemic period, enabled faster commissioning of oxygen generation, storage and distribution infrastructure.

Further, coordinated logistics interventions by the Government, including deployment of Oxygen Express trains by Indian Railways and airlifting of cryogenic containers by the Indian Air Force, strengthened inter-state transportation networks and improved access to oxygen in remote and high-demand regions.

Collectively, these measures have structurally expanded India's medical oxygen ecosystem, enhanced emergency preparedness, and improved long-term supply resilience for liquid medical oxygen in the country.

Average capex requirement for setting up an industrial gas supply plant based on capacity

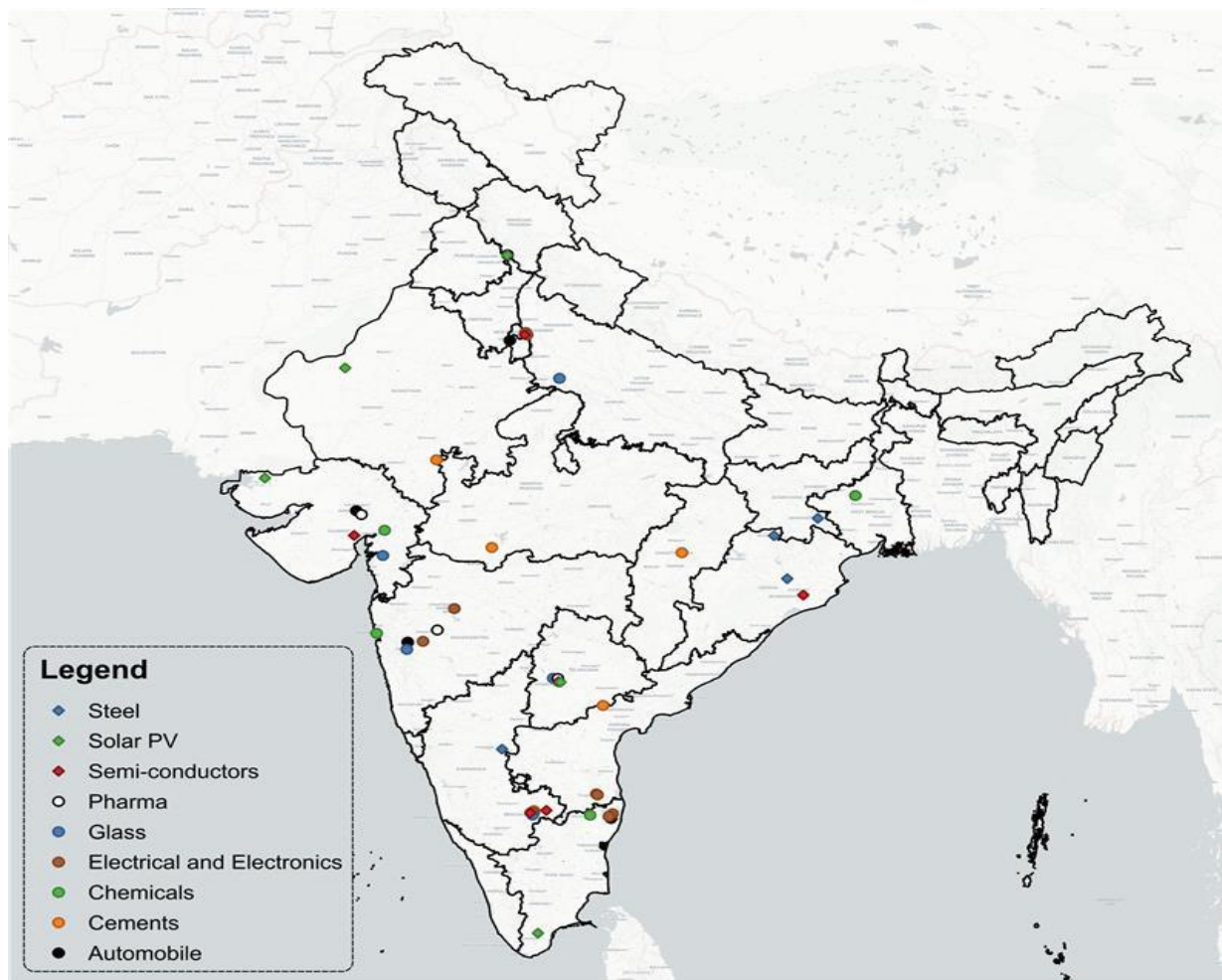
In the industrial gases sector, the capital expenditure for air separation units (ASUs), the core facilities used to produce oxygen, nitrogen, and argon, is significant and varies primarily with plant capacity, product configuration, and site integration requirements. Industry engineering benchmarks indicate that large cryogenic ASUs typically require a capital investment of several hundred crores of rupees, with per-unit costs declining at higher capacities due to economies of scale.

In the small plant category (<200 TPD), investments are relatively moderate and focused on decentralized and rapid-deployment solutions. For instance, Air Liquide India commissioned a 70 TPD air separation unit (ASU) along with a cylinder filling station in Nagpur, Maharashtra, in 2022, with an investment of approximately ₹120 crore. The facility, capable of filling around 5,000 cylinders per day, was developed under Maharashtra's Mission Oxygen Swavalamban scheme. Similarly, INOX Air Products operates a 108 TPD plant at SAIL's Salem Steel Plant under a build-own-operate model, although the investment value for this project has not been disclosed. Typically, small plants involve a capital expenditure of up to ₹60 crore for gaseous configurations and up to ₹120 crore for liquid (cryogenic) units, depending on the deployment scale and application.

In the mid-scale plant segment (200-500 TPD), investments increase significantly as plants serve both industrial clusters and regional healthcare demand. Air Liquide India has established a 365 TPD liquid gas plant at Kosi Kalan in Uttar Pradesh in 2024, with an investment of around ₹350 crore, making it one of the largest liquid gas plants in the state and catering to multiple regions, including Delhi NCR and adjoining states. In parallel, INOX Air Products commissioned a 200 TPD plant (including 150 TPD liquid oxygen capacity) at Hosur, Tamil Nadu, in 2022, with an investment of about ₹150 crore. This plant supplies over 100 hospitals, along with industrial customers. These examples suggest that mid-scale plants typically require a capital expenditure of ₹100-200 crore for gaseous configurations and ₹150-400 crore for liquid plants, reflecting higher infrastructure requirements and broader supply capabilities.

In the large plant category (>500 TPD), investments are substantially higher and are typically linked to long-term industrial demand. INOX Air Products' ASU at SAIL Bokaro in Jharkhand represents a significant example, with a total capacity of 2,150 TPD and an investment of approximately ₹750 crore. The plant includes 2,000 TPD gaseous oxygen, 150 TPD liquid oxygen, 1,200 TPD nitrogen, and 100 TPD argon. Additionally, the company operates another ASU at the same site with a capacity of 1,250 TPD, although the investment for this earlier unit has not been disclosed. More broadly, large plants typically involve a capital expenditure of above ₹300 crore for gaseous on-site units and above ₹500 crore for large cryogenic liquid plants, driven by their scale, integration with anchor customers, and infrastructure complexity..

State wise major manufacturing units/clusters wherein industrial gas would be required



Source: Crisil Intelligence

The above-mentioned industries represent key end-use segments for industrial gases in India, with demand largely concentrated in established manufacturing clusters. The automobile hubs in Maharashtra (Pune–Aurangabad), Tamil Nadu (Chennai–Hosur), Haryana (Gurugram–Faridabad) and Gujarat (Sanand) drive significant consumption of oxygen, nitrogen, argon and specialty gases for fabrication, welding and heat treatment. Steel-producing states such as Odisha, Chhattisgarh, Jharkhand and Karnataka account for substantial oxygen demand for blast furnace and steelmaking operations.

Similarly, cement clusters across Rajasthan, Andhra Pradesh, Madhya Pradesh, Chhattisgarh and Karnataka, and glass manufacturing centers in Uttar Pradesh, Maharashtra and Gujarat contribute to steady bulk gas consumption. The pharmaceutical and chemicals hubs in Gujarat, Maharashtra, Andhra Pradesh, Telangana and Himachal Pradesh require medical-grade oxygen, nitrogen and specialty gases for process applications. Emerging sectors such as solar PV, semiconductors and electronics manufacturing in Gujarat, Tamil Nadu, Uttar Pradesh, Karnataka and Telangana are expected to drive incremental demand for high-purity and specialty gases. Accordingly, industrial gas demand in India is closely aligned with the geographic concentration of these manufacturing ecosystems. A diversified customer base, spanning various segments and products, along with a broad geographical presence, offers industrial gas companies the

opportunity to effectively meet customer needs while reducing dependence on any single customer segment. This approach also helps cushion the impact of cyclical trends in specific industries. Also, companies in the industrial gas sector aim to maximize renewable energy sourcing within applicable regulatory frameworks, leveraging their renewable energy share as a means of reducing power cost volatility and enhancing sustainability credentials. These initiatives are expected to reduce power cost volatility and enhance sustainability credentials.

Major capex plan across end-user industries and the growth of on-site business

Several large Indian industrial corporates have publicly disclosed multi-year capital expenditure plans that signal sustained expansion across core industrial sectors and provide strong visibility for ancillary infrastructure demand. Tata Steel has officially earmarked a Rs. 15,000 crore capex for FY2026, with approximately Rs. 11,000 crore dedicated to domestic projects, including brownfield capacity expansion, blast furnace and electric-arc furnace projects at its Indian operations, reflecting continued steel sector investment momentum. In the automotive and electric vehicle segment, Tata Motors has announced plans to invest up to Rs. 35,000 crore over the next five years to expand EV and new car manufacturing capacity, aligning with India's EV adoption goals. In metals and materials, Hindalco Industries announced Rs. 21,000 crore smelter expansion. These projects form part of Hindalco's broader growth capital expenditure programme, with around Rs. 37,000 crore planned for Odisha across upstream and downstream aluminium operations. In the renewable energy and solar value chain, Tata Power is progressing plans to establish a 10 GW solar wafers and ingots manufacturing plant, representing one of the largest solar manufacturing capex commitments in India. In the glass manufacturing industry, Asahi India Glass Limited has entered a 20-year green hydrogen offtake agreement backed by a solar-powered electrolyser that produces up to 190 tonnes per annum of green hydrogen for its Soniyana facility, marking a significant decarbonisation-linked capex at an industrial customer site. INOXAP's long term, onsite gas supply partnership with AM/NS India began in year 2005, when erstwhile Essar Steel awarded a contract for an 885 TPD Cryogenic ASU on BOO basis. Essar Steel then outsourced the majority of its captive ASUs resulting in INOXAP acquiring all 3 ASU assets of 1700 TPD capacity each from Essar Steel in 2015 and entered into a long term contract for supply of all Industrial Gases on a BOO basis. At an investment of INR 300 Cr, INOXAP's 5th cryogenic ASU at AM/NS India's Hazira plant, would have the capacity to generate 700 TPD of Gaseous Oxygen and 300 TPD of Gaseous Nitrogen along with other liquid gases. These large-scale, company-level capex commitments across steel, automotive, metals and clean energy sectors underscore long-term industrial growth trajectories and create an environment for on-site energy, gas supply and utility infrastructure investments over the medium to long term.

Note: The examples set out above are indicative and not exhaustive.

Recent investments by key players in India

Recent investments by leading industrial gas players in India reflect continued capacity expansion aligned with growth in steel, glass, solar and advanced manufacturing sectors. For example, INOX Air Products commissioned its first green hydrogen manufacturing plant at the facility of Asahi India Glass Limited in Soniyana, Rajasthan, under a 20-year supply arrangement, with the solar-powered plant designed to produce up to 190 tonnes per annum of green hydrogen for float glass manufacturing. Further, the company entered into a long-term Build-Own-Operate agreement to install a dedicated cryogenic air separation unit for Premier Energies Limited to support solar cell manufacturing. Globally diversified players are also expanding in India: Linde India Limited announced expansion of its long-term agreement with Steel Authority of India Limited to build and operate a new 1,000 TPD air separation unit at Rourkela to support SAIL's steel capacity expansion, Linde's investment is expected to be approximately \$60 million. Similarly, Air Liquide India has commissioned new air separation capacity in North India having invested around Rs. 350 crore, in a unit with a production capacity of 350 TPD, and has announced additional investments to strengthen supply to automotive, electronics and healthcare segments.

These investments highlight sustained capital deployment by industrial gas suppliers to support long-term industrial growth and decarbonisation initiatives in India.

Evolution of Supply Models in the Indian Industrial Gases Market

The Indian industrial gases market operates primarily through two established supply models: long-term Build-Own-Operate (BOO) arrangements and merchant supply from industrial gas companies. These models form the backbone of the industry, providing large consumers with reliable, energy-efficient and professionally managed gas supply solutions. In parallel, a portion of demand continues to be met through captive production facilities operated by end-user industries. Captive air separation units (ASUs) and hydrogen generation units are typically found in large integrated complexes in sectors such as iron and steel, refining, chemicals and non-ferrous metals, where continuous and high-volume gas requirements historically led industries to install in-house generation assets.

Captive production has traditionally supported operational reliability and alignment with plant-specific consumption patterns. However, captive systems often involve higher lifecycle costs, technology obsolescence risks and operational responsibilities unrelated to the core business of end-users. As a result, the industry has seen a gradual shift toward BOO and merchant supply models, which offer scale efficiencies, improved energy performance, enhanced reliability and reduced operational burden for customers.

This transition is contributing to a progressive rationalisation of captive gas production in favour of outsourced, professionally operated supply solutions.

Few examples of captive industrial gases plants by companies in steel sector:

Company	Plant - location	Capacity
Steel Authority of India Limited (SAIL) – Bhilai Steel Plant	Bhilai, Chhattisgarh	~700 TPD (captive ASU)
Steel Authority of India Limited (SAIL) – Rourkela Steel Plant	Rourkela, Odisha	~700 TPD (ASU-III)
Steel Authority of India Limited (SAIL) – IISCO Steel Plant	Burnpur, West Bengal	3 x 150 TPD (Basic oxygen furnaces)
Tata Steel	Jamshedpur, Jharkhand	1,800 TPD oxygen (ASU) – Originally captive ASU supplying blast furnaces and steel melting shops; now the plant has been purchased by AWIPL who will be responsible for O&M and supply to Tata Steel.
JSW Steel - Dolvi Steel Plant	Raigad, Maharashtra	2,750 TPD oxygen
Jindal Steel and Power - Angul Steel Plant	Angul, Odisha	250 MT Basic Oxygen Furnace (BOF)

Note: The above list is indicative and is not exhaustive

Few examples of captive industrial gases plants by companies in refinery sector:

Company	Plant - location	Capacity
Indian Oil Corporation - Panipat Refinery & Petrochemical Complex	Panipat, Haryana	10,000 Tonnes Per Annum
Mangalore Refinery and Petrochemicals Limited	Mangalore, Karnataka	500 TPA hydrogen (Green hydrogen plant)

Note: The above list is indicative and is not exhaustive

Few examples of captive industrial gases plants by companies in Healthcare sector:

Company	Plant - location	Capacity
All India Institute of Medical Sciences Delhi	New Delhi	~1,000 LPM (PSA Oxygen Plant)
Safdarjung Hospital	New Delhi	~1,000 LPM (PSA Oxygen Plant)
Dr. Ram Manohar Lohia Hospital (RML Hospital)	New Delhi	~1,000 LPM (PSA Oxygen Plant)

Note: The above list is indicative and is not exhaustive

The Indian industrial gases industry has witnessed a growing shift toward the decaptivation of on-site gas generation assets, wherein industrial gas companies assume ownership and operation of existing captive units under long-term supply arrangements. This trend reflects a broader industry transition toward professionally managed Build-Own-Operate (BOO) and merchant supply models, which enable end-user industries to optimise capital allocation, reduce operational and maintenance responsibilities for non-core activities, and ensure reliable, energy-efficient gas supply.

Decaptivation arrangements are increasingly being adopted across major industrial clusters. INOX Air Products has entered into such arrangements with large integrated steel producers, including ArcelorMittal Nippon Steel and Jindal Steel & Power Limited, under which captive air separation units have been transitioned to long-term on-site supply models. Another example is Linde India has expanded its partnership with Tata Steel through agreements to decaptivate two additional air separation units at the Kalinganagar industrial complex, thereby increasing on-site supply capacity under long-term arrangements. Similar structures are being implemented across other sectors, where industrial gas companies install, own and operate air separation units or hydrogen generation facilities within customer premises. As this shift continues, captive gas infrastructure at large industrial sites may represent a potential avenue for expanding on-site supply networks over time.

West Asia Crisis Impact

India's industrial gases industry entered fiscal 2026 from a position of underlying strength. Demand from the steel sector was growing at a double-digit pace, supported by infrastructure spending and capacity expansion. Healthcare and pharmaceutical applications also remained robust, while the emerging electronics manufacturing ecosystem, supported by PLI schemes, began generating premium demand for high-purity specialty gases. This momentum continued through the first three quarters of fiscal 2026. However, the escalation of the West Asia conflict in late February 2026 materially changed the industry's operating environment in the fourth quarter, affecting costs, demand visibility, and supply-chain resilience. The impact on the industrial gases sector was largely indirect. End-use industries such as metals, ceramics, and glass,

which rely on gas-fired furnaces, were adversely affected by tighter LNG availability and higher fuel costs. Many small and mid-sized operators in these segments curtailed production in March 2026, leading to a sharp decline in demand for industrial gases during the quarter. The fertilizer and chemicals sectors faced further disruption because natural gas is a key feedstock for ammonia and urea production, reducing operating rates and associated gas demand. The refinery segment, a major consumer of hydrogen, was also affected, with certain plants, including Mangalore Refinery and Petrochemicals, suspending selected operations due to crude supply uncertainty. Taken together, these disruptions created a concentrated demand shock in the fourth quarter across industries that account for a meaningful share of industrial gas consumption.

Review and outlook of the Indian steel industry

Historic growth review and outlook of market size

The steel demand witnessed an estimated growth of 11.6% in fiscal 2025, driven by strong demand from end-user sectors such as building and construction, infrastructure, and capital goods. However, the automotive sector experienced a slowdown in the steel-intensive commercial vehicle segment, primarily affecting Medium and Heavy Commercial Vehicles (MHCV) segment. Flat steel has achieved a growth rate of 15% year on year. A notable rapid surge in consumption has been seen in the non-alloy segment, with CR coils/sheets (Cold Rolled), Galvanized Plain (GP)/ Galvanized Corrugated (GC) sheets/coils & Galvalume and large-diameter steel pipes experiencing growth of 7.1%, 24.7%, and 33.1% respectively. Meanwhile, the long steel segment has experienced a growth rate of 9% year on year, with non-alloy bars and rods increasing by 9.9%.

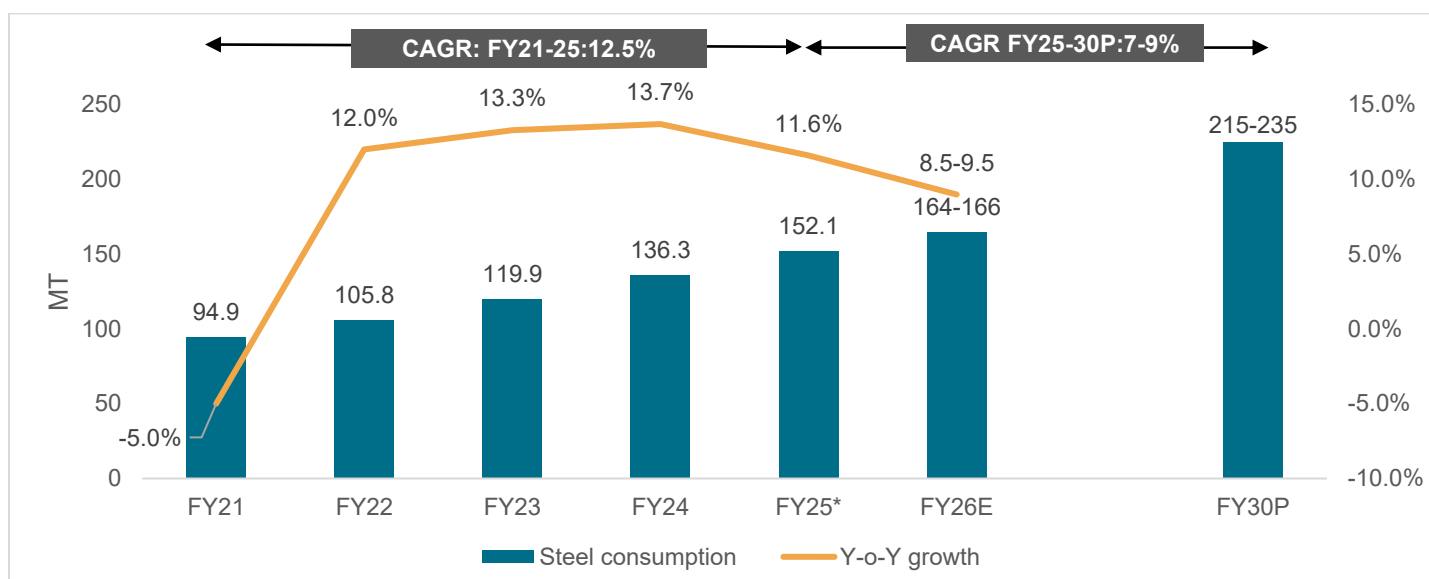
The domestic demand is expected to grow at 8.5-9.5% year on year in fiscal 2026 driven by healthy demand across the sectors including building and construction, infrastructure and automotive.

Key growth drivers and trends

Growth by end users: Infrastructure is expected to witness a growth rate of 10-12% year-on-year. The building and housing segments are expected to witness a growth rate of 7-9% year-on-year. A healthy housing market in the top 7 cities and an increase in individual house constructions across the country are supporting this segment. Additionally, it has been observed that traditional brick-and-mortar construction methods are being replaced with RCC (Reinforced Cement Concrete) type construction to increase the pace of construction and reduce overall costs. Meanwhile, in the commercial space, the trend of prefabricated steel buildings is gaining increased adoption in India. Government initiatives, such as the Pradhan Mantri Awas Yojana (PMAY), are further supporting this segment. In the automotive segment, production growth rates are expected to rise from a lower base. The increase in commercial vehicle (CV) production growth in fiscal 2026 is influencing this segment. The Domestic CV and PV sales are projected to grow at 4-6% CAGR and 5-7% CAGR respectively between fiscal 2025 and 2031, driving the demand for steel products.

Growth by steel type: Flat steel is forecast to increase by 9-11% year-on-year, whilst long steel is predicted to rise by 7-9% year-on-year. The flat steel sector is expected to experience higher growth due to strong demand and increasing usage of flat steel in end-user sectors such as building and construction, infrastructure, automotive, and capital goods. Furthermore, steady progress in urban housing is driving demand for flat steel and continues to boost its uptake.

Trend in domestic steel demand growth



Note: *:provisional E: Estimated; P: Projected

Source: Joint Plant Committee, Crisil Intelligence

Across product categories, healthy demand from steel consuming segments such as building and construction, infrastructure and capital goods has supported the overall growth rate.

Infrastructure to continue dominating steel end use mix

	Share of steel consumption	Growth in FY22	Growth in FY23	Growth in FY24	Growth in FY25*	Growth in FY26P
Building & construction	35-40%	10%	11%	14%	11%	7-9%
Infrastructure	30-32%	12%	17%	15%	14%	10-12%
Automotive	5-7%	15%	21%	6%	2%	4-6%
Engineering & Packaging	23-27%	11%	10%	13%	12%	8-10%

Source: Crisil Intelligence

Infrastructure: NHAI ongoing Projects to support the steel demand growth in fiscal 26

Within infrastructure, roads have been the largest contributor to steel demand, followed by railways, irrigation, and urban infra. In the budget 2025-26, the Central government's capital expenditure has remained at the same level for the road ministry and railways compared to previous fiscal with the quantum of the capex still being high. Infrastructure to continue its steady momentum, led by the government's spending, primarily across its flagship schemes, such as PM Gati Shakti, PMGSY and the National Infrastructure Pipeline. Projects focusing on port connectivity, tourism infrastructure and amenities on islands, including Lakshadweep, to also support the infra segment along with ongoing metro construction, and development of airports. Also, a 10% rise in capex for core infrastructure ministries for fiscal 2026BE over fiscal 2025RE is expected to support the demand growth of the infrastructure segment to 6.0-7.0% in fiscal 2026. The government's focus on developing dedicated rail corridors for the energy, mineral and cement sectors, higher budget allocation for metro, UDAN

scheme for airports, expansion of metro rail and Nammo Bharat to more cities, ongoing NHAI road projects should continue to support infrastructure demand in fiscal 2026.

Roads: The allocation for MoRTH is further distributed towards NHAI and roads and bridges construction. The budgeted capex for roads and bridges has increased moderately by 5% in fiscal 2026BE (Budget Estimates) over fiscal 2025RE (Revised Estimated). Similarly, the NHAI has been allocated a marginal 1% increase in capex in fiscal 2026BE compared to the previous fiscal 2025RE under MoRTH. While there is no growth in overall allocation for MoRTH and Railways, the high quantum of capital expenditure is expected to support steel consumption from construction of roads. A portion of the funds from NHAI will be directed toward completing pending works under the Bharatmala Pariyojana program, an initiative focused on highway expansion and connectivity improvements.

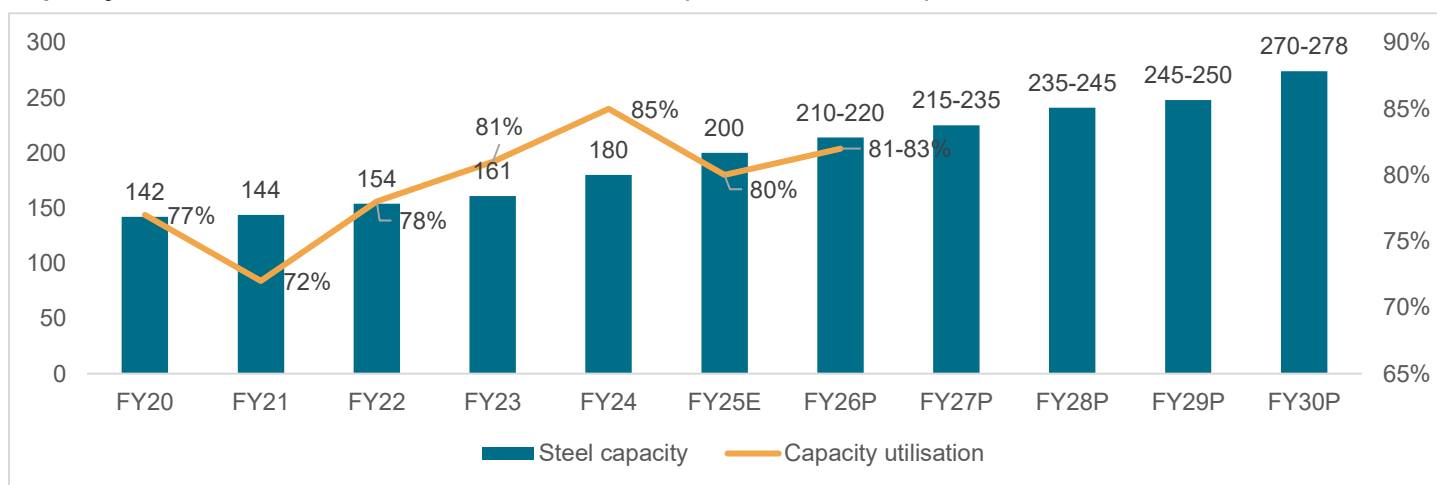
Steel capacity utilization to remain healthy on the back of strong domestic demand

The provisional crude steel capacity stands at 200.3 million tonnes as of fiscal 2025. Steel production experienced a modest 5.5% year-over-year increase in fiscal 2025, despite being hindered by a surge in imports and production halts at major steel mills. The top seven steel producers, accounting for 56.8% of total crude steel output, saw relatively flat growth, while smaller players, holding the remaining share, achieved a notable 12.6% year-over-year increase in fiscal 2025. The addition of approximately 22 million tons of capacity over the past two years contributed to the growth of smaller steel producers in fiscal 2025. Furthermore, the influx of imports has led to a disparity between finished steel production and consumption, with the shortfall being largely bridged by imports and existing steel inventory.

In pursuit of the National Steel Policy's 2031 target of 300 million tonnes, significant capacity expansions are underway. Major steel players, including Tata Steel, JSW, JSPL, and AMNS, are investing in Blast Furnace-Basic Oxygen Furnace (BF-BoF) route expansions. These expansions are expected to increase capacity and drive growth in the steel sector. Notably, Tata's Kalinganagar and JSW's Vijayanagar capacity additions are in the ramping stage.

Other capacity additions are in the pipeline, wherein Integrated Steel Plants (ISPs) have submitted their proposals for expansion. However, such additions are subject to ISPs receiving necessary approvals from various government department ministries. Around 70–75 million tonnes of crude steel capacity additions are expected to be commissioned from fiscal 2026 to fiscal 2030, keeping demand and supply in balance.

Capacity utilisation levels for the Indian steel market (FY2020 – FY2030P)



E: Estimated; P: Projected

Source: Joint Plant Committee, Crisil Intelligence

Several new capacities are expected to be commissioned by fiscal 2030, the pace of which has increased since high profitability in the first half of fiscal 2022. Healthy demand coupled with steady prices due to India's protectionist measures will lead to utilisation levels staying healthy in fiscal 2026.

Utilisation level is expected to reach 81-83% levels in fiscal 2026 despite the sizable additions. For the fiscal year 2026, crude steel production is anticipated to rise by 10.5–12.5% year-over-year, driven by robust demand and the commissioning of new capacity, as well as the ramping up of already added capacities. Although starting from a relatively low base, this growth is expected to lead to a slight increase in utilization rates, which are projected to remain high at 81–83%. The expansion will be fuelled by the addition of new production capacity and strong domestic demand, as well as the implementation of safeguard duties by the Indian government. These duties are expected to reduce the influx of cheaper imports, thereby supporting the growth of the domestic steel industry. In fact, for the first five months, crude steel production, on a low base, has already grown by 12% on-year in fiscal 2026.

Application of industrial gases in the industry

Industrial gases play a critical role in the metal industry by enabling controlled, efficient, and high-quality metallurgical processing across ferrous and non-ferrous segments. Gases such as oxygen, nitrogen, hydrogen, and argon are integral to core thermal and chemical operations, supporting processes including melting applications, and refining for iron and steel, heating for iron and steel, and extrusion for metals. Oxygen is widely used in blast furnaces, basic oxygen furnaces, and ore processing, recovery, and smelting, significantly enhancing combustion efficiency and throughput. Nitrogen and argon enable protective atmospheres for critical heat-treatment operations such as annealing, carburizing, nitriding, and hardening, ensuring uniform microstructures and minimizing oxidation. Additionally, inert gases are essential for inerting, stirring and refining for non-ferrous metals production and inerting and blanketing in high-temperature furnaces.

Advanced fabrication and finishing operations increasingly depend on industrial gases for high-precision applications such as plasma cutting, welding and hard facing, laser processing, hot isostatic pressing (HIP), sintering, metal injection molding, and quenching. Industrial gases such as Argon (Ar) and Nitrogen along with helium are used for high precision applications. These gases are also used in controlled atmosphere storage, heat treating, and cooling processes to maintain metallurgical quality and dimensional stability. The use of oxy-fuel technologies in gouging, cutting, and heating and forming for glass/metal further improves productivity and lowers energy costs. As the industry moves toward low-carbon production, industrial gases also support decarbonizing iron and steel production, oxygen enrichment, and hydrogen-based reduction routes, making them indispensable to modern metal manufacturing.

Review and outlook of end user Indian Hospitals/healthcare delivery industry

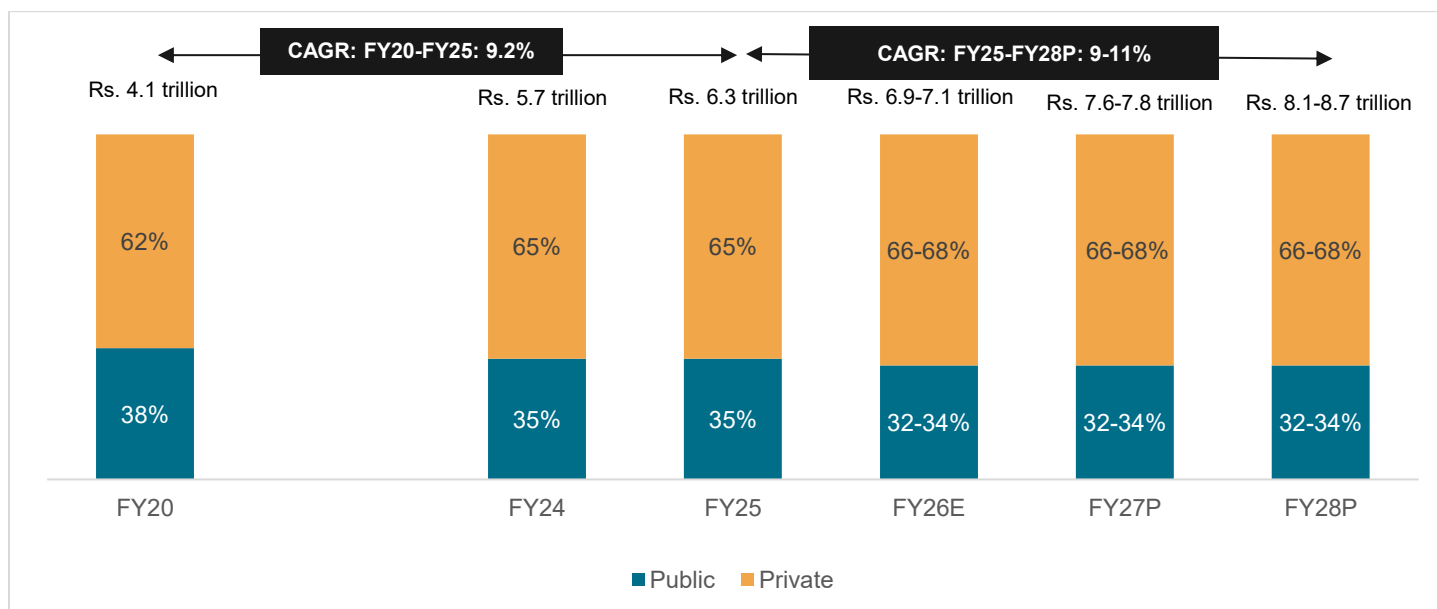
Review and Outlook of Indian hospitals and healthcare delivery industry

The hospital sector is capital-intensive, with costs of ~Rs 8–10 million per bed (excluding land) for tertiary care hospitals, driven by high equipment and technology costs, especially when imported. Despite this, India has only 16 beds per 10,000 population (vs global median of 33). The sector is also labour-intensive, with shortages reflected in 7 physicians and 18 nurses per 10,000 people (vs global medians of 16 and 40, respectively). Healthcare delivery in India is dominated by private players across IPD and OPD, due to limited public healthcare spending and infrastructure constraints.

As per CRISIL Intelligence, the healthcare delivery market grew from ~Rs 4.1 trillion in Fiscal 2020 to ~Rs 6.3 trillion in Fiscal 2025 (CAGR: 9.2%), driven by higher insurance penetration, rising non-communicable diseases, urbanisation, and medical tourism. In Fiscal 2025, private players accounted for ~65% of the market.

Growth remains supported by strong fundamentals, including rising incomes, insurance coverage, and favourable policies. Hospital chains are increasingly focusing on brownfield expansions and entry into Tier 2/3 cities, adopting cost-efficient models such as hub-and-spoke and no-frills formats. Specialty-focused players have shown resilience across geographies.

Review and Outlook of healthcare delivery market



P: Projected

Source: Crisil Intelligence

The sector is expected to grow to ~Rs 6.9–7.1 trillion in Fiscal 2026 (10–12% growth) and at a projected CAGR of 9–11% through Fiscal 2028, led by demand for routine care, elective surgeries, and OPD services. High-growth segments such as critical care, oncology, neurology, and orthopaedics are expected to sustain momentum.

On the supply side, listed players (~8% of private market) plan to add 24,500–25,500 beds during Fiscal 2026–2029, with 17–20% via brownfield expansion. Smaller chains are expected to add 8,000–9,000 beds with capex of Rs 6,400–7,200 crore. States such as Bihar, Maharashtra, Punjab, and Tamil Nadu are likely to see bed capacity double over this period.

Application of industrial gases in the industry

Industrial gases constitute a critical component of the healthcare ecosystem, supporting patient care, surgical procedures, diagnostics, and select pharmaceutical processes. With the expansion of hospitals, diagnostic centres, and overall healthcare delivery infrastructure, the consumption of medical gases has continued to rise, reflecting their indispensable role in clinical operations.

Oxygen remains the most extensively used medical gas, serving as a life-support element for patients with respiratory distress and functioning as a core component of medical air supplied for respiratory therapies and humidification treatments. Carbon dioxide (CO₂) is widely used in minimally invasive procedures such as laparoscopy, arthroscopy, and endoscopy, as well as in cryotherapy applications. It is also used in diagnostic assessments for chronic respiratory conditions, including asthma, bronchitis, and Chronic Obstructive Pulmonary Disease (COPD). Liquid nitrogen is employed for cryosurgical removal of certain cancers, warts, and skin lesions and is also used in various pharmaceutical processing steps. Nitrous oxide continues to be an essential anaesthetic and analgesic agent across a range of surgical and dental procedures.

While post-pandemic healthcare utilisation remains higher than pre-pandemic levels due to strengthened medical preparedness and the growth of healthcare infrastructure, the demand for oxygen and other medical gases has now stabilised at a steady, sustainable level.

Key trends and demand drivers

A combination of economic and demographic factors is expected to drive healthcare demand in the country. Crisil Intelligence believes that the PM-JAY scheme launched by the government would be an addition to these drivers.

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

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

Rising income levels to make quality healthcare services more affordable

Over the years, disposable incomes of Indian consumers and share of households falling in higher income brackets, have both risen significantly and thus, driven up the overall spending power of consumers.

Increasing health awareness to boost hospitalization rate

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

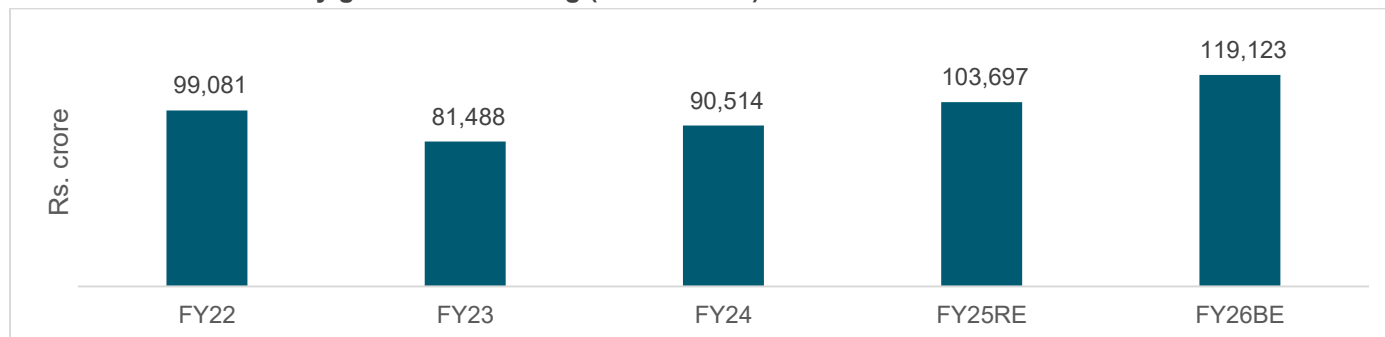
Crisil Intelligence, therefore, believes that the hospitalisation rate for in-patient treatment as well as walk-in out-patients will improve with increased urbanisation and rising literacy.

Healthcare allocation and scheme

The FY26 Budget increased the overall health outlay by nearly 15% to about Rs. 1.2 lakh crore, with roughly 8% allocated to Ayushman Bharat. This heightened spending is expected to largely benefit smaller hospitals, supported by a healthcare expenditure CAGR of 5% and a strong 37% CAGR in PM-JAY (Pradhan Mantri Jan Arogya Yojana allocations) between fiscal 2022A and fiscal 2026BE. Despite this push, many Tier I hospitals remain reluctant to empanel under PM-JAY due to

stringent price caps on high-value procedures and prolonged payment delays, which weaken the scheme's financial viability for larger players. Further, the Comptroller and Auditor General (CAG) audit of PM-JAY highlighted significant gaps in beneficiary verification, hospital empanelment, claims processing, and financial governance, underscoring systemic issues that continue to constrain effective implementation.

Healthcare allocations by government during (FY22-FY26E)



Note: Healthcare spending includes allocation to the Ministry of Health and Family Welfare, Ministry of Ayush, and the Finance Commission's Grants for Health

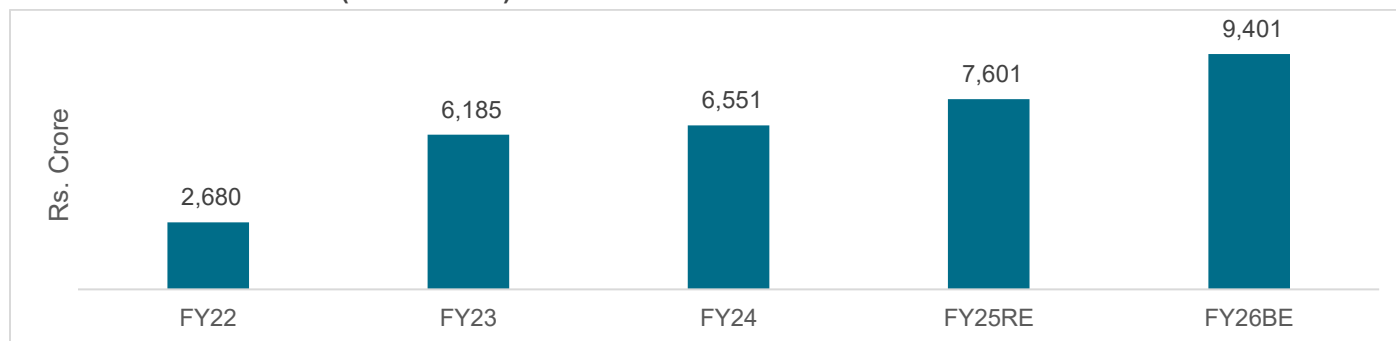
Source: Budget documents, Crisil Intelligence

Pradhan Mantri Jan Arogya Yojana (PM-JAY)

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

- Upgrading sub-centres under physical health infrastructure
- Strengthening government hospitals under physical health infrastructure
- Expansion of health insurance coverage - Ayushman Bharat

Central funds for PM-JAY (FY22-FY26E)



Source: Budget documents, Crisil Intelligence

In a bid to strengthen the country's healthcare infrastructure, the government launched the Pradhan Mantri-Ayushman Bharat Health Infrastructure Mission (PM-ABHIM) in response to the Covid-19 pandemic. The mission aims to enhance healthcare infrastructure in both rural and urban areas, with a planned outlay of INR 64,180 crores (~US\$ 7.40 billion) until 2025-26.

Further demonstrating its commitment to the healthcare sector, the government has initiated several projects to boost domestic production of pharmaceuticals and medical devices. In March 2024, the Union Minister for Chemicals & Fertilizers and Health & Family Welfare inaugurated 27 greenfield bulk drug park projects and 13 greenfield manufacturing plants for

medical devices. The Union Budget 2025-26 has also allocated a substantial INR 99,858 crore (US\$ 11.50 billion) to the healthcare sector, aimed at developing, maintaining, and enhancing the country's healthcare system.

Growing health insurance penetration to propel demand

Government push, rising awareness and accessibility driving insurance penetration. Post pandemic, insurance penetration rose from ~36% in fiscal 2019 to ~41% in fiscal 2024, driven by growing awareness and accessibility.

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

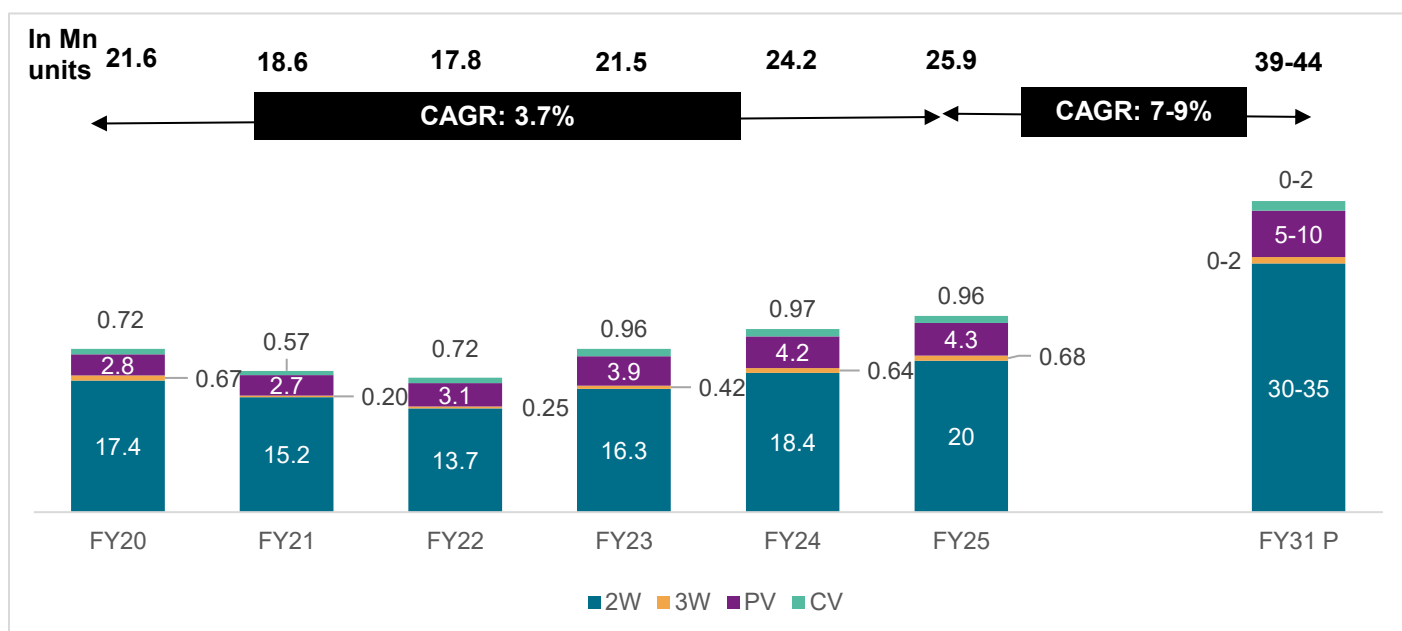
Review and outlook on the Indian Automotive industry

Overview of Indian automotive industry

The Indian automotive industry continues to be led by the two-wheeler (2W) segment, with volumes rising from 17.4 million units in FY20, accounting for nearly 80% of total sales, to 20.0 million units in FY25, contributing about 77% of the overall market. The passenger vehicle (PV) segment shows steady expansion as well, growing from 2.8 million units in FY20, which represented around 12.9% of the market, to 4.3 million units in FY25, forming nearly 16.6% of total sales, supported by personal mobility needs and strong utility vehicle demand. The three-wheeler (3W) category, after facing a sharp decline during the pandemic, increased from 0.67 million units in FY20, making up roughly 3.1% of sales, to 0.68 million units in FY25, contributing close to 2.6% of the market, driven by the rapid uptake of electric autos and the rise of last-mile delivery services. Meanwhile, the commercial vehicle (CV) segment remains relatively steady, moving from 0.72 million units in FY20, which was about 3.3% of total volume, to 0.96 million units in FY25, reflecting around 3.7% market share, supported by improvements in freight activity and infrastructure development. Overall, the automotive industry grew from 21.6 million units in FY20 to 25.9 million units in FY25, indicating a CAGR of about 3.7%, with 2W retaining dominance while PV and 3W gradually strengthen their position.

In fiscal 2025, the two-wheeler industry contributed ~77.0% of the total market comprising two-wheeler, three-wheelers, passenger vehicles (PVs) and commercial vehicles (CVs) by volume. The PV industry contributed to ~17.0%, followed by CVs at ~4.0% and three-wheeler industry at ~3.0% of the total market by volume.

Split by vehicle segment



Source: SIAM, Vahan, Crisil Intelligence

The Indian automotive industry is projected to grow from 25.9 million units in FY25 to about 39-44 million units by FY31, registering a healthy CAGR of around 7-9%. Two-wheelers are projected to remain the largest segment, rising from 20.0 to 30-35 million units (8-10% projected CAGR), supported by strong rural recovery, affordability, and rapid EV adoption. Passenger vehicles are projected to grow from 4.3 to 5-10 million units (5-7% projected CAGR) driven by sustained SUV demand, premiumization, and improved financing access. Three-wheelers and commercial vehicles are set to expand at 3-

5% and 4-6% CAGR respectively, backed by last-mile connectivity, e-commerce fleet demand, and infrastructure-driven freight growth.

Application of industrial gases in the industry

India's GDP growth of 6.5% in FY26, supported by strong manufacturing and infrastructure activity, directly drives demand for oxygen, nitrogen, hydrogen, and specialty gases. Industrial gases are embedded in steel, chemicals, automotive, electronics, and healthcare sectors forecasted to expand steadily.

- Industrial gases play a critical role in the automotive manufacturing value chain, supporting high-precision, high-productivity and quality-driven operations across vehicle and component production. Core gases such as oxygen, nitrogen, argon, hydrogen and carbon dioxide are extensively used in welding, cutting, brazing and heat-treating applications, which are essential for body-in-white assembly, chassis fabrication, structural parts and exhaust system manufacturing. Processes such as plasma cutting, laser processing, plasma welding, hard facing/cladding and metal injection molding rely on controlled gas environments to ensure dimensional accuracy, superior joint strength and reduced rework rates.
- In component manufacturing, industrial gases enable heat treatment processes such as carburizing, nitriding, quenching, annealing and hardening, which are critical for gears, shafts, bearings and transmission parts to achieve the required hardness, wear resistance and fatigue strength. Atmosphere control, inerting and blanketing using nitrogen and argon are vital for maintaining metallurgical integrity during melting, extrusion (a manufacturing process that shapes materials), sintering (process that bonds fine particles of metals/ceramic into a solid) and forging operations. Additionally, gases are used for cooling, cryogenic chilling, cryogenic deflashing and quenching, improving surface finish and tolerances of rubber, plastic and metal automotive components.
- With the gradual transition toward electric and advanced vehicles, the role of industrial gases has expanded further. Applications such as lithium-ion battery production and recycling, integrated circuit and PCB assembly, semiconductor processing and clean-room inerting use high-purity nitrogen, argon and specialty gases to prevent contamination and ensure operational safety. Helium-based leak detection has become critical for battery packs, thermal management systems and air-conditioning units, while hydrogen is increasingly relevant in fuel-cell electric vehicle applications and hydrogen fueling infrastructure. Furthermore, Gas Authority of India Limited (GAIL) has started hydrogen blending in 2022 as a pilot project to establish the techno-commercial feasibility of blending hydrogen in the City Gas Distribution (CGD) network. In 2023, NTPC Ltd commissioned India's first green hydrogen blending project wherein the green hydrogen was blended with the piped natural gas (PNG) network of NTPC Kawas township, Surat.
- Beyond core manufacturing, industrial gases support testing, safety and sustainability objectives in the automotive industry. They are used in environmental testing, low-temperature testing, fire suppression systems, pipeline testing, purging (removing unwanted substances from system) and pressurization across production facilities. Gases also contribute to process cooling, solvent abatement and emission control systems, helping OEMs and component manufacturers comply with tightening environmental and safety regulations while improving overall plant efficiency and product reliability.

Demand drivers

- **Infrastructure development:** The progress of national highways in India has been remarkable over the past decade, with significant growth in terms of length and infrastructure development. Notably, the length of national highways has increased 60.0% from 91,287 km in 2014 to 1,46,195 km as of March 2026. This expansion demonstrates the government's efforts to improve the transportation network. Furthermore, the development of four-lane and above national highways has multiplied more than 2.5-fold to ~48,000 km.
- **Rising disposable income and urbanization:** Rising household incomes, expanding urban middle class, and improving affordability are driving higher vehicle ownership across segments. Urbanization is increasing personal mobility needs, while Tier 2 and Tier 3 cities are emerging as new growth centres for two-wheelers and compact cars. Rural markets, supported by improving farm income and access to finance, are also contributing to sustained demand momentum.
- **Premiumization:** In the PV segment, customers are steadily shifting from entry-level hatchbacks towards compact and mid-size SUVs, supported by demand for higher ground clearance, enhanced safety, and connected technologies. SUV penetration has crossed 50.0% of overall PV sales, while the small-car category shows contraction. Also, cars with ADAS features and connected technologies are preferred more. A similar shift is visible in two-wheelers, where consumers are moving up from 100–110cc commuter motorcycles to 125cc+ and premium 150cc–350cc models, reflecting preference for performance, fuel efficiency, and feature-rich offerings. Within CVs, small commercial vehicles (SCVs) have seen penetration of electric variants, while M&HCVs are witnessing increasing preference for vehicles equipped with telematics, ADAS-ready platforms, and improved driver comfort.
- **Vehicle penetration per population:** According to Crisil Intelligence, car penetration was 26 per 1,000 people in India as of fiscal 2024 which was significantly lower than that of developed countries and even emerging economies such as Brazil, Russia, and Mexico. India had around 147 two-wheelers for every 1000 people. This two-wheeler penetration of India is much lower than many of the countries like Indonesia (469 per thousand people), Thailand (315), Sri Lanka (276), and Brazil (156) as per the International Road Federation - World Road Statistics 2025 report. This provides significant headroom for growth, especially given the expected increase in disposable income, faster economic growth, younger population, and increased focus of international OEMs.
- **Policy Support and Incentives:** Government initiatives such as FAME-II, PLI for Auto & Advanced Chemistry Cells, and Scrappage Policy are encouraging both traditional and electric vehicle production and adoption. Lower GST on EVs and incentives for localization of components are further driving the industry.
- **Financing and leasing ecosystem:** Enhanced financing access has improved vehicle affordability and penetration. Banks, NBFCs, and fintech players offer faster approvals and competitive interest rates, expanding credit reach across urban and rural segments. Emerging models such as vehicle subscription and leasing are appealing to buyers, especially in metro markets, helping boost new vehicle registrations.
- **Electrification Push:** India's move toward green mobility is reshaping the industry landscape. EV penetration is accelerating, especially in the two- and three-wheeler segments, supported by incentives under FAME-II, declining battery costs, and private investment in charging infrastructure. OEMs are committing to net-zero targets, and state EV policies (e.g., Delhi, Maharashtra, Tamil Nadu) offer additional purchase and manufacturing incentives.
- **Growth in e-commerce:** The rapid expansion of India's e-commerce sector has emerged as a demand driver for the automotive industry, particularly within last-mile and mid-mile logistics. With rising online retail penetration, faster

delivery expectations, and deeper rural reach, e-commerce platforms and third-party logistics operators are expanding and upgrading their fleets.

Review and outlook on the Indian Chemicals industry

Overview of the Indian chemical industry

Insight into different chemicals

Review and outlook of Chlor alkali industry

The chlor alkali industry comprises caustic soda, chlorine and soda ash. Caustic soda and chlorine are co-products that form the caustic chlorine market, and the soda ash market has different demand-supply dynamics. Globally, chlorine demand drives the caustic-chlorine market, with caustic soda being a by-product of chlorine. Chlorine is primarily used for manufacturing polyvinyl chloride (PVC), which is used in the construction and automotive industries.

The domestic demand for chlor alkali rose ~6% in fiscal 2025, driven by strong demand from the alumina and glass sectors. The demand is expected to rise 5-7% in fiscal 2026, driven by domestic demand, mostly from the alumina sector (due to capacity addition in the aluminium sector) and glass sector (due to capacity addition in the solar power sector)

Alumina sector to drive Chlor -alkali demand in the medium term

Segment	Share in demand	FY25	FY26E	FY27P	FY28P		
Caustic Soda end users							
Textiles	17-21%	~6%	~3-5%	4-6%	4-6%	↔	Increase in domestic demand, led by readymade garments (RMG) and home textiles; exports gradually recover as well
Alumina	15-20%	~14%	10-12%	13-15%	6-8%	↑	Long-term aluminium demand to be supported by power, construction and automobile sectors
Paper	4-8%	~5%	4-6%	0-2%	6-8%	↔	Growth in e-commerce as well as writing and paper board sectors to strengthen demand
Total consumption		~8%	5-7%	6-8%	4-6%	↔	
Soda ash end users							
Glass	35-40	~5%	5-7%	5-7%	5-7%	↔	Glass demand to be fuelled by an increase in renewable energy and sustainable technologies
Soap and detergent	35-40	~8%	7-9%	7-9%	7-9%	↔	FMCG volumes likely to recover with an improvement in rural demand; demand growth in urban markets to be moderate
Chemicals	13-18%	~5%	3-5%	4-6%	3-5%	↔	Chemical inventory expected to touch historical lows in the next few quarters, which will potentially increase production due to sustained domestic demand
Total consumption		~7%	5-7%	5-7%	5-7%		

↑ High growth

↔ Stable growth

Decline in demand
 No major change
 Slight recovery
 Good in demand

Aluminium demand is expected to log a CAGR of 6-8% until fiscal 2031 due to the gradual rise in the penetration of electric vehicles and increasing usage of aluminium in construction. Glass demand is expected to clock a CAGR of 6-8% between fiscals 2026 and 2031, due to renewable energy capacity addition, driven by solar power plants.

Crisil Intelligence expects demand for chlor-alkali to grow at a moderate rate on account of moderate downstream demand..

Demand drivers for chlor alkali

- Sustained growth in domestic demand from the readymade garments (RMG) and home textiles segments, along with lower cotton prices, is expected to support a gradual recovery in exports, thereby driving demand for chlor-alkali products.
- Alumina production is expected to increase, driven by capacity additions and rising demand from the solar energy and automotive sectors, supporting incremental consumption of chlor-alkali products.
- Demand from the soaps and detergents segment is expected to rise on the back of improving rural growth, supported by increasing income and aspiration levels, while urban demand is expected to remain healthy.
- Demand from the paper segment is expected to be driven by rising requirements from the packaging and paperboard sub-segments, supported by growth in e-commerce.
- The organic chemicals segment is expected to witness robust growth, driven by rising demand from pharmaceuticals, agrochemicals, and specialty chemical applications, supporting chlor-alkali demand.

Review and outlook of Commodity chemicals

The domestic chemical commodity industry expected to rebound in fiscal 2026 on stable demand. Chemical exports remain sluggish amid China's slow economic recovery and domestic oversupply. The commodity chemical expected to grow by 6-8% by volume in fiscal 2026-31P, driven by a recovery in the domestic industry. In the medium term, however, growth is expected to sustain at 6-8% led by recovery in end user segment.

- The domestic capacity of commodity chemicals stood at ~4,500 KT in fiscal 2025 and it is set to increase by 1000-1200 KT by fiscal 2031 driven by capacity addition in carbon black and phenol.
- Exports of commodity chemicals are expected to grow at a CAGR of 12-14% over the next five years, primarily driven by an anticipated 18-22% increase in phenol exports due to capacity additions.
- Imports are expected to rise at a CAGR of 6-8% over the period, driven by stable demand and the absence of major capacity additions in Linear alkyl benzene (LAB)and methanol.
- Commodity chemical industry is facing challenge of high import dependence and input shortage however implementation of BIS quality norms, Anti-Dumping Duty (ADD) and government support will drive the domestic players in the medium term.

Growth forecast

Commodity Chemical	FY20-25 CAGR	FY25E	FY26P	FY27P	FY26-FY31P CAGR
PAN (phthalic anhydride market)	~1%	3-5%	4-6%	5-7%	4-6%
Carbon Black	~7%	7-9%	5-7%	6-8%	5-7%
Methanol	~5%	4-6%	5-7%	5-7%	4-6%

Phenol	~10%	8-10%	8-10%	9-11%	8-10%
LAB (Linear alkyl benzene)	~1%	3-5%	4-6%	3-5%	2-4%
Overall demand growth	~5%	5-7%	6-8%	6-8%	6-8%

Note: P-projected

Source: Crisil Intelligence

Demand drivers for commodity chemicals

- Rising construction activity across the India and Asia-Pacific region is expected to support demand for plasticisers, a key input in PVC production.
- Increasing requirements for corrosion resistance and thermal stability in automotive and construction applications are likely to drive demand for alkyd resins.
- Growth in the paints and coatings industry in developing economies is expected to support alkyd resin consumption, thereby contributing to demand for downstream commodity chemicals such as PAN.
- Increasing preference for lightweight materials in automotive applications is expected to support demand for unsaturated polyester resins (UPR).
- Expansion of application areas across agrochemicals, specialty chemicals, polymers, electric vehicles, and electronics is expected to support broader demand for commodity chemical intermediates.
- Rising surfactant consumption is expected to drive domestic demand for alkyl phenols, a key commodity chemical intermediate.
- Sustained domestic demand from the automotive and packaging sectors is expected to support growth across multiple commodity chemical segments.

Review and outlook of Petro chemicals

The petrochemical demand reached 8% in fiscal 2025 and it is expected to grow at 5-7% in fiscal 2026. Demand in fiscal 2026 will be driven by healthy growth in end user sectors such as automobiles, infra, industrial, packaging, irrigation and construction as the consumption is expected to increase with a growing population, urbanization and rise in income levels.

Domestic supply Scenario

- With demand exceeding supply in domestic market, operating rates are expected to remain healthy and above 90% for majority of the commodities.
- Significant capacity expansions in PE, PP, PVC and ABS will boost domestic supply.
- While limited capacity expansions in SBR and PBR will lead to continued reliance on imports.

Polymers and Olefins to lead demand growth over medium-term

Segment	Share in demand	FY21-25	FY25	FY26E	FY27P	FY26-30P
Polymer	51-53%	10%	7%	7-9%	7-9%	7-9%
olefins	41-42%	6%	14%	1-3%	13-15%	9-11%

Intermediates	2-4%	8%	12%	10-12%	9-11%	4-6%
Engineering plastics	0-2%	9%	9%	7-9%	6-8%	6-8%
Elastomers	0-2%	10%	7%	4-6%	4-6%	4-6%
Overall Petrochemicals		8%	10%	5-7%	9-11%	8-10%



Growth up to 5%



Growth between 5-10%



Growth >10%

Source: Crisil Intelligence estimates

Major Investments

Capital investments of INR 3-3.4 trillion in petrochemicals are planned over the next 10-15 years to reduce import dependency, which currently accounts for over 30%.

Major announced/ under construction petrochemical projects over next decade

Upcoming projects	Investment	Indicative product slate
HRRL, Barmer, Rajasthan	INR 260-300 billion	HDPE – 479 KTPA LLDPE - 479 KTPA PP - 1073 KTPA Butadiene – 146 KTPA Benzene – 134 KTPA Toluene – 104 KTPA
Adani Mundra, Kachchh, Gujarat	INR 350 billion	PVC: 2000 KTPA
Petronet LNG, Dahej, Gujarat	INR 207 billion	PP: 500 KTPA
GAIL, Usar, Maharashtra	INR 113 billion	Propylene – 500 KTPA Propylene derivatives
GAIL, Sehore, MP	INR 600 billion	Ethylene – 1500 KTPA Ethylene derivatives
IOCL, Paradeep, Odisha	INR 611 billion	HDPE, LLDPE, PVC PP, Phenol, Isopropyl Alcohol (IPA)
BPCL, Bina, MP	INR 130-140 billion	Swing HDPE/LLDPE – 650 KTPA HDPE - 500 KTPA PP- 550 KTPA Benzene – 300 KTPA Toluene – 180 KTPA

Note: Total investment includes plants not listed above

Source: Industry, Crisil Intelligence

Application of industrial gases in the industry

Industrial gases are widely used across the chemicals industry to support core production processes, maintain controlled reaction environments, and ensure safe handling of materials. Gases such as hydrogen, oxygen, nitrogen, and carbon

dioxide enable a range of activities including oxidation, reduction, inerting, blanketing, pH control, and purification. Their use helps improve reaction efficiency, enhance safety, and ensure consistent product quality across the broader chemicals value chain.

- In the chlor-alkali segment, gases such as hydrogen and chlorine are used in downstream applications such as hydrochlorination, bleaching, and disinfection. Nitrogen is commonly used for inerting and blanketing storage tanks and pipelines to prevent reactions with moisture or air.
- In the commodity chemicals industry, oxygen, nitrogen, and carbon dioxide support processes such as oxidation, polymerization, and neutralization. Oxygen enhances reaction efficiency, nitrogen provides oxygen-free environments for safe processing and storage, and carbon dioxide is used for pH control and carbonation.
- Within the petrochemicals sector, hydrogen is essential for hydrotreating, hydrocracking, and desulphurization, which improve fuel quality. Nitrogen is extensively used for purging, blanketing, and pressure testing, while oxygen-enriched combustion helps improve furnace efficiency and reduce emissions.

These applications ensure safer operations, stable processing conditions, and improved product efficiency across the chemical value chain.

Demand drivers for Petrochemicals

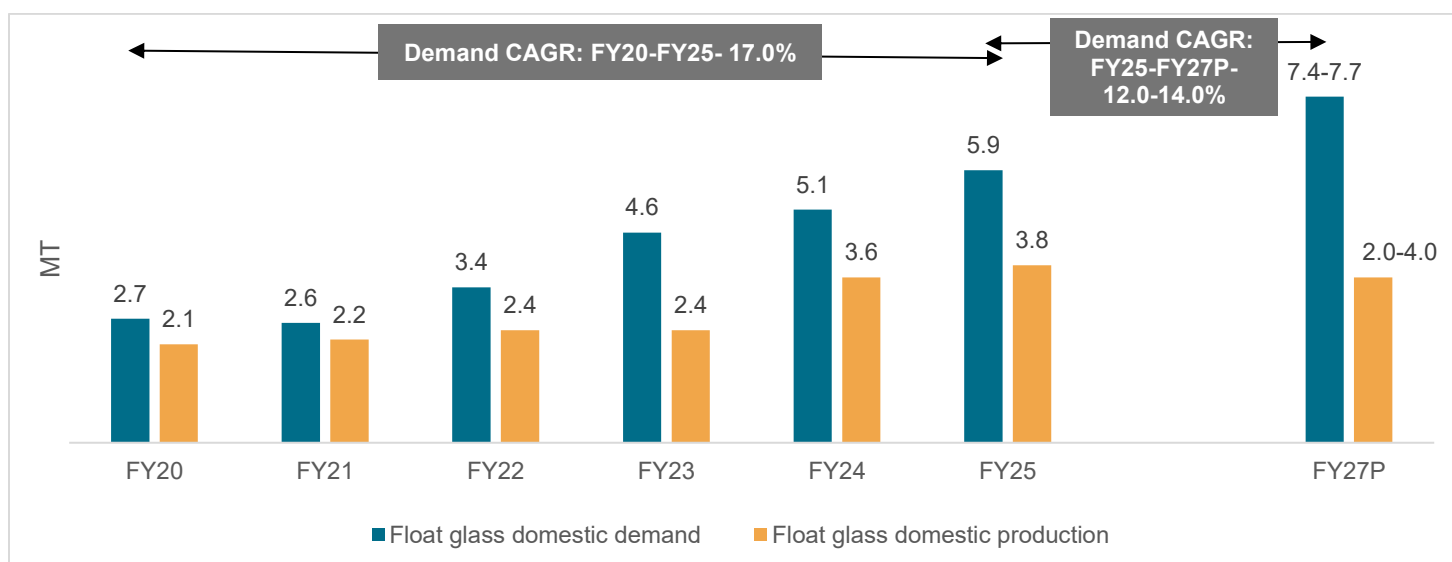
- Increased government spending under infrastructure and housing programs, including higher allocations for the Jal Jeevan Mission and Pradhan Mantri Awas Yojana, is expected to support demand from water supply, sanitation, and housing-related applications.
- Rising urbanisation and population growth, along with continued industrialization, are expected to drive demand for petrochemicals across a range of end-use segments.
- Expansion in the building and construction sector, supported by increased investments, is expected to drive consumption of petrochemical derivatives used in pipes, insulation, and construction materials.
- Growth in the automotive, consumer durables, electrical appliances, and tyre industries is expected to support demand for polymers, rubber, and other petrochemical products.
- Capacity additions by petrochemical manufacturers, in response to rising demand from downstream industries, are expected to support industry growth.

Review and outlook of the Indian Glass industry

As per Crisil Intelligence estimates, the demand for float glass has grown at a CAGR of 17.0% from fiscal 2020 to fiscal 2025 with the demand in fiscal 2025 reaching 5.9 MT from 5.1 MT in fiscal 2024.

For most part of period from fiscal 2020 to fiscal 2025, demand witnessed a moderate recovery after certain state governments revoked pandemic restrictions, partially offset by rising interest rates and capital values. Meanwhile, higher demand for office spaces from MNCs, the entry of foreign players in office space, expansion of the e-commerce sector, expansion of commercial retail projects, emergence of the concept of shared office spaces and a growing preference for green buildings supported demand for float glass.

Indian float glass market demand:



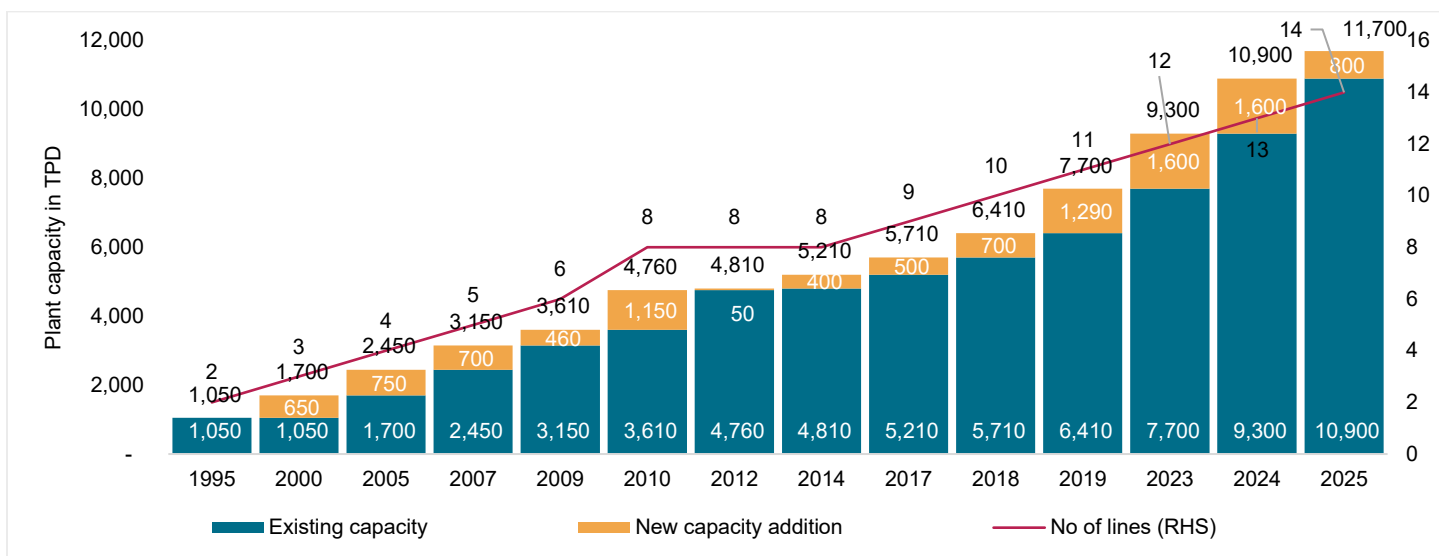
Note: Float glass market includes clear and value-added glass.

Source: Crisil Intelligence estimates

Demand for float glass is expected to rise to 7.4-7.7 MT in fiscal 2027, at a CAGR of 12-14%. Demand revival after the pandemic and faster economic growth should support demand for float glass through fiscal 2026 and beyond. Domestic demand is significantly higher than domestic supply, translating into a growth opportunity for domestic manufacturers.

Existing supply and capacity addition

Domestic float glass industry capacity additions



Note: Industry capacity for CY2026

Source: Crisil Intelligence

Demand drivers

Demand for glass in India is supported by strong growth across construction, automotive, infrastructure and consumer segments. Rising urbanisation, higher household spending and a shift toward modern designs are driving increased adoption of architectural and value-added glass. These factors contribute to steady and broad-based industry demand.

- **Growing standard of living of Indian households**

Rising per capita income has elevated household standards, particularly in urban and semi-urban areas. Glass products such as tinted, frosted, and lacquered glass are increasingly used for aesthetics and privacy in windows, partitions, and furniture. Mirrors are also being adopted more widely for both functional and decorative purposes.

- **Evolving building designs and usage in commercial real estate applications**

Commercial real estate is shifting from traditional materials to glass exteriors, driven by demand for modern aesthetics, solar control, and insulation. The adoption of green building practices among corporates and MNCs is increasing the use of tinted, reflective, and low-e glass. Value-added glass is also enhancing hotel and office interiors, providing both elegance and privacy.

- **Investments in Airports and Large Public Infrastructure**

Modernisation of airports and large public projects such as metro stations and convention centres—has increased demand for flat and value-added glass, valued for visibility, aesthetics, and energy efficiency. Government initiatives like UDAN further support this trend.

- **Automobile Production**

The automotive sector is a major consumer of tempered and laminated glass for windshields, windows, and sunroofs. Growth in vehicle production, premium models, and electric vehicles, along with stricter safety standards, is driving higher glass usage.

- **Demand for Railway and Metro Coaches**

Expansion of railway and metro networks is increasing demand for high-strength, impact-resistant glass in coaches and stations. Government investments in projects like Vande Bharat trains and metro expansions ensure continued growth.

- **Demand from Consumer Durables**

The consumer durables sector including refrigerators, washing machines, microwaves, LED televisions, and kitchen appliances creates consistent demand for specialised and decorative glass. Premium appliances are driving steady demand for decorative and specialized glass, supported by organized retail and frequent upgrades.

Application of industrial gases in the industry

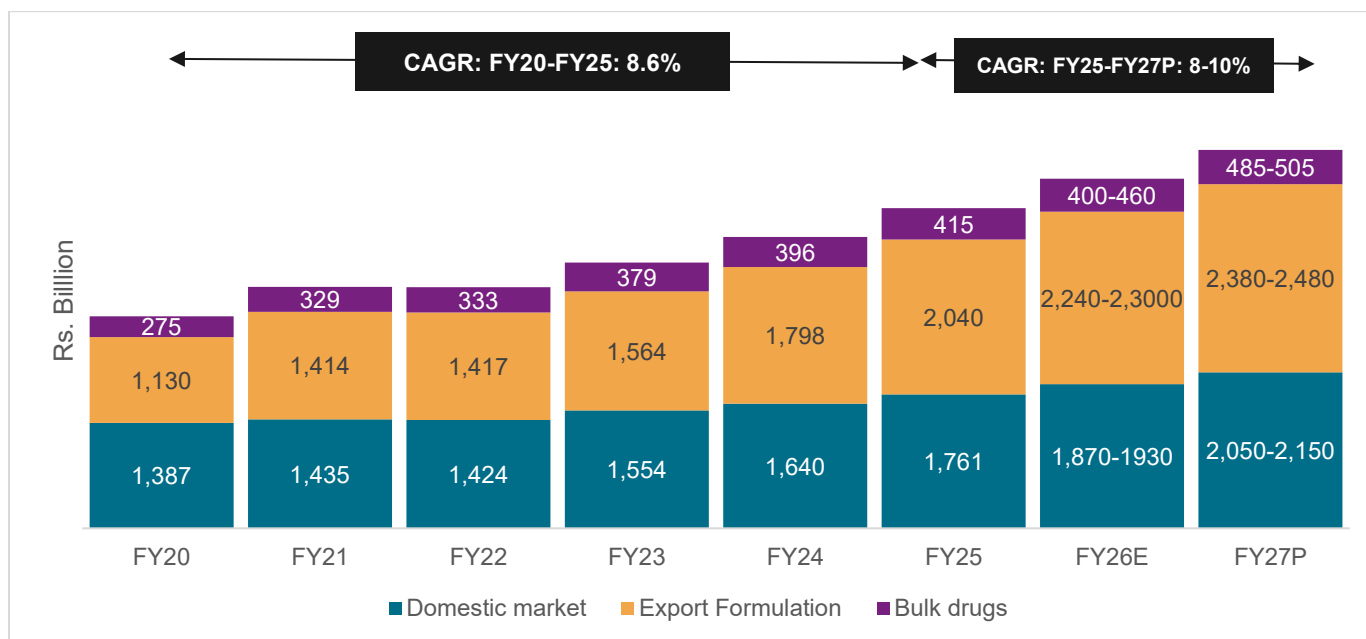
The glass industry relies heavily on gases for various processes, including melting, forming, and finishing. Furnaces used in glass manufacturing are fuelled by natural gas (methane) or other gases like propane, butane, or coal gas, which provide the high temperatures (around 1400°C) needed to melt the glass raw materials. Inert gases like nitrogen (N₂), argon (Ar), or carbon dioxide (CO₂) are used to blanket or purge glass tanks, forehearths, and forming machines, preventing oxidation, reducing defects, and maintaining a stable atmosphere.

Gases are also used in various stages of glass production, such as pressurization and conveying, glass forming and shaping, annealing, and finishing and coating. Compressed gases like air, nitrogen, or carbon dioxide are used to convey glass particles, pellets, or cullet through pipes, and to pressurize vessels and tanks. Additionally, gases like compressed air, nitrogen, or argon are used to shape and form glass products, while nitrogen or air is used to control the cooling rate of glass products during annealing. Insights into float glass industry.

Review and outlook of Indian Pharmaceutical industry

Review and Outlook of Indian pharmaceutical industry

Market size of the Indian pharmaceutical industry



E: Estimated

Source: Crisil Intelligence

Domestic market grew at a CAGR of 4.9% during fiscal 2020 to fiscal 2025. Market size has increased from ~ Rs. 1.4 trillion in fiscal 2020 to ~ Rs. 1.8 trillion in fiscal 2025. The contribution of price and volume to the overall growth was stable at 5% and 2%, respectively, in each of the last two fiscals (2024 and 2025).

Crisil Intelligence estimates, the domestic market to grow by approximately 7–9% in fiscal 2026, over a base of approximately 8% growth during the fiscal 2025. Domestic formulation growth will be driven by an increase in prices and new launches. Demand from the US market is expected to be slightly lower in the near term, due to trade and regulatory uncertainties.

Going forward, this outperformance of chronic therapies is likely to continue due to the expected increase in the incidence of lifestyle diseases, such as diabetes and hypertension, and thereby the demand for drugs required to manage them is also expected to be sustained in the medium to long term.

The export market is estimated to grow ~7-9% in fiscal 2026 year after recording a healthy growth of ~12% in fiscal 2025. Growth will be driven by factors such as new product launches, drug shortages and easing of pricing pressures, however, it will be offset by quality concerns, and currency depreciation in certain markets. Indian players are diversifying into emerging markets in Asia and Africa to reduce their dependence on the US market.

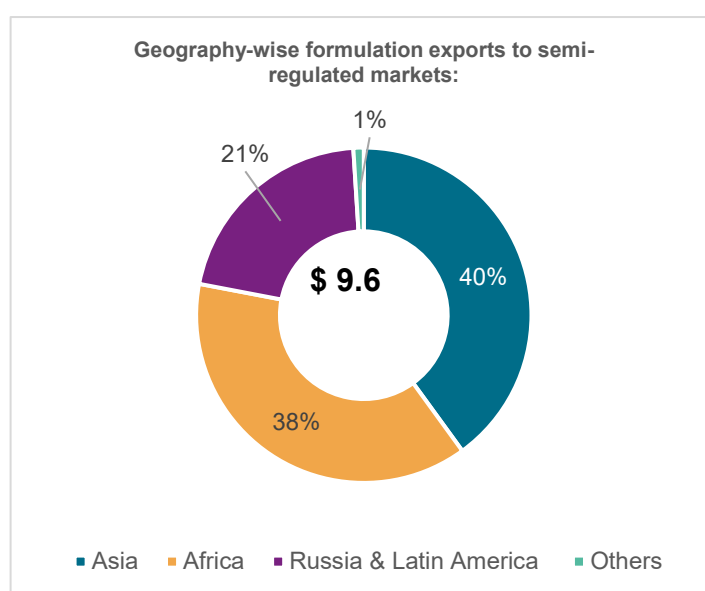
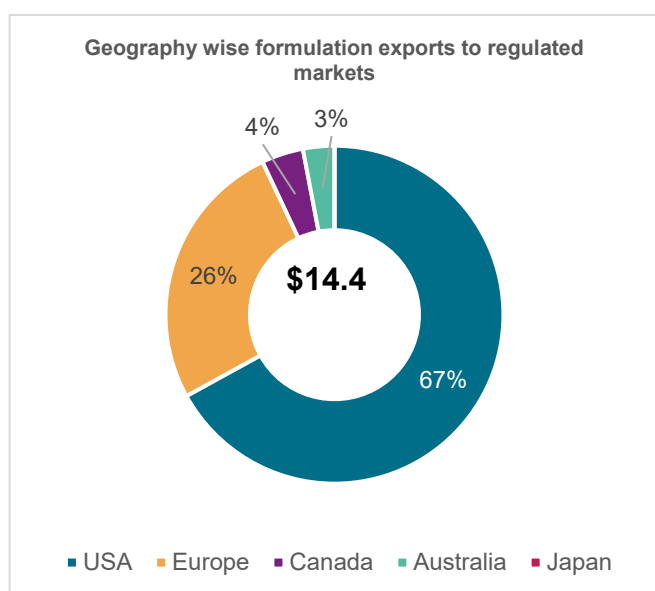
Overall, Indian Pharmaceutical Industry is projected to grow at a CAGR of ~8-10% during fiscal 2025 to fiscal 2027.

Export growth:

Exports grew at a CAGR of ~12.5% between Fiscal 2020 and Fiscal 2025, with 13.5% growth in Fiscal 2025 on a high base. Growth is expected to be driven by new product launches, expansion into low-competition segments, and diversification into untapped markets. The US market, accounting for over one-third of formulation exports, is likely to support growth due to easing pricing pressure and strong ANDA approvals.

Growth in regulated markets is expected to moderate in the near term, led by stabilising pricing and easing drug shortages in the US and Europe. Exports remain a key growth driver for the Indian pharmaceutical industry, supported by rising global healthcare spend and India's cost competitiveness.

India's formulation exports to regulated markets stood at USD 14.4 billion in Fiscal 2025, with the US and Europe accounting for ~67% and ~26%, respectively. While US exports have grown strongly in recent years, easing drug shortages are expected to moderate growth going forward.



Source: Directorate General of Commercial Intelligence & Statistics (DGCIIS), Crisil Intelligence

Application of industrial gases in the industry

Industrial and cryogenic gases such as hydrogen, nitrogen, oxygen, carbon dioxide, argon, and helium play an essential role across multiple stages of pharmaceutical manufacturing, supporting both chemical synthesis and formulation processes. These gases are widely used in the synthesis of active pharmaceutical ingredients (APIs) and intermediates, enabling controlled reaction environments for operations such as hydrogenation for pharmaceuticals, hydroformylation, carbonylation, and other low-temperature or pressure-sensitive reactions. Nitrogen and other inert gases are integral to inerting and blanketing, purging, and sterilization processes, ensuring that products and equipment remain protected from oxygen, moisture, microbial exposure, and other contaminants. These gases also support downstream steps such as particle size reduction for pharmaceuticals, polymer processing, injection or blow molding for packaging materials, and atmosphere control during filling and sealing.

Cryogenic gases such as liquid nitrogen and liquid oxygen are widely used for preservation, stabilization, and storage of temperature-sensitive pharmaceutical products. Liquid nitrogen enables cryopreservation, lyophilization/freeze drying, and low-temperature reactions, helping maintain the structural integrity, potency, and efficacy of biologics, vaccines, enzymes,

and other high-value compounds. The creation of inert, ultra-low-temperature environments using liquid nitrogen and nitrogen gas prevents oxidation, microbial growth, and thermal degradation during processing, packaging, storage, and transit. These applications collectively support compliance with stringent GMP and regulatory standards and make industrial gases a critical enabler of quality, safety, and efficiency for the pharmaceutical sector.

Key trends and demand drivers

India - a preferred manufacturing hub

India has the highest number of USFDA (US Food and Drug Administration (FDA))-compliant plants outside of US, thereby providing Indian companies the opportunity to supply to lucrative regulated markets. USFDA inspections on Indian manufacturing units have yielded favourable outcomes, with only 3% resulting in Official Action as of August 2025. Large sized Indian formulation exporters face relatively lower regulatory risk, as most warning letters and import alerts have been issued to mid & small-sized players.

India maintains lead in total ANDA approvals

Indian pharmaceutical companies continue to maintain a sizable market share in the US generics market. The number of firms seeking abbreviated new drug application (ANDA) approvals and tentative approvals from the US Food and Drug Administration (FDA) is also increasing. Mid- and small-sized formulation manufacturers, who are traditionally engaged in contract manufacturing, are now exploring opportunities to tap into the generic drugs market in regulated markets. The increasing number of ANDA approvals is expected to offset pricing pressure in the US market, with India accounting for ~50% of recent approvals. This positions Indian players well to launch new products and navigate pricing challenges. In CY2024, India's share of ANDA approvals was ~47%, rose to ~50% as of August 2025, solidifying its lead over the US and China.

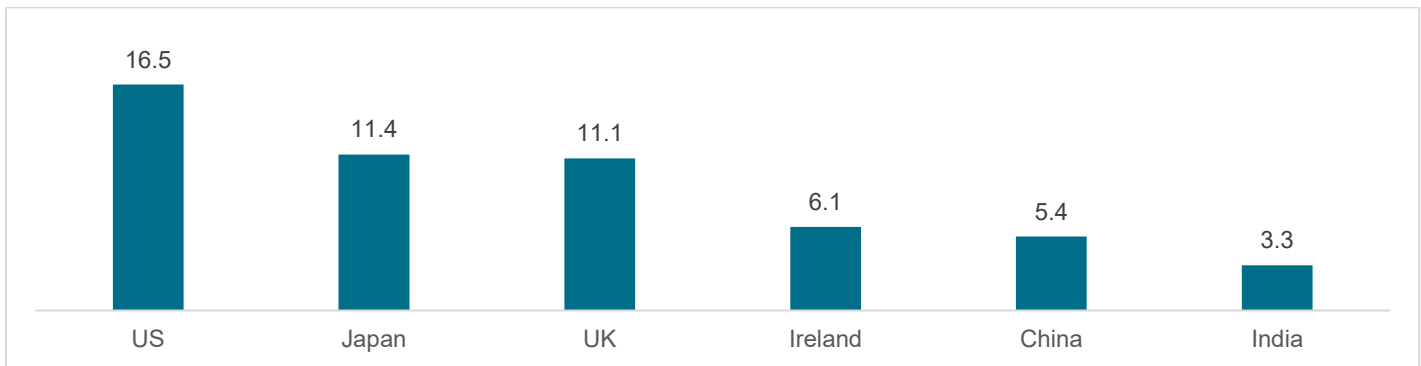
With the highest number of ANDA approvals, India is better positioned than most other exporting countries to address the growing market for generic drugs in the US.

Increasing generic drugs penetration to lower healthcare costs in regulated markets

Developed economies spend a major portion of their gross domestic product (GDP) on healthcare. Going forward, demand for pharma products in developed markets is expected to be driven by factors such as an ageing population and growing incidences of chronic diseases. We believe that austerity measures adopted in Europe will continue to drive demand for generic drugs, though pricing realization may not be as favourable as in the past. On the other hand, healthcare reforms in the US are driving higher insurance coverage and greater usage of generic medicines. Share of generics in the US markets increased from ~80% in CY2010 to about 90% in CY2024 in terms of prescriptions.

India ranks among the lowest in healthcare expenditure globally. As of fiscal 2021, India's healthcare spending was only ~3.3% of its GDP, owing to lower healthcare penetration compared with developed markets such as the US and Europe, which spend about 10-18% of their GDP on healthcare. As per the World Health Organization (WHO) data, India's per-capita expenditure on healthcare is among the lowest in developing countries and, therefore, offers significant potential.

Healthcare expenditure as percentage of GDP for global peers (2022)



Source: WHO, Crisil Intelligence

Ayushman Bharat to support long term growth

Rising lifestyle diseases and growth in insurance penetration (mainly because of Ayushman Bharat) would aid demand for the sector in the long term.

Ayushman Bharat, a Government of India scheme launched in September 2018, is unlikely to have a major impact in the short term. This is because the initial years are being spent on getting the majority of the population enrolled as well as private hospitals' empanelment in the scheme. Nevertheless, the scheme can be a huge positive for the pharma industry in the long run, as it will accelerate healthcare coverage in the country. Ayushman Bharat was launched with the aim to provide diagnostic services and free medicines for preventive care through healthcare centres. Coming to the status update, as of August 2025, around 1.78 lakh Ayushman Arogya Mandir (AAMs) (including sub health centres and primary health centre) in the country have been transformed into Ayushman Bharat-Health and Wellness Centres.

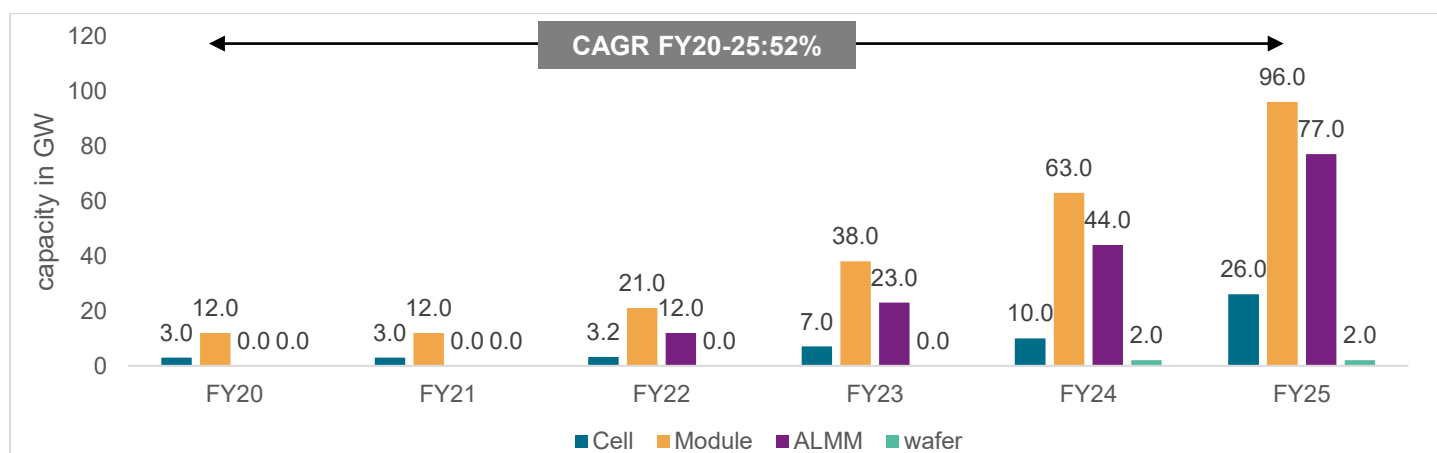
Review and outlook on the Indian Solar Photovoltaic (PV) cell and module industry

Overview of the Indian Solar photovoltaic (PV) industry

Review and Outlook of the Indian Solar PV

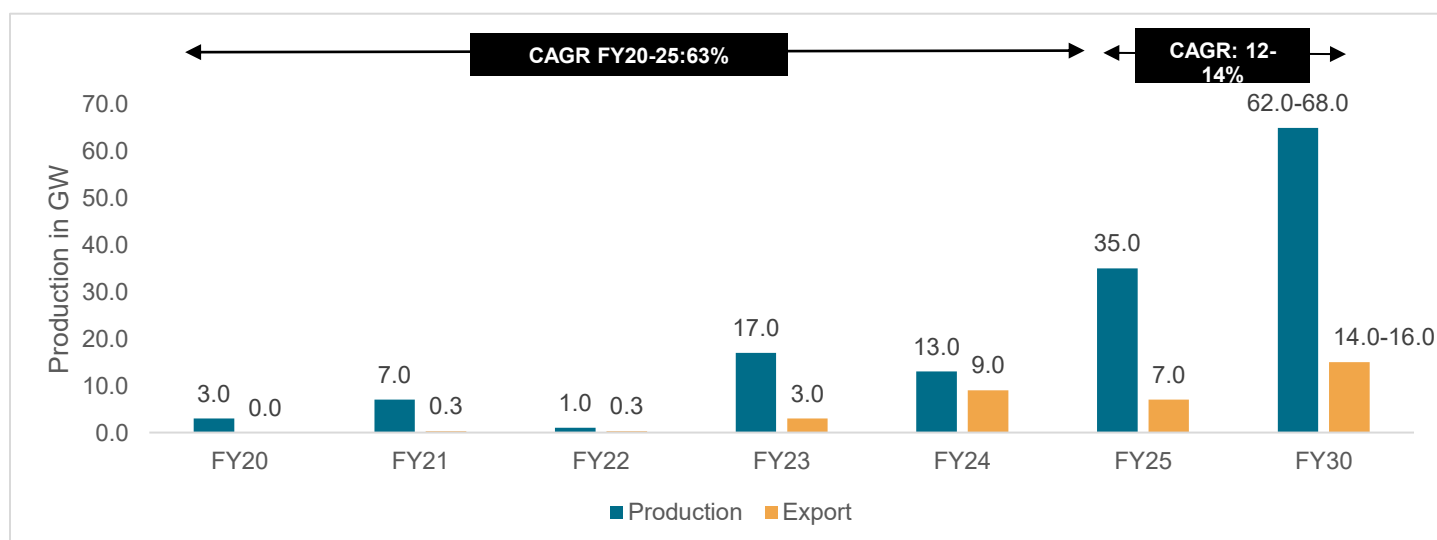
India's solar module manufacturing capacity has increased substantially at 52% CAGR over the period from fiscal 2020 to fiscal 2025. The solar photovoltaic (PV) industry has undergone a remarkable transformation with rapid expansion and significant investments propelling the country to the forefront as a key player in the global renewable energy market. This increase has been driven by government initiatives such as the Production Linked Incentive (PLI) scheme, the reimposition of the Approved List of Models and Manufacturers (ALMM) order, and a robust pipeline of solar projects.

Solar cell and panel manufacturing capacity



Source: Crisil Intelligence

Domestic Solar PV Module demand



Source: Crisil Intelligence

Domestic solar module manufacturing has led to a significant rise in exports, with production increasing from 3 GW in fiscal 2020 to 35 GW in fiscal 2025 (CAGR: ~63%). Exports accelerated in fiscal 2023 and fiscal 2024 but moderated in fiscal 2025. In value terms, exports rose from ~Rs 0.6 trillion in fiscal 2022 to ~Rs 1.6 trillion in fiscal 2024. This growth was supported by the Uyghur Forced Labour Prevention Act (UFLPA), which restricted Chinese imports into the US, redirecting demand towards India and ASEAN, with over 95% of India's exports to the US. However, export value declined ~42% YoY in fiscal 2025 due to a ~36% fall in module prices and weaker demand on a high base.

Supply chain diversification amid US-China geopolitical tensions continues to support exports from India and CMTV countries, though potential tariffs remain a key risk. Ongoing antidumping (ADD) and countervailing duty (CVD) investigations may increase US solar costs and impact imports; however, India remains competitive despite a 10% baseline tariff.

Module imports declined sharply (CAGR: ~60% during fiscal 2021–2025), with value falling to ~Rs 1.0 trillion in 8M fiscal 2025 from ~Rs 3.6 trillion in fiscal 2024 due to ALMM-related policy changes.

Solar cell imports increased, highlighting limited domestic integration. The absence of a fully integrated value chain remains a key risk, exposing the sector to pricing and supply disruptions. However, the partial implementation of ALMM II from June 2026 is expected to accelerate the demand for domestic solar-cell manufacturing. In response, industry participants have announced significant capacity additions. ALMM II already reflected the enlistment of 24 GW of cell capacity in November 2025, suggesting early compliance by manufacturers.

Module capacity is expected to grow ~30–35% in fiscal 2025 to ~120–130 GW in fiscal 2030, supported by technological advancements (500 Wp+ modules) and annual demand of ~40–50 GW (fiscal 2021–2030), driven largely by utility-scale projects (~62%) and rooftop/open access segments. ALMM is also expected to support domestic cell capacity addition.

Module prices declined ~42% YoY in fiscal 2025 due to a ~12% fall in cell prices and ~56% decline in wafer prices, benefiting integrated players. Crisil Intelligence estimates imported cell-based module prices at ~USD 0.13–0.15/Wp (excluding GST) in fiscal 2026, with domestically sourced cell-based modules priced ~55–65% higher.

Domestic module production is expected at ~62–68 GW during fiscal 2025–2030, with exports contributing ~20–25% and the balance meeting domestic demand. Module capacity is expected to nearly double over this period, with ~60–70% of additions concentrated in western and southern states, particularly Gujarat.

Crisil Intelligence estimates investments of ~Rs 150–200 billion during fiscal 2025–2030 to support capacity expansion. These additions are expected to strengthen exports and reduce import dependence over the medium term.

Solar Cell Capacity

Since 2014, India's solar PV cell manufacturing capacity has expanded significantly, increasing from about 1.2 GW in 2014 to nearly 25 GW by March 2025 registering a CAGR of 31.8% during this period. Solar PV cell capacity also grew substantially, from about 9 GW to 25 GW between March 2024 and 2025. By end of fiscal 2026, Crisil Intelligence estimates the solar cell manufacturing capacity to nearly double to 40–50 GW.

Application of industrial gases in the industry

Industrial gases play a pivotal role in the solar cell manufacturing by enabling high material purity, controlled processing environments, and precision across wafer and cell fabrication stages. In upstream processing, gases such as argon and nitrogen are used during silicon melting and refining to maintain inert atmospheres, prevent oxidation, and support the production of high-purity silicon, and are further applied in annealing, heat treatment, and precision cutting during ingot and

wafer preparation. During cell fabrication, chemical vapor deposition and plasma-based processes use gases such as silane (SiH_4), phosphine (PH_3), and ammonia (NH_3) for thin-film deposition, doping, while etching and texturing operations employ hydrogen fluoride (HF), chlorine, nitrogen, and oxygen to remove surface impurities, modify wafer surfaces, and enhance light absorption characteristics. Industrial gases are also used to maintain controlled atmospheres during diffusion, oxidation, and metallization processes, including sintering of metal contacts, and for equipment purging, process cooling, and cleanroom environment control within solar cell production lines. Overall, the use of industrial gases supports consistent process control, improved cell efficiency, and higher manufacturing yields, and expansion of domestic solar cell manufacturing capacity, supported by renewable energy policies and manufacturing incentives, is expected to drive demand for industrial gases aligned with cell-level production processes.

As the industry continues to expand, the demand for industrial gases is expected to rise, creating opportunities for gas suppliers and equipment manufacturers to invest further in India's solar PV module industry and support advanced processing technologies across the value chain.

Growth drivers of the Solar Cell market

The solar cell market is supported by a combination of policy initiatives, downstream manufacturing expansion, and sustained growth in solar power installations. These factors continue to drive demand for solar cells as a critical intermediate component in the solar value chain.

Policy-led shift towards domestic sourcing: Measures such as domestic content requirements under select government solar schemes and the imposition of Basic Customs Duty (BCD) on imported solar cells have supported increased offtake from domestic solar cell manufacturers.

Scale-up of downstream module manufacturing capacity: Rapid expansion of domestic solar module manufacturing has increased the requirement for reliable domestic solar cell supply, driving incremental demand for solar cells.

Sustained solar capacity additions: Continued growth in solar power installations, driven by renewable energy targets and rising electricity demand, supports steady demand for solar cells as a critical intermediate input.

Transition towards higher-efficiency cell technologies: Gradual adoption of advanced cell technologies to improve efficiency and output supports ongoing investments and capacity expansion in solar cell manufacturing.

Growth drivers and restraints of the PV module market

The PV module market in India is poised for substantial growth, driven by a combination of government initiatives, policy incentives, and emerging energy demands. However, the market also faces certain restraints that could impact its trajectory. Below is a detailed analysis of the key demands for drivers and restraints:

Growth drivers

Rising Share for Domestic Manufacturers:

The share of domestic manufacturers in the Indian PV module market is expected to increase significantly, with an estimated 40-50 GW per annum of modules being sourced locally between FY26-30 which is 2.5 times higher over fiscal 2019-2025. The allocated utility scale solar pipeline to drive for 62% of the module demand. This surge in demand for domestically produced modules is driven by several factors:

- CPSU Scheme
- Rooftop Solar Projects (DCR/Government)

- **Open-access solar projects**
- **PM KUSUM Scheme**
- **PM SuryaGhar**

Significant Solar Capacity Additions Expected

Solar power capacity additions are expected to reach approximately 220-230 GW between FY26-30, significantly surpassing the 77 GW added between fiscal years 2020 and 2025.

Competitive Bids and Utility Projects

Competitive bidding processes for utility-scale solar projects, including those requiring adherence to the Approved List of Models and Manufacturers (ALMM), are expected to account for 90-95 GW of installations between FY25-29.

EPC-Oriented Solutions

Engineering, Procurement, and Construction (EPC) services offered by larger players in the market are expected to drive demand for high-quality, domestically produced modules.

Emerging Opportunities in Green Hydrogen and Renewable Generation Obligations (RGO)

In addition to traditional solar power projects, emerging opportunities in green hydrogen production and Renewable Generation Obligations (RGO) are expected to provide an additional upside of 42-47 GW in solar capacity installations between FY25-29. The push for green hydrogen, driven by the need to decarbonize sectors such as transportation and industry, is expected to create new demand for solar power, further boosting the market for PV modules.

Basic Customs Duty (BCD) on Modules and Cells

The imposition of a 40% Basic Customs Duty (BCD) on imported solar modules and a 25% BCD on solar cells, effective from April 1, 2022, is a critical policy measure aimed at protecting the domestic manufacturing industry.

The central benefit provided for the rooftop solar

The central government aimed to achieve 40% of the 100 GW generation capacity target under the National Solar Mission (NSM) from the rooftop segment by 2022, however it fell short by ~31 GW. Hence, favourable policy plays a key role in driving additions. The allocation of Rs 200 billion to the Pradhan Mantri Surya Ghar Yojana in the Union Budget 2025-26 which can aid towards addition of 7-8 GW of potential residential generation capacity and benefit ~25 lakh incremental households. The financial assistance around Rs 124.4 billion has already been released under PM Surya Ghar scheme, as of 31st October 2025.

PLI Scheme

The Production Linked Incentive (PLI) Scheme for the National Programme on High Efficiency Solar PV Modules aims to develop the manufacturing capacity to a gigawatt (GW) scale in high-efficiency solar photovoltaic (PV) modules with an outlay of Rs 24,000 crore. It will promote domestic manufacturing of solar panels and reduce dependence on imports. The scheme aims to incentivize manufacturers to set up production facilities in India and produce high-efficiency solar modules.

This Scheme has provision for PLI to the selected solar PV module manufacturers for five years post commissioning of the manufacturing or sale of solar PV module. The cabinet approved the Scheme Guidelines for PLI on 'National Programme on High Efficiency Solar PV Modules' on 28th April 2021, with an outlay of Rs. 4,500 crores.

Tariff ceiling provisions

US imposed a reciprocal tariff of 26% on India. It was at pause till July 2025 with baseline 10% tariffs on solar cells and modules. Similar tariffs have been placed on all Southeast Asian competitors of India. While the reciprocal tariffs are at pause with 10% baseline, the impact of rates can increase the cost of installation in the US.

Supply chain diversification, owing to geopolitical tensions between China and the US, continues to favour the export market for growing PV economies such as India and Cambodia, Malaysia Thailand and Vietnam (CMTV). However, uncertainty because of tariffs on India and CMTV is expected to impact solar module demand from the US.

Supply dynamics of solar modules

Additional Taxation and ALMM: The Indian government has consistently implemented measures to protect the domestic solar module manufacturing sector from the dumping of imported modules by global suppliers. These measures include the imposition of safeguard duties (previously ranging from 15-25%) and the introduction of a 40% Basic Customs Duty (BCD) on imported modules from April 2022. Furthermore, the non-inclusion of foreign manufacturers in the ALMM list thus far serves as a long-term barrier to imports.

PLI Scheme: The central government's Production Linked Incentive (PLI) scheme, with a financial outlay of Rs. 240 billion, has attracted significant interest from various players seeking to expand their presence in the solar module manufacturing sector. The resulting expansion in high-purity manufacturing environments including polysilicon processing, wafering, cell fabrication, and module assembly is likely to increase demand for industrial gases such as nitrogen, hydrogen, argon, and specialty gases used in inerting, process stabilization, and quality control. As domestic solar manufacturing scales, industrial gas suppliers are positioned to benefit from sustained incremental demand tied to new plant commissioning and ongoing production operations.

Capacity Expansion plans

Players	Capacity expansion plans
Adani Power	3500 MW cell and module (total capacity)
Vikram Solar	2500 MW cell, module and wafer
Waaree Energies	2000 MW module and 500 MW cell
Saatvik	1000 MW module
Renewsys India	280 MW module and 130 MW cell
Premier Solar	1250 MW modules and 750 MW cell
Tata Power Solar	400 MW module and 580 MW cell
BHEL	105 MW cell and MW module
Indostar	450 MW cell and module

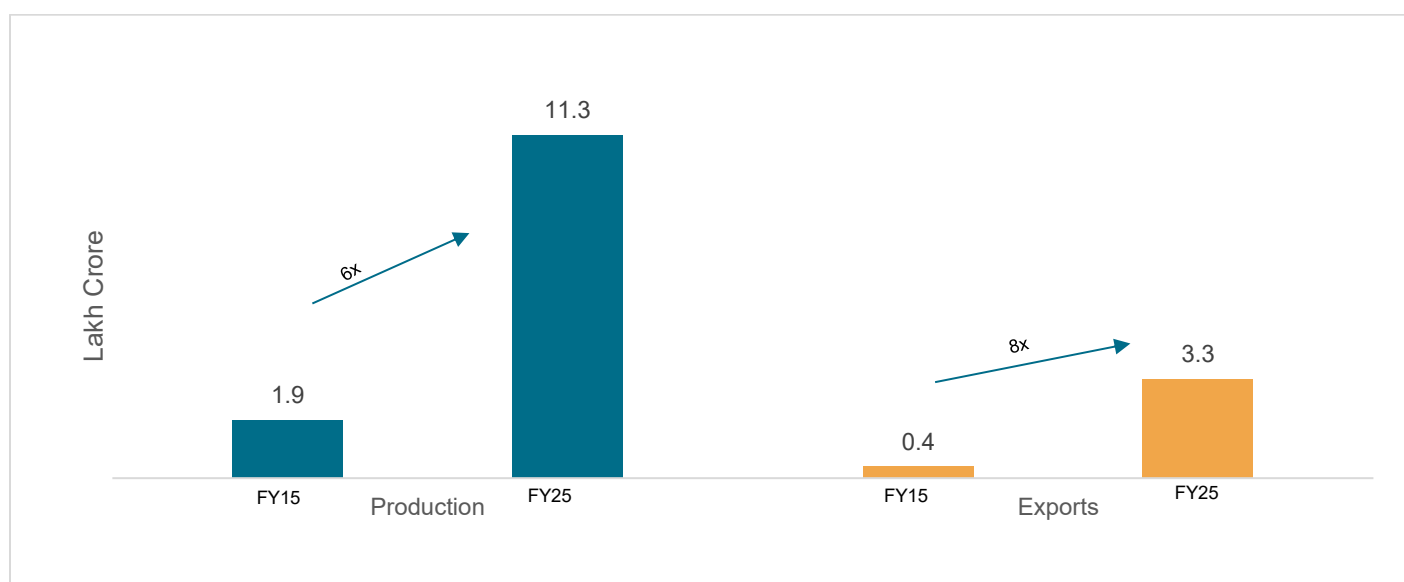
Source: Crisil Intelligence

Review and outlook on Indian Electronics (consumer durables) industry

Overview of Indian electronics industry

According to PIB, electronics has become a vital driver of global innovation, transforming economies through advancements in communication, automation, and connectivity. India has emerged as major electronics manufacturing hub, achieving nearly six times growth in production over the past decade, highlighting its role in economic development and employment generation. Strategic government initiatives such as Make in India and Atmanirbhar Bharat, along with strong policy support, and technological progress, have significantly boosted local manufacturing, exports, and foreign investment. With an ambitious goal to develop a \$500 billion domestic electronics ecosystem by FY31, India is positioning itself as a global technology leader. The sector's rapid expansion underscores India's transformation into a key player in the global electronics landscape, driven by policy, innovation, and a focus on sustainable growth.

Electronics production and export in India

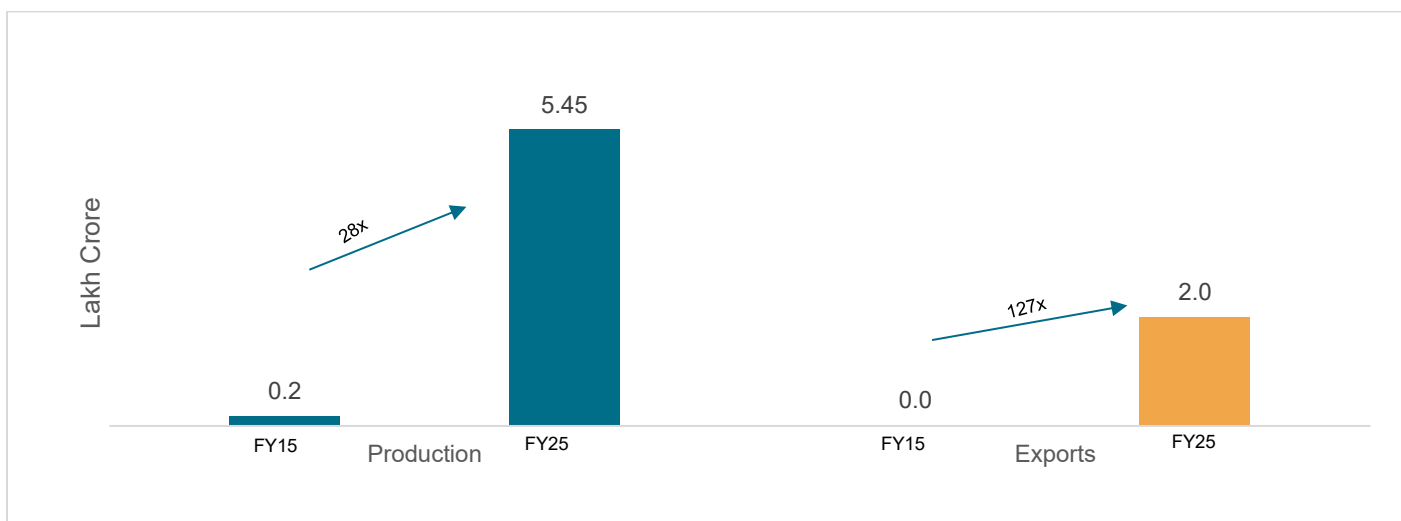


Source: Ministry of Electronics & IT, PIB

India Mobile Manufacturing

According to PIB, India's mobile phone revolution has significantly transformed the nation into a global manufacturing hub. Mobile phone production has surged 28-fold from INR 18,000 crore in FY15 to INR 5.45 lakh crore in FY25, making India the world's second-largest mobile manufacturer. Exports have increased 127 times, reaching INR 2 lakh crore in FY25. Apple exports hit a record INR 1,10,989 crore (US\$12.8 billion), a 42% YoY growth in FY24. In the first five months of FY26, smartphone exports totalled INR 1 lakh crore, a 55% rise over the same period last year. India has achieved near self-reliance, reducing imports from 78% in 2014–15 to manufacturing almost all devices domestically. Notably, in Q2 FY26, India surpassed China as the top smartphone exporter to the United States, cementing its position as a global mobile manufacturing powerhouse.

Mobile production and export in India



Source: Ministry of Electronics & IT, PIB

Electronics are essential to the modern economy, supporting homes, hospitals, factories, and vehicles. They drive efficiency, and innovation across industries, improving performance, and safety. As technology advances, their role in fostering progress and development becomes increasingly vital, making electronics indispensable for societal growth and economic prosperity in a connected, automated world.

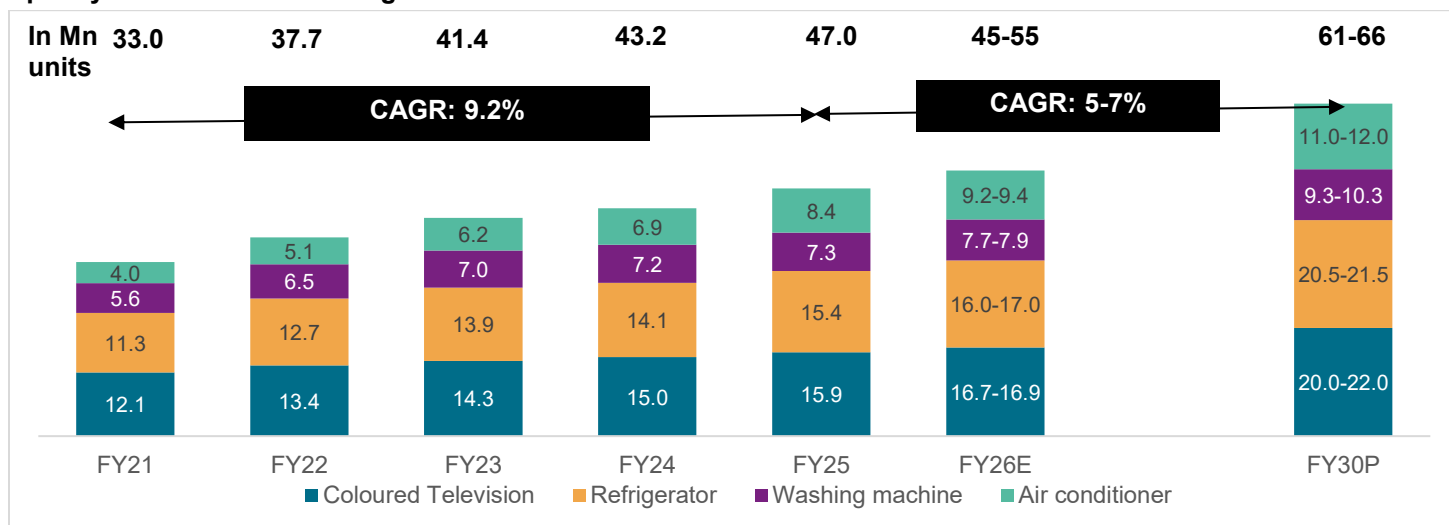
Consumer Electronics

Consumption witnessed moderation in fiscal 2024, which impacted household appliances growth. Unexpected rainfall during the first quarter, combined with inflation, affected volume demand in fiscal 2024. Consumer durables industry grew by 4-5% in fiscal 2024. In fiscal 2025, consumption slowdown was observed in urban middle class. The urban middle class felt the dual pinch of increased food inflation and high interest rates. Growth in premium products, like side-by-side refrigerators and larger TVs (>55"), was largely driven by higher-income groups in urban areas, who are less sensitive to price. Rural areas showed signs of revival. Cooling products, such as ACs and refrigerators, were expected to drive growth in fiscal 2025 on account of high summer temperatures. May recorded the highest average temperature since 1988. Thus, the sector clocked 8-9% volume growth in fiscal 2025. Tax relief, low inflation, interest rate cuts and increased cash in hand for rural households to aid consumer durables, with volume growth of 7-9% in fiscal 2026 primarily driven by ACs.

Within the household appliances space:

- Constrained supply from China has led to upward pressure on TV panel costs in fiscal 2025, leading to higher product prices that has impacted the demand. However, premium products were likely to perform well, driving segment growth of 9-10% in fiscal 2025.
- With a harsh summer in fiscal 2025 coupled with pent-up demand, refrigerator volume has witnessed an uptick and grew by 8-10%.
- Washing machine demand has been impacted in fiscal 2025 on account of consumption slowdown. The first quarter witnessed flat volume growth. Limited recovery was there due to predicted milder winter with La Niña impact. Thus, the segment grew by 0-2% in fiscal 2025.
- For air conditioners, in fiscal 2025, a hot summer and low base led to a significant volume increase, with growth of 45-50% in the first quarter. Growth was normalized from the second quarter onwards; thus, the AC segment achieved healthy growth of 23-25% for the year.

Split by consumer durable segment



Note: E- Estimated, P - Projected
Source: Industry, Crisil Intelligence

Application of industrial gases in the industry

Industrial gases like nitrogen, hydrogen, argon, helium and ultra-high-purity (UHP) speciality gases are crucial in India's electronics industry for manufacturing, assembly, and packaging. Applications include creating inert atmospheres for processes like soldering, material processing and wafer storage to prevent oxidation, high-purity environments for semiconductor fabrication steps like plasma etching and thin-film deposition, and cooling systems to manage heat.

Semiconductor fabrication

- **Inerting and purging:** Nitrogen is used to purge and protect chambers, preventing oxidation of sensitive semiconductor materials and silicon wafers during storage.
- **Heat treatment (Annealing):** Hydrogen is used in controlled atmospheres for annealing and heat treatment to uniformly heat silicon wafers and improve their crystal structure.
- **Deposition:** Hydrogen is used in epitaxial deposition (EPI) to grow thin films of semiconductor materials, while argon is used to support plasma-enhanced chemical vapor deposition (PECVD) and physical vapor deposition (PVD) by stabilizing plasma during deposition and etching reactions.
- **Photolithography:** Argon is a primary plasma gas in dry etching, reactive ion etching (RIE) and deposition processes, and hydrogen can be used to remove tin contamination during the photolithography stage.
- **Chemical Vapor Deposition (CVD):** Ultra-high purity (UHP) gases like ammonia, silane, and dopant gases such as boron trifluoride are used for specific chemical vapor deposition (CVD) and doping processes like plasma doping (PLAD) and ion implantation for precise material layering and electrical property modification..

Assembly and packaging

- **Soldering:** Nitrogen is used to create inert atmospheres in wave soldering and reflow soldering machines to prevent oxidation and ensure reliable connections.

- **Forming:** Specific mixtures of nitrogen and hydrogen are used to form solder balls for chip-to-board interconnections in ball grid array (BGA) packaging.
- **Inerting:** Nitrogen is used in dry-pack packaging to create inert atmospheres that prevent moisture and oxidation, ensuring the longevity of components.

Cooling and other applications

- **Cooling:** Helium's high thermal conductivity makes it ideal for cooling semiconductor devices, wafer-chuck cooling due to its high thermal conductivity and managing heat during production.
- **Laser cutting and welding:** High-purity oxygen, nitrogen, and carbon dioxide are supplied for precise laser cutting, laser micromachining, laser drilling and micro-welding of electronic components.
- **High-voltage equipment:** Argon is used as an insulating gas in high-voltage switchgear, dielectric testing and gas-insulated circuit breakers (GIS) to improve their dielectric strength and operational reliability.

Demand drivers

Semiconductor manufacturing in India

India is aggressively building its semiconductor manufacturing sector through the India Semiconductor Mission (ISM), which includes a Production Linked Incentive (PLI) Scheme and a focus on design, talent development, and attracting global investment. Key developments include approving multiple manufacturing units, with a joint venture between HCL and Foxconn approved in May 2025. The government is also investing in training programs and has supported startups through the Design Linked Incentive (DLI) Scheme.

Government initiatives and schemes

- **India Semiconductor Mission (ISM):** Launched in 2021, the ISM aims to position India as a global hub for semiconductor manufacturing and design while serving as the nodal agency for the efficient and seamless implementation of semiconductor and display schemes. It includes the PLI and DLI schemes and provides incentives for manufacturing projects.
- **Production Linked Incentive (PLI) Scheme:** Offers fiscal support of up to 50% for manufacturing projects to encourage large-scale facilities.
- **Design Linked Incentive (DLI) Scheme:** Supports chip design capabilities and intellectual property development, with several projects already sanctioned for startups and innovators.

Recent developments

- **New manufacturing units:** The Union Cabinet approved several new semiconductor projects in 2025, including a joint venture between HCL and Foxconn, and facilities in Odisha and Punjab.
- **Indigenous chips:** India announced its first indigenous semiconductor chip is on track for production in 2025.
- **Talent development:** The government has initiated a program to train 85,000 engineers in advanced semiconductor and electronics manufacturing to build a skilled talent pipeline.

- **Startup funding:** Startups like Netrasemi have received significant Venture Capital (VC) investment, with Netrasemi securing Rs. 107 crore for its work on chips for smart vision and IoT applications.
- **Specialized manufacturing:** India is focusing on advanced areas like compound semiconductors and advanced packaging, with new units for these technologies being established.

The Indian semiconductor market is projected to witness substantial growth, propelled by rising consumption of smartphones, wearables, automotive components, and computing devices, all of which continue to drive strong electronics demand in the country. The strategic policy focus on domestic chip fabrication seeks to significantly minimize India's heavy reliance on imports, which are presently sourced predominantly from supply hubs such as Taiwan and China. This transition is further strengthened through global collaborations and a concentrated effort to establish an end-to-end semiconductor ecosystem spanning chip design, wafer fabrication, assembly, testing, and manufacturing support industries. A landmark development in this journey is the creation of India's first indigenous 32-bit microprocessor, the Vikram 3201 chip, developed by the Indian Space Research Organization (ISRO) for space applications, underscoring the country's advancing technological self-reliance in critical and high-performance semiconductor domains.

PLI scheme for manufacturing electronics

The Production Linked Incentive (PLI) framework for electronics manufacturing has become a fundamental growth driver for India's consumer durable and electronics industry by fostering large-scale domestic production, supply-chain localization, and export competitiveness. Introduced by the Ministry of Electronics and Information Technology, the program provides outcome-based incentives typically ranging from 4% to 6% on incremental sales over a predetermined base year, ensuring support is linked to production scale rather than fixed subsidies. The scheme is operational for five years, though the base year and product coverage differ across sub-segments to align with industry cycles.

The PLI structure spans three critical electronics manufacturing pillars. The PLI Scheme for Large Scale Electronics Manufacturing, anchored on high-volume finished goods, supports manufacturing of mobile handsets and key device sub-assemblies that increasingly integrate into consumer durables such as smart televisions, home appliances, and connected devices. Complementing this, the Electronics Component Manufacturing Scheme (ECMS) strengthens local capacity for core hardware including SMT components, passive electronics, discrete semiconductors, and power-management modules, all of which are essential for consumer durable manufacturing. Additionally, the PLI Scheme for Telecom & Networking Products incentivizes advanced transmission-grade electronics such as 4G/5G radio access network modules, broadband hardware, and other wireless communication electronics that enable digital infrastructure demand. Implementation governance is sector-aligned device and component incentives are administered through the Ministry of Electronics and Information Technology, while telecom-electronics incentives are routed through SIDBI, ensuring tailored financial oversight.

The program's impact includes accelerated localization of printed circuit boards (PCBs), display modules, embedded controllers, and semiconductor-enabled electronics, lower lead times for durable manufacturers, and globally competitive bill-of-materials economics. India's improved cost position has expanded consumer durable exports to regions such as ASEAN and the Middle East, driving scale visibility and SKU diversification. By strengthening ecosystem depth, enabling smart-electronics integration, and reducing import reliance, the PLI framework has evolved into a structural demand multiplier and a long-term competitiveness engine for India's consumer durable and electronics manufacturing landscape.

Other key demand drivers

The low penetration of consumer durables suggests higher scope for market growth in future. Key growth drivers for India's consumer durables industry are as follows:

- **Changing demographics** – an increase in the number of nuclear families, rising urbanization, and growing rural connectivity
- **Rising per capita income** - improving affordability, growth in rural income, and the ownership of multiple consumer products
- **Improving power situation** - improving rural electrification to boost demand for consumer durables
- **Changing lifestyles and perception of products** – changing consumer perception on products (such as washing machines and dish washers) as utilities rather than luxury items, rising household labour costs, an increase in the number of working women, and better water supply in semi-urban cities have backed washing machine sales growth in a trend that is expected to continue
- **Increasing product range and options** – A wide variety of options at different affordable price points, attracting first-time buyers
- **Multiple financing options** – Easy and flexible financing options, increasing buyers' affordability; easy availability of finance at 0% interest has been a major driver of the consumer durables industry's growth over the past few years. While EMI loans have always been available through banks, overall finance penetration remained low until the entry of NBFCs, due to the absence of EMI finance options at points of sale (retail shops), slower processing time, and high interest rates and processing fees

Capacity additions and supply

India's consumer durables industry is experiencing significant capacity additions and supply growth, driven by strong demand from a rising middle class and government initiatives like the Production-Linked Incentive (PLI) scheme. Major growth is seen in mobile manufacturing and white goods (refrigerators, air conditioners, washing machines), with the overall electronics and durables market projected to grow substantially by 2030. While demand fluctuations occur, such as during a weak summer, the overall outlook remains positive due to increased disposable income and the expansion of credit facilities.

The Indian consumer durables industry has undertaken steady capacity additions and supply-side expansion, aligned to the country's growing consumption base and increasing emphasis on domestic manufacturing. Government initiatives, notably the Production-Linked Incentive (PLI) scheme, have played a pivotal role in encouraging industrial investment, with 84 companies committing investments of approximately Rs 10,478 crore under the PLI framework for white goods as of January 2025, supporting higher production of finished consumer appliances and key components. Capacity build-outs have also been supported by increased innovation and product premiumization, including the rising production of inverter and convertible refrigerators, BLDC (brushless) DC fans, IoT-enabled appliances, and energy-efficient air-conditioning and cooling solutions, reflecting a category shift toward advanced and higher-value durable models.

Demand outlook remains structurally strong, driven by a rising middle-class consumer base with improving disposable incomes, enhanced retail penetration across semi-urban and rural markets, and growing consumer preference for in-home digital entertainment and appliance upgrades. Rural India presents a sizable market opportunity, aided by deeper distribution networks and increasing aspiration for improved lifestyle electronics. Additionally, improved access to consumer financing, including retail credit, pre-approved loans, and flexible EMI options from financial institutions and durable brands, has further strengthened supply absorption into the market.

Review and outlook on Indian Tyre industry

Industrial gases are an integral enabler of operations in the Indian tyre industry, supporting both manufacturing efficiency and product quality. Common gases such as nitrogen, oxygen, hydrogen, and carbon dioxide are used across various stages of the production process. The use of industrial gases helps enhance process reliability, ensure consistent product performance, and improve operational safety across tyre manufacturing facilities.

Review and outlook of Indian tyre industry

Demand for tyres comes from both original equipment manufacturers (OEMs) and the replacement market. While OEM demand typically mirrors the trends in vehicle production, replacement market demand is linked to usage characteristics and replacement cycles. As of fiscal 2025, the share of OEM demand in overall domestic tyre production stood at 31% while the replacement market accounted for the balance.

Outlook on demand (FY25-30P)

The Indian tyre industry is projected to grow by 5-7% in fiscal 2026, supported by a recovery in OEM demand and steady replacement demand. This growth is expected to be driven by improved consumer sentiment, repo rate cuts, and the resumption of normal government spending. The OEM segment, contributing around 31% of total tyre production, is likely to grow by 4-6%, led by stronger performance in the automobile sector, particularly commercial vehicles. The commercial vehicle segment, accounting for nearly half of total tyre sales, is expected to expand by 5-7%, supported by rising demand for medium and heavy commercial vehicles as well as light commercial vehicles. Additionally, passenger vehicles are projected to grow by 4-6%, while two-wheelers and tractors are expected to see growth of 5-7% and 7-9%, respectively, driven by personal mobility needs and improved farm incomes.

On the replacement side, which constitutes about 69% of total tyre demand, growth is expected at 6-8% in fiscal 2026, supported by rural demand, better monsoons, and improved agricultural output. Higher food prices and stronger crop yields have enhanced farmers' purchasing power, further boosting replacement demand. Over the medium term, tyre demand is expected to grow at a CAGR of 5-7% between fiscals 2025-30, driven by economic expansion, infrastructure development, and evolving consumer preferences. Rising income levels, increased vehicle ownership, and the growth of e-commerce and logistics will continue to support demand across segments. However, improvements in road infrastructure and higher radialization may extend tyre life, potentially moderating replacement demand over the long term.

Overall tyre demand expected to register a CAGR of 5-7% between FY25-30P

	FY25		FY26P	FY25-30P
Segments	Tonnes ('000)	Growth (%)	Growth (%)	CAGR (%)
OEM demand	805	2-4%	4-6%	5-7%
Replacement demand	1921	8-10%	6-8%	4-6%
Overall tyre demand	2726	6-8%	5-7%	5-7%

Note: P- Projected

Source: Rubber Board, Crisil Intelligence

Application of industrial gases in the industry

Industrial gases are critical enablers across the Indian tyre manufacturing value chain, supporting raw-material processing, product quality, safety, and energy efficiency. Tyre producers such as CEAT Ltd., Apollo Tyres Ltd. and MRF Ltd. utilize gases in varied stages of compound mixing, curing, testing, and tyre inflation due to their inert properties, combustion support, and pressure stability. The key gases deployed include nitrogen, oxygen, hydrogen, carbon dioxide, and acetylene supplied by firms such as INOX Air Products Ltd. and Linde India Ltd.

Oxygen is widely used in carbon black production as an essential reinforcing material in tyres where controlled oxidation improves yield and consistency. Nitrogen is integral to curing operations, especially in nitrogen-inflated bladder systems, as its inert nature ensures stable pressure, higher uniformity, and enhanced vulcanization quality compared to steam-based systems. Nitrogen is also used to create oxygen-free atmospheres during mixing and extrusion to prevent oxidation of rubber compounds.

Hydrogen is used in specialty applications such as hydrogenation of certain rubber feedstocks to improve heat resistance and durability, while carbon dioxide supports rapid cooling in extrusion and helps maintain dimensional stability of green tyres. Additionally, argon and nitrogen atmospheres are used in analytical and quality-control processes, including gas chromatography and material testing. Across the value chain, these gases enable tighter process control, improved energy efficiency, reduced defects, and superior tyre performance, making them a key enabler in modern tyre manufacturing.

Key demand drivers

The Indian tyre market is a critical sector in the country's automotive industry, reflecting the growing demand for both two-wheeler and four-wheeler vehicles. With India's automotive sector continuing to expand rapidly, the tyre market is experiencing significant growth, driven by factors like urbanization, an expanding middle class, and the increasing popularity of personal and commercial vehicles. Tyres, being one of the most essential components of vehicles, are pivotal to the functioning of the automotive industry and the economy at large.

○ **Automotive Sector Growth**

- Rising domestic sales of passenger vehicles, two-wheelers, and increased fleet utilization of commercial vehicles.
- Improving consumer affordability and shift toward SUV and premium vehicle segments.
- The surge in EV adoption is creating a new market for specialized tyres designed for lower rolling resistance, higher load capacity, and noise reduction.

○ **Expansion in Freight & Logistics**

- Growth in manufacturing and logistics ecosystems, supported by improved inter-state goods movement enabled by the GST Council.
- Higher tonnage movement driving truck replacement and tyre refitment demand.

○ **Infrastructure Development**

- Continued highway construction and road-quality upgrades led by NHAI.
- Better roads enabling increased average vehicle kilometers travelled, influencing replacement frequency.

- **Mining & Construction Activity**
 - Increased deployment of earthmoving and construction equipment, benefiting Off-The-Road (OTR) tyre demand.
 - Prominent push in equipment utilization by companies such as Tata Hitachi.
- **Strong Replacement Market Dynamics**
 - Replacement segment contributes majority industry volume due to:
 - Sub-optimal road conditions in non-highway regions.
 - Vehicle overloading and operational wear in commercial fleets.
 - Increased mobility, last-mile logistics, and e-commerce delivery usage.
 - Replacement cycles supported by extensive distribution networks of manufacturers including MRF Ltd.
- **Radialization Trend**
 - Higher adoption of radial tyres, particularly in trucks and buses.
 - Increasing radial capacity and market penetration driven by industry participants such as Apollo Tyres Ltd.
- **Export Demand Growth**
 - Strengthening global distribution networks and rising overseas demand.
 - Indian manufacturers gaining from global sourcing diversification (e.g., China+1 strategy).
- **Raw Material & Policy Support**
 - Natural rubber price movement influencing production and replacement timing.
 - Government support for domestic manufacturing and supply-chain strengthening.

Tyre manufacturing landscape in India

The Indian tyre industry is undergoing a notable shift toward the two-wheeler segment, which accounts for approximately 130 million tyres produced annually, reflecting rising middle-class incomes and increasing demand for personal mobility. Passenger vehicles also represent a significant share, with nearly 59 million tyres produced each year, driven by the growing popularity of SUVs and sedans. In comparison, commercial vehicles, agricultural, industrial, and off-the-road segments contribute relatively lower volumes, at around 33 million, 8 million, 2.5 million, and 2 million tyres respectively. Radialization levels vary considerably across segments, with passenger vehicles leading at approximately 90%, followed by commercial vehicles at around 80%, while two-wheelers lag at nearly 40%. This variation highlights the need for continued technological advancement to enhance efficiency and performance across segments.

The Indian tyre market is dominated by key domestic and global manufacturers, including Apollo Tyres, Bridgestone, CEAT, JK Tyre, MRF, and TVS Srichakra, which collectively account for over 80% of industry revenues. While global players such as Michelin, Goodyear, and Maxxis have established manufacturing operations in India, their market share remains relatively limited due to high price sensitivity among customers.

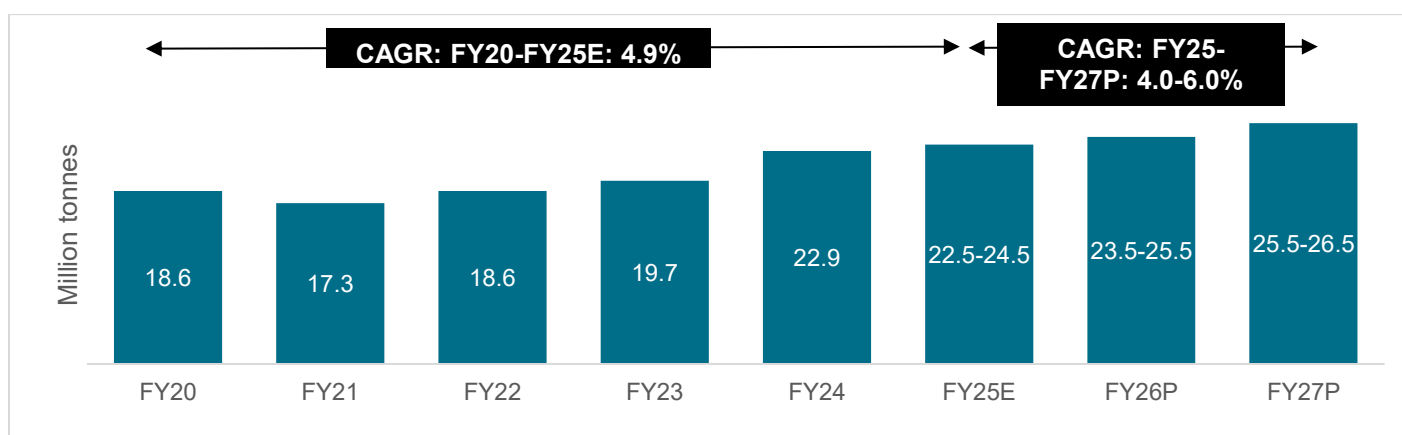
Review and outlook of Indian Paper industry

Historic growth and outlook (market size)

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

The paper and paperboard (including newsprint) demand is estimated to grow by 2-3% year-on-year to reach ~22.5-24.5 million tonnes in fiscal 2025. The paperboard segment is expected to drive demand in the near and long term due to healthy demand from end-use industries. Paperboard demand is estimated to grow by 3-4% year-on-year in fiscal 2025. W&P paper demand is expected to witness a growth of 2-4% in fiscal 2025. The demand for W&P has been rising on account of growing demand in schools, offices and colleges.

Review and Outlook of Indian paper industry demand trend



P: Projected

Source: Crisil Intelligence

Crisil Intelligence expects the overall paper demand to grow at a healthy two-year CAGR (FY25-FY27) of 4-6% to ~25.5-26.5 million tonne by fiscal 2027 driven largely by paperboard and specialty paper demand. The newsprint segment continues to witness slow demand due to decline in English paper circulation on account of shift towards digitised versions of newspapers with proliferation of digitisation and smartphones.

The paperboard segment is estimated to grow by 3-4% during fiscal 2025 to fiscal 2027 on back of healthy demand from the end use industries like FMCG, pharma and e-commerce. Specialty paper segment is estimated to grow at a 7-8% CAGR from fiscal 2025 to fiscal 2027. The online retail growth in fiscal 2025 is estimated to have grown to 19-21% and the quick commerce market is also estimated to witness a stupendous growth of 90-100% which has contributed significantly to the paperboard demand. The newsprint segment is on a declining trend and is expected to witness a decline of 4-6% by 2027. W&P demand is expected to increase at a modest 2-3% CAGR over fiscal 2025 to fiscal 2027. Specialty paper (majorly tissue and thermal paper) is expected to continue to log a robust 11-13% CAGR over fiscal 2025 to fiscal 2027.

Application of industrial gases in the industry

Industrial gases play a critical role across multiple stages of paper and pulp manufacturing, contributing to improved process efficiency, product quality, and environmental performance. In the delignification process, oxygen is extensively used to

remove lignin from pulp more effectively while reducing reliance on chlorine-based chemicals. Its application also improves efficiency in the bleaching process, enhances pulp brightness, and supports mills in achieving higher yield and improved fibre strength. Carbon dioxide is utilised during pulping and bleaching for pH stabilisation, helping regulate alkalinity, optimise reaction conditions, and enhance overall fibre quality.

Beyond core pulping operations, industrial gases support several auxiliary processes within paper mills. Nitrogen is used for inerting and oxidation control in chemical storage and handling systems, thereby enhancing safety and preventing degradation of sensitive raw materials. Carbon dioxide also plays an important role in wastewater treatment, where it neutralises alkaline effluents and reduces scaling, offering a safer alternative to mineral acids. Additionally, oxygen is used in oxygen-enriched combustion in recovery and power boilers to improve combustion efficiency, lower fuel consumption, and reduce emissions. Collectively, these applications make industrial gases integral to modern, energy-efficient, and environmentally compliant paper manufacturing.

Supply and capacity addition

Utilization levels remained in the range of 85-90% for the industry in fiscal 2025, following similar level to fiscal 2024. In the long run, with pending capacities commercializing by fiscal 2027, capacity utilization is expected to remain high led by rising demand from the paperboard and specialty paper segment. Crisil Intelligence expects the capacity utilization for overall paper industry to reach 90-95% by fiscal 2027.

Crisil Intelligence expects paper and paperboard capacity to increase by 0.5-1.5 million tonne (MT) by fiscal 2026. Key organized players (Best paper, TNPL, West Coast Paper Mill, Nepa, Seshasayee Paper and Boards and Yash Pakka Ltd) are expected to add an aggregate of 1-2 MT of capacities over the next five years in the paper and paperboard segment. Within the specialty paper segment, key organized players (TNPL, Andhra Papers, Pudumjee Papers) are expected to add 0.11MT of capacities by fiscal 2030.

Within the paper segment, we expect paperboard and specialty to witness healthier growth as opposed to other segments and capacity additions in both segments to rise on the back of healthy demand prospects, largely from unorganized players. Moreover, capacity additions in both the segments will be driven by their lower capital intensity, growing demand, better margins and lower technical requirements.

Key trends and demand drivers

Low per capita consumption: India's per capita paper consumption remains low at 14–16 kg, significantly below the global average of ~57 kg, indicating strong long-term headroom for growth.

E-commerce and online retail expansion: The online retail industry is expected to clock a 20–25% CAGR over the next 2–3 fiscals, driving sustained demand for packaging grades. Growth in e-commerce is also boosting consumption of specialty papers such as thermal paper for shipping labels, invoices, and receipts.

Education sector demand: Rising literacy levels, increasing government spending on education, and the implementation of the National Education Policy (NEP) are expected to push demand for printing and writing paper.

Urbanization, hygiene focus & tissue paper demand: Rising urbanization along with stronger emphasis on hygiene through government initiatives like Swachh Bharat is accelerating consumption of tissue, napkin, toilet, and towel-grade paper. Growing hospitality and healthcare activities further support this segment.

Growth in digital payments & organized retail: An increase in cashless transactions (ATM, card-based purchases) and higher billing volumes in organized retail are driving demand for thermal paper.

Paperboard demand: Higher disposable incomes and rising consumption of ready-to-eat / convenience foods are supporting paperboard volumes. Additionally, pharmaceutical exports and new drug launches are aiding demand for paperboard packaging.

Regulatory push – single-use plastic ban: The ban on single-use plastics continues to create structural tailwinds for paper and paperboard products as sustainable packaging alternatives.

Overall, these structural, regulatory, and consumption-led forces are collectively driving the Indian paper industry growth.

Review and outlook of Indian Oil & Gas industry

Industrial gases constitute an essential input across the oil and gas value chain, supporting both operational continuity and process efficiency. Key gases such as nitrogen, hydrogen, oxygen, and carbon dioxide are utilised in upstream activities for well stimulation, pressure maintenance, and inerting, and in downstream refining processes for hydrotreating, hydrocracking, desulphurisation, and quality enhancement of end products. The use of these gases enables safer operations, improved recovery and throughput, and adherence to stringent product and environmental standards.

Review and Outlook of Indian crude oil industry

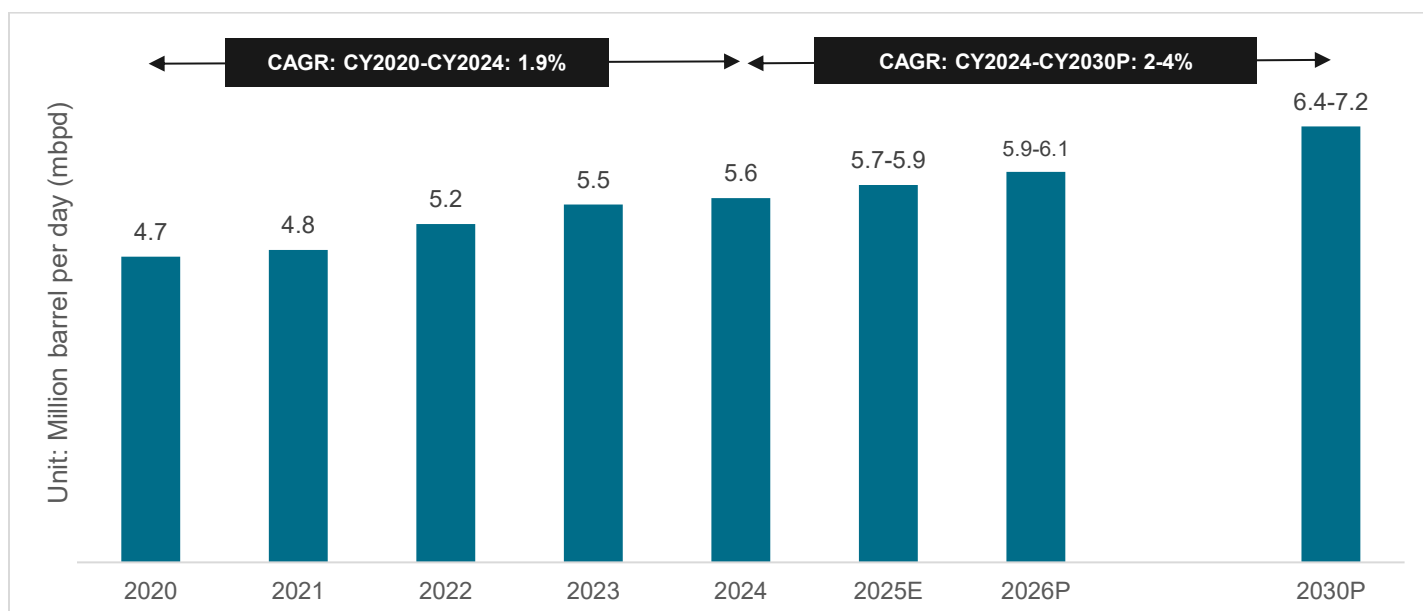
Crude oil, a complex mixture of hydrocarbons, is a key storable and transportable energy source, refined into products such as petrol, diesel, and naphtha. Its key characteristics include density, sulphur content, viscosity, and pour point. Found beneath the earth's surface, crude oil requires refining before use. Derived products include gasoline, diesel, aviation fuel, and fuel for power generation. It is the most traded energy source globally, with demand not constrained by local availability, unlike natural gas. Natural gas, primarily composed of methane, is transported via pipelines and is mainly used in fertilizers (feedstock) and power generation.

India's crude oil demand grew at a CAGR of ~1.9% between CY2020 and CY2024, reaching 5.6 million barrels per day (mbpd) in CY2024 (vs ~5.2 mbpd in CY2019). Demand reached a record high in CY2024, supported by strong economic growth (GDP growth of 6.5% as per S&P), recovery in refinery utilisation to pre-COVID levels, and robust transportation demand, particularly during the festive season.

Demand is expected to grow by 1–3% in CY2025, driven by continued economic growth (~6.5%), with higher petrol consumption supported by improved mobility, partly offset by moderation in naphtha, industrial fuel, and petroleum coke demand.

Further, demand is projected to grow at 4.0–5.0% in CY2026, led by increased economic activity (GDP growth of ~6.7% as per S&P), rising transportation fuel demand, recovery in aviation turbine fuel (ATF) consumption, and higher naphtha usage in the petrochemical sector.

Review and Outlook of Indian crude oil industry



E: Estimated, P: Projected

Source: Crisil Intelligence

According to Crisil Intelligence, India's crude oil demand is expected to increase moderately in the coming years. The country's refinery capacity is projected to grow at a compound annual growth rate (CAGR) of 5.0-7.0% from 258 million metric tons (MMT) in CY2025 to 290-310 MMT in CY2030. As a result, crude oil demand is expected to rise at a CAGR of 2.0-4.0% up to CY2030, reaching 6.4-7.2 million barrels per day (mbpd). India is likely to be a leading driver of global crude oil demand growth, given its relatively low per capita fuel consumption and forecasted high economic growth rate of 6.5%. The growth will be driven by increasing consumption of petrol, jet fuel, and naphtha.

Scheme for Promotion of Coal/Lignite Gasification:

In January 2024, India provided significant budgetary support for coal gasification through an Rs. 8,500 crore financial incentive scheme (Viability Gap Funding) approved for PSUs and private players. Additionally, a 50% revenue share rebate for coal used in gasification was introduced to promote its use.

The Ministry of Coal received an allocation of Rs 3,525 crore in fiscal 2027BE, up from just Rs 285 crore in fiscal 2026BE under the scheme. This specific provision was introduced to facilitate the government's ambitious target of achieving 100 MT of coal gasification by 2030. Gasification of coal allows for the conversion of coal into high-value chemical products and relatively cleaner energy forms, thereby optimising the utility of India's vast coal reserves while attempting to mitigate traditional environmental impacts.

Application of industrial gases in the industry

Industrial gases are essential across upstream, midstream, and downstream segments of the oil and gas industry, supporting a wide range of processing, refining, and operational activities. Gases such as nitrogen, oxygen, hydrogen, carbon dioxide, and specialty gas mixtures are used in refineries for fluid catalytic cracking (FCC) optimization, hydrotreating, hydrocracking, hydrogenation, and sulphur recovery, improving conversion efficiency, product yields, and fuel quality. Hydrogen plays a critical role as a feedstock in hydrotreating and hydrocracking units, enabling the removal of sulphur and other impurities, upgrading heavy fractions, protecting catalysts, and ensuring compliance with clean-fuel specifications, while nitrogen is widely used for inerting, purging, blanketing, and pressurization to ensure safe refinery operations.

In the midstream and LNG value chain, industrial and cryogenic gases support pipeline testing, maintenance, leak detection, and pressure control, as well as LNG systems, where cryogenic nitrogen and other industrial gases are used for purging, cooldown, inerting, cryogenic separation, liquefaction support, and temperature-controlled handling of natural gas across liquefaction plants, storage tanks, and regasification terminals. Carbon dioxide is additionally used in enhanced oil recovery (EOR) and, along with nitrogen, in well completions and unconventional oil and gas operations, while industrial gases also support VOC recovery, environmental monitoring, and wastewater treatment, reinforcing operational safety and regulatory compliance.

Review on Indian natural gas industry

Natural gas is one of the major fossil fuels and enjoys a reputation as a clean fuel in comparison with other fossil fuels such as gasoline or diesel. It is a combustible mixture of hydrocarbon gases. Methane constitutes 70 to 90 per cent of natural gas. It is used as fuel and feedstock in different industrial sectors like fertilizers, petrochemicals, and polymers etc. Naphtha, which can also be used as fuel and feedstock is closest substitute for natural gas. Natural gas can be converted into different forms like LNG, CNG and PNG.

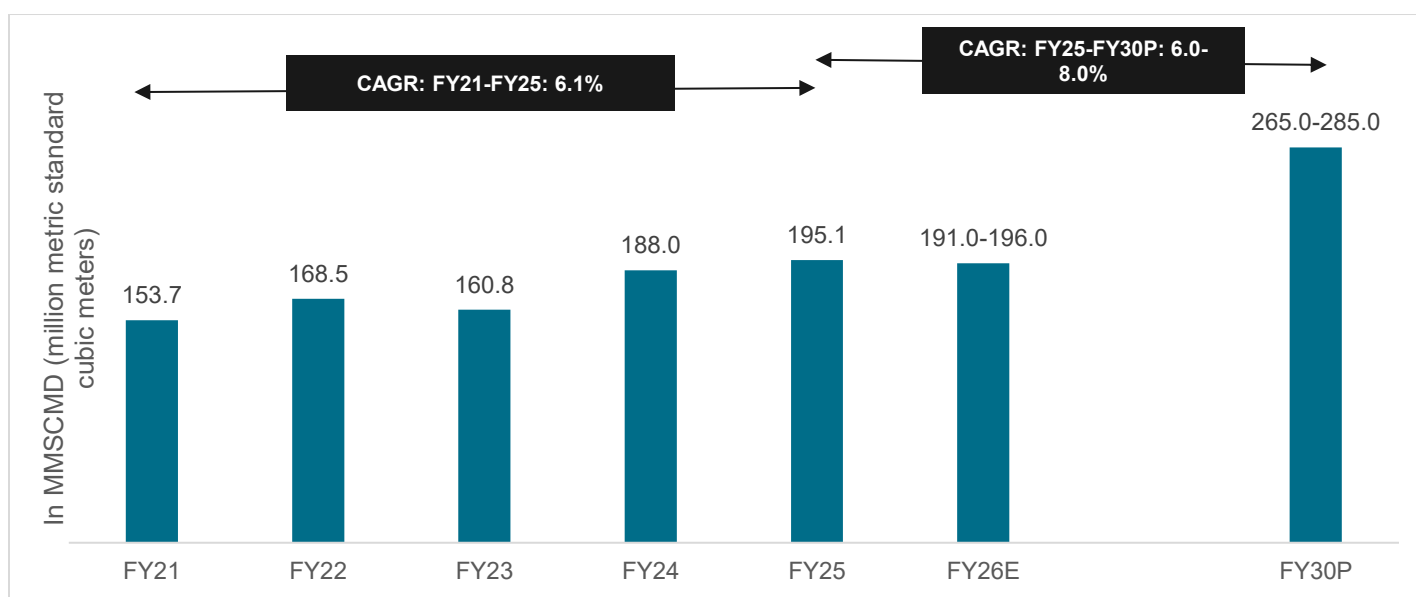
Natural gas is the third-largest energy source after crude oil & coal, and accounts for nearly 24 per cent of global primary energy consumption. It is combustible in nature as it is a mixture of hydrocarbons, which results in emissions of a large amount of energy when burned.

Natural gas consumption trend and Outlook

Natural gas demand has witnessed a CAGR of 6.1% during fiscal 2021 to fiscal 2025 period, with demand going from 153.7 million metric standard cubic meter per day (MMSCMD) in fiscal 2021 to 195.1 MMSCMD in fiscal 2025 driven mainly by rising consumption in the city gas distribution, refinery, and petrochemical industries.

By fiscal 2026, natural gas demand is expected to change slightly, with a daily consumption range of 191-196 MMSCMD. This is largely due to reduced demand in the power sector, which was affected by the early monsoon. Demand from the fertilizer and refinery sectors also decreased in the first half of the fiscal 2026 due to maintenance shutdowns at some units and higher spot prices. However, demand from these sectors is expected to increase in the second half of the fiscal 2026. In contrast, the city gas distribution (CGD) sector is expected to grow as it expands to new areas.

Natural gas consumption trend and outlook:



E: Estimated

Source: Crisil Intelligence

The CGD sector is expected to drive natural gas demand, supported by government initiatives promoting cleaner fuels and expansion of CGD networks. Industrial PNG demand is also likely to grow as industries shift from alternate fuels due to cost advantages. Allocation of domestic gas for CNG and domestic PNG, along with infrastructure expansion, will further support growth.

In the fertilizer segment, growth is expected to remain subdued in Fiscal 2026 due to high spot LNG prices and plant shutdowns, increasing production costs and subsidy burden. However, easing LNG prices and capacity additions may support recovery over the medium term.

Natural gas usage in power generation is expected to remain limited in the near term due to cost disadvantages versus coal and renewables, financial stress of DISCOMs, and lack of regulatory support. However, improvements in LNG prices and infrastructure could drive gradual adoption over time.

As per CRISIL Intelligence, India's natural gas demand is projected to grow at a CAGR of 6.0–8.0% between Fiscal 2025 and 2030, reaching 265–285 MMSCMD, driven by CGD, refineries, and petrochemicals. Growth will be supported by higher domestic supply, favourable policies, and competitive LNG prices, though absence of strong policy support for the power sector may limit upside.

Over the long term, demand is expected to rise steadily, led by CGD, refinery, and petrochemical sectors. While domestic production is expected to increase, it will remain insufficient to meet total demand, necessitating continued reliance on LNG imports.

Application of industrial gases in the industry

Industrial gases play an important role across natural gas processing, transmission, distribution, and end-use segments, supporting purification, equipment safety, and process efficiency. Nitrogen is extensively used for purging, leak testing, pipeline displacement, compressor maintenance, and inerting across gas processing plants and transmission pipelines to minimise fire and explosion risks. Hydrogen is utilised in select upgrading and hydroprocessing steps, particularly for treating natural gas liquids and removing sulphur compounds, while oxygen is used in sulphur recovery units (SRUs) for controlled oxidation of hydrogen sulphide into elemental sulphur in line with environmental norms. Carbon dioxide is employed in specific gas separation processes and is also removed from raw natural gas streams to meet pipeline and LNG quality specifications.

In downstream applications, industrial gases support CNG, PNG, and LNG systems, including pipeline purging and pressure testing for PNG networks, inerting and safety management in CNG stations, and cryogenic nitrogen is used in LNG liquefaction, storage, and regasification terminals for cooldown, inerting, and temperature control. Industrial gases also support LNG use in heavy-duty vehicles and marine transport by enabling safe handling of cryogenic fuel systems, reinforcing operational safety, reliability, and regulatory compliance across the natural gas value chain.

Factors impacting the demand

Natural gas is a popular energy source due to its efficiency and versatility, but the Indian market is constrained by limitations in supply, pricing, distribution, and import infrastructure, which are impacted by three critical demand drivers:

Demand-supply dynamics in end-user sectors

- **Availability of domestic gas:** Due to the limited availability of domestically produced gas, the government has implemented a priority-based allocation system to distribute the available gas among various sectors. The domestic piped natural gas, CNG, and fertilizer sectors have been assigned higher priority in the allocation, with the priority determined by the affordability of the end-consumer and the level of regulatory oversight in each sector.
- **Shift to CNG from petrol:** As more regions are getting connected to gas networks, the adoption of CNG is anticipated to rise. Given the current petrol price of approximately Rs 95 per liter in Delhi as of September 2025, CNG offers a cost advantage, being 20-25% cheaper at Rs 77.1 per kg in Delhi. This substantial price difference is expected to make the transition to CNG vehicles more appealing. Furthermore, the introduction of new CNG-focused models by original equipment manufacturers (OEMs) will likely accelerate the shift towards CNG vehicles, driving growth in this segment.
- **Regulatory push for cleaner fuels:** The government's initiative to promote cleaner energy sources is expected to gain momentum, with a likely expansion of the regulatory ban on polluting fuels such as petcoke and fuel oil to more states. The widespread development of CGD infrastructure will facilitate this transition. Additionally, the regulatory drive

towards cleaner fuels, combined with declining spot LNG prices, is anticipated to accelerate the long-term shift from fuel oil (FO) to industrial PNG, further supporting the adoption of more environmentally friendly energy solutions.

- **Infrastructure availability:** Along with the cost advantage, regulatory restrictions and infrastructure availability are critical for the shift to CGD. With increasing gas network coverage across different Indian states due to city gas distribution (CGD) bidding rounds 9, 10, and 11, reach of gas pipelines would not be a problem, resulting in a swifter shift from FO to industrial PNG and petrol to CNG.

With high levels of affordability and/or higher priority in allocation, sectors such as fertilizers and CGD are expected to drive demand for natural gas over the next five years. Sectors such as power, refineries, and petrochemicals will have to rely on LNG.

Review and outlook of Indian F&B industry

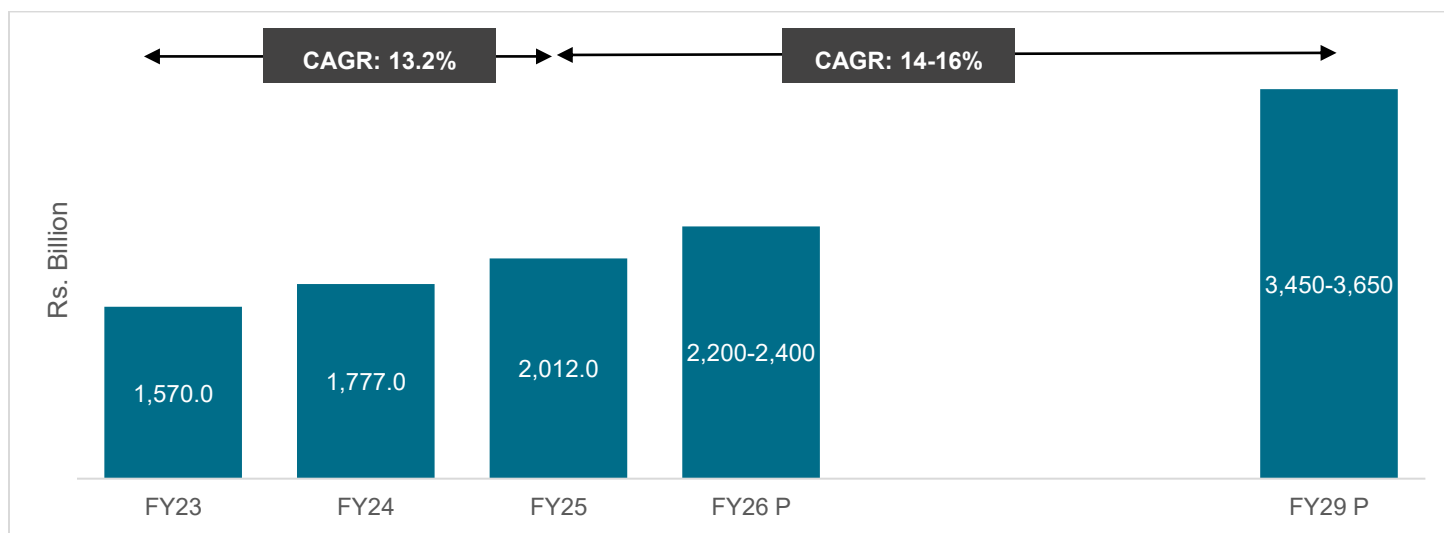
Historic growth and outlook of market size

Organized consumer food

The organized consumer food industry grew by ~14.0% between fiscal 2018 and fiscal 2024 and further by 13.0% in fiscal 2025, reflecting a CAGR of ~13.2% between fiscal 2023 and fiscal 2025. Manufacturing is split between standalone (~55–60%, preferred for high-value products) and contract manufacturing, the latter widely used by large players for rapid scale-up, especially in biscuits and bakery.

Strong supply chains and wide distribution networks remain critical for sourcing key inputs (flour, sugar, cocoa, etc.) and driving regional penetration. Growth is further supported by expansion of modern retail and a sharp rise in online sales, with share increasing from ~1.0% in fiscal 2019 to over 5.0% in fiscal 2024.

Revenue of the consumer foods sector to be driven by healthy demand



Source: Company reports, Industry, Crisil Intelligence

The industry is expected to grow at 13–15% in fiscal 2026, led by snacks and RTE/RTC segments. Rising incomes, urbanisation, and shifting preferences towards premium, healthy, and convenient foods are key demand drivers, supported by new product launches and expanding distribution.

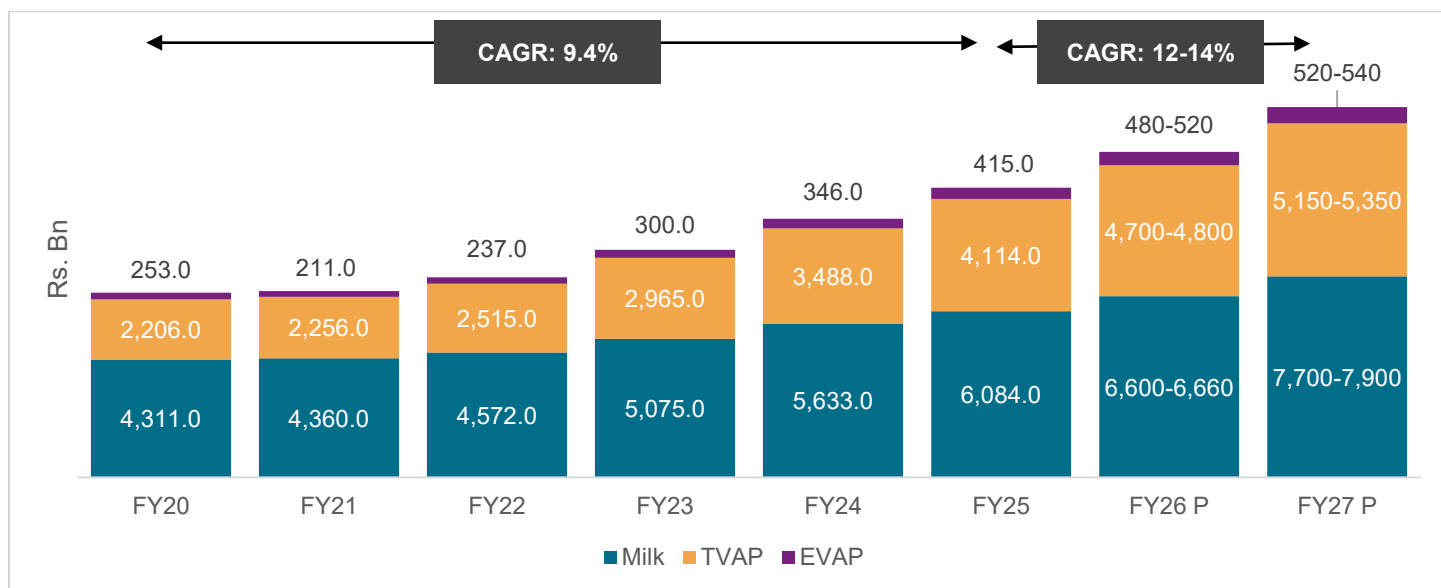
Segment-wise, bakery is expected to grow relatively slower at 9–10% due to moderation in biscuits. In contrast, chocolates and confectionery are likely to see healthy growth. Snacks growth will be driven by increased penetration and regional innovations, while RTE/RTC products are expected to witness strong demand from both B2C and institutional channels such as HORECA, railways, and airlines.

Dairy and milk products

India is among the fastest growing dairy markets and the largest global producer of milk since 2000. Domestic milk production has averaged a significant 25-30% share in global milk production since 2015. Milk production increased from 198 million tonnes in fiscal 2020 to 249 million tonnes in fiscal 2025 reflecting a CAGR of approximately 4.6%.

Growth is expected to be supported by increased adoption of artificial insemination and advanced breeding, stable fodder prices, and favourable monsoons. Government support remains strong, with Rs. 3,880 crore allocated for FY25–FY26 towards animal health and disease control, including Rs. 75 crore under the Pashu Aushadhi program.

Revenue growth review and outlook of dairy industry



TVAP: Traditional Value-Added Products (Butter, Ghee, Curd, buttermilk, flavored milk)

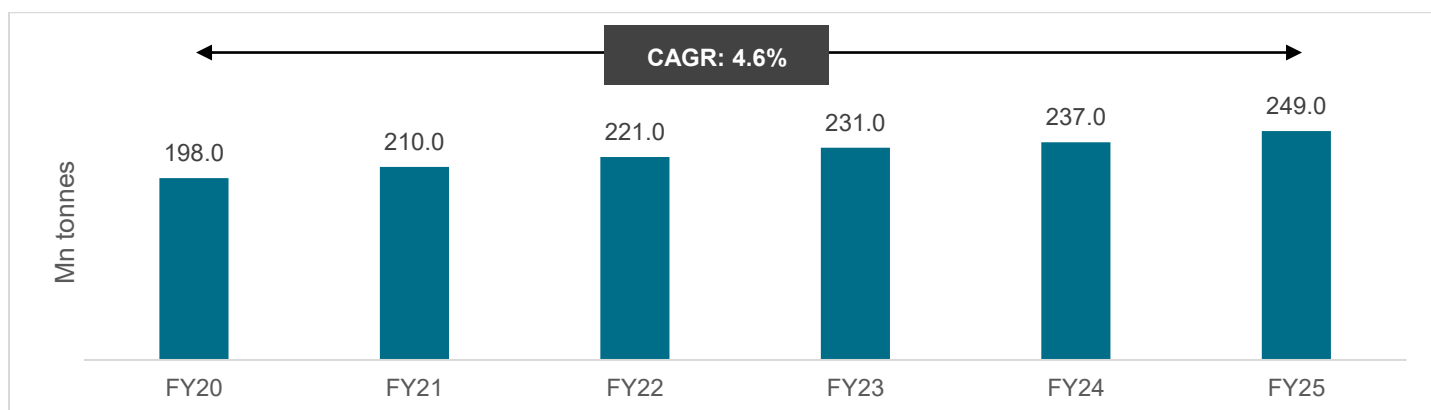
EVAP: Cheese, Yogurt, Ice-cream, Whey

Source: Crisil Intelligence

Milk production growth moderated to ~4.0% in fiscal 2024 (vs ~6.0% during fiscal 2018–fiscal 2022) due to high fodder costs (+22.0%) and adverse weather. However, with normal monsoons expected, growth is likely to revert to ~6% in fiscal 2026. Milk procurement prices increased ~50% in fiscal 2024 and ~3.0% in fiscal 2025, and are expected to rise moderately by ~2–3% in fiscal 2026.

The dairy sector remains critical to rural livelihoods and is supported by rising urbanisation and income growth. Demand is expected to be driven by value-added products, with strong growth in ghee, packaged curd, and paneer, supported by health awareness, convenience, and protein demand. Institutional demand (HORECA) is also expected to contribute to growth, supporting a positive overall outlook for the sector.

Milk production



Source: Crisil Intelligence

Application of industrial gases in the industry

Applications of Industrial Gases in Consumer Foods (Processed & Packaged Foods)

Industrial gases are extensively used in the manufacturing of consumer foods to improve product safety, quality, and shelf-life. Modified Atmosphere Packaging (MAP) using nitrogen (N₂) and carbon dioxide (CO₂) helps displace oxygen inside food packs, thereby reducing microbial growth and oxidation. Processes such as cryogenic freezing, cryogenic chilling and cryopreservation (using liquid nitrogen (LN₂) and liquid carbon dioxide (LCO₂)) are widely used for frozen foods, ready-to-eat meals, meat, and bakery products to preserve texture, color, and nutritional value. Carbonation of soda and beverages is supported by high-purity CO₂, while controlled atmosphere storage solutions using N₂, CO₂, and oxygen (O₂) help extend freshness of fruits, vegetables and packaged snacks during storage and transportation. In food processing, industrial gases enable operational efficiency and product consistency through cooling, process cooling, and heat transfer applications. Sparging and stripping and inerting/blanketing applications using N₂ and CO₂ are used to control oxidation and maintain product stability in edible oil processing and seasoning lines. Cryogenic grinding and particle size reduction for the food industry using liquid nitrogen (LN₂) support spice processing and powdered food formulations, ensuring better aroma retention and uniformity. Supercritical CO₂ extraction using CO₂ is used for decaffeination and extraction of flavors and essential oils, while inerting, purging and pressurization using N₂ and CO₂ improve plant safety and hygiene in high-throughput food manufacturing facilities.

Applications of Industrial Gases in Dairy and Milk Products

In the dairy and milk processing sector, industrial gases play a critical role in maintaining hygiene, freshness, and extended shelf life. MAP and packaging, inerting and blanketing using N₂ and CO₂ for pharmaceutical-grade food applications are used in cheese, butter, milk powder, and ready-to-consume dairy product packaging to prevent spoilage and oxidation. Cryogenic freezing, cryogenic chilling, and hardening/crust freezing solutions (using LN₂ and LCO₂) are applied in ice cream, frozen desserts, and value-added dairy products to retain structure and sensory characteristics. Cooling, process cooling and temperature control for food mixing and forming processes are integral to pasteurization, homogenization, and downstream dairy processing. Industrial gases also support core dairy processing operations such as fermentation solutions using O₂, CO₂, and N₂ for microbial cultures, which are essential in the production of yogurt, cheese, and probiotic products. pH control of dairy products and pH control and neutralization using CO₂ improve texture, consistency, and taste stability. Additionally, ozone (O₃) for drinking water and ozone (O₃) for waste and wastewater are used for sanitation and water treatment within dairy plants, while line or vessel drying, inerting and blanketing using N₂ and CO₂ ensure contamination-free storage and handling of milk powders and sensitive dairy ingredients.

Demand drivers

Low penetration of processed foods: Penetration levels (defined as volume of processed foods *divided by* the total volume of food in that segment, after adjusting for input-output norms) of consumer foods in India are only about 10%. Going forward, rise in urbanization and change in consumer lifestyles are expected to lead to higher consumption of processed foods.

Rise in urbanization and increase in disposable incomes: Rising urbanization, higher disposable incomes and changing consumer lifestyles are expected to lead to higher out-of-home consumption. In addition, focus on quality packaged food and improved convenience will lead to greater access and demand for consumer foods.

Changing in consumer preferences: Consumers are seeking more diverse and convenient dairy products, such as flavoured milk, yogurt, and cheese. They are also looking for products with added health benefits, like probiotics and omega-

3 fatty acids. Consumers are becoming more health-conscious, driving demand for dairy products perceived as healthy, such as low-fat milk, Greek yogurt, and organic dairy products.

Increase in number of women working: The government has taken several steps to create a congenial workplace. The decision to increase the maternity leave to 26 weeks is expected to increase the number of working women in the coming years. This will lead to less time to cook at home and families are expected to depend on packaged foods more often in the coming few years.

Innovation in product mix and packaging and catering to markets across price points: Increasing focus on taste, quality and better packaging is leading to higher shelf-life of products in the consumer foods industry. Companies are also increasingly manufacturing products across price points, and innovating products to cater to different consumers with varying tastes and preferences. We expect that this will lead to a significant rise in the penetration levels of various segments within the consumer foods industry, leading to sharp growth in the industry over the medium term.

Improvement in supply chain infrastructure through Food Parks: The expansion of cold storage, transportation and other critical supply chain infrastructure across the country will result in the growth of the consumer foods industry over the long term, as it will reduce waste and increase the shelf-life of food products. Total number of 42 food parks have been sanctioned by the government as of 1st July 2019. Currently (as of March 2026) 24 food parks are operational in India.

Government's thrust on industry through priority lending status: Crisil Intelligence believes that the priority lending status given to the consumer foods industry would help the industry grow at a strong pace, as more companies will plan to invest in the industry.

Review and outlook on the Indian Semiconductor industry

Review and outlook for semiconductor market (CY20-30) in India

The semiconductor industry is the backbone of modern digital economies supporting a wide range of technologies across computing, communications, automotive, industrial automation, and consumer electronics. Semiconductors serve as the foundational components for data processing, storage, connectivity, power management, and advanced sensing which makes them essential for the growth of artificial intelligence (AI), 5G networks, cloud infrastructure, electric mobility, and connected devices. Over the past few years, the industry has undergone rapid transformation driven by rising technological complexity, increased silicon content across end-use applications, and structural shifts in global supply chains.

From 2020 onward, industry's strategic importance increased significantly as countries and enterprises recognized semiconductor capability as critical to national competitiveness. This period also marked a transition towards advanced manufacturing nodes, expanded investments in semiconductor packaging and power electronics, and increasing adoption of software-defined and AI-accelerated systems.

Review and Outlook of semiconductor market

In 2020, the semiconductor industry witnessed steady growth, but the COVID-19 pandemic created unprecedented disruptions. While the first half of 2020 saw demand volatility, the second half recorded a sharp rebound as remote work accelerated the need for laptops, cloud infrastructure, data centers, and networking equipment. Simultaneously, strong demand from smartphones and consumer electronics strained global semiconductor fabrication capacity.

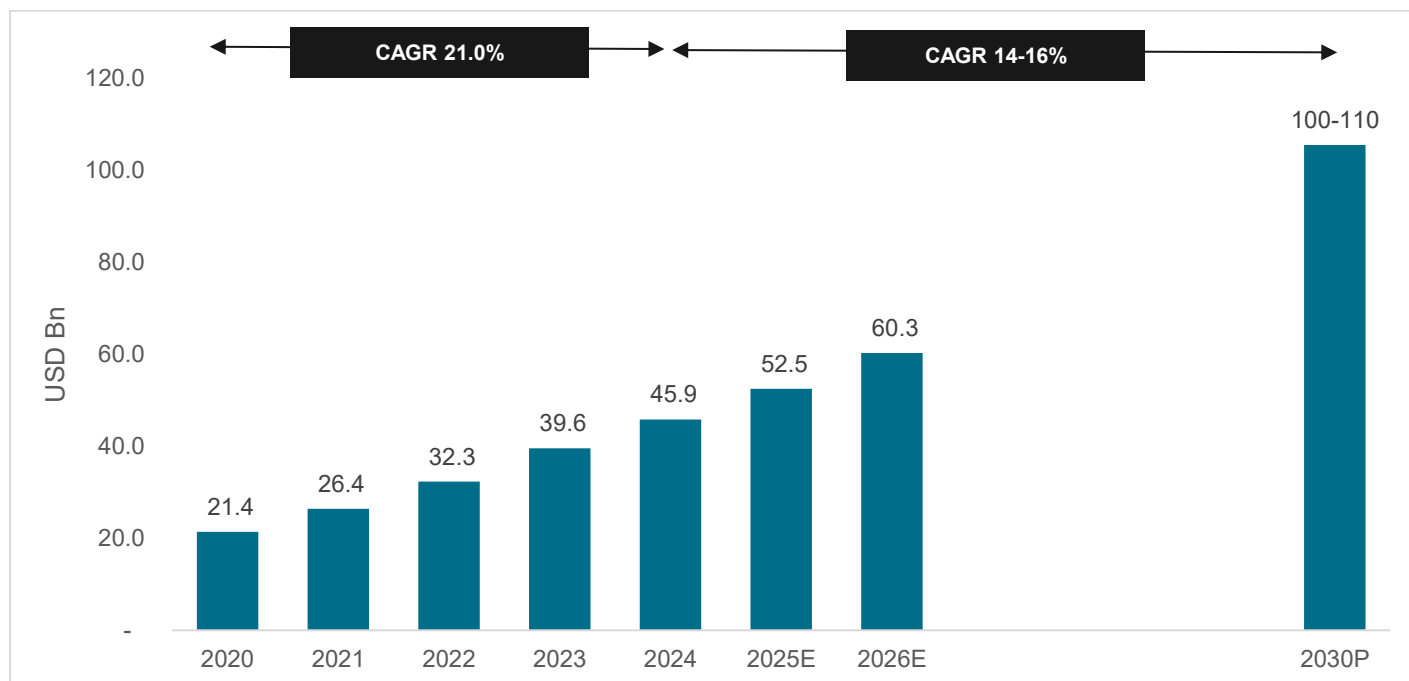
A combination of supply-chain disruptions, wafer shortages, and logistics bottlenecks resulted in a global chip shortage through 2021, severely impacting the automotive, industrial electronics, and telecom equipment sectors. This period highlighted the concentration of global fabrication capacity in select geographies and reinforced the industry's vulnerability to external shocks.

Post pandemic, in response to global shortages, the industry witnessed a multi-year investment super-cycle, with leading foundries, Integrated Device Manufacturers (IDMs), and Outsourced Semiconductor Assembly and Test (OSAT) players announcing large capital expenditure programs. Governments across the US, EU, Japan, Korea, and India introduced semiconductor incentive schemes to localize manufacturing, support R&D, and build resilient supply chains. This phase was characterized by the scaling of advanced logic nodes (5nm and below), rapid adoption of Extreme Ultraviolet (EUV) lithography, and the commercial emergence of chiplet-based architecture. Power semiconductors, especially Silicon Carbide (SiC) and Gallium Nitride (GaN), saw significant momentum due to rising EV penetration and renewable-energy applications. Automotive semiconductor content increased materially, driven by electrification, Advanced Driver Assistance Systems (ADAS), connected mobility, and domain-based vehicle architectures. Memory markets, particularly high-bandwidth memory (HBM), started benefiting from AI workloads, while advanced semiconductor packaging became a core differentiator as computing architectures moved closer to heterogeneous integration.

In 2024, AI and generative-AI adoption significantly accelerated demand for high-performance compute (HPC) chips, Graphics Processing Units (GPUs), AI accelerators, and High Bandwidth Memory (HBM). Cloud and data-center operators expanded capacity to support AI training and inference workloads, driving strong recovery in memory and advanced logic segments.

Automotive remained one of the most resilient demand drivers throughout this period, with semiconductor value per vehicle rising steadily due to electrification, safety systems, and connected-vehicle electronics. By 2025, the industry had largely emerged from earlier shortages, with supply and demand trends becoming more balanced across segments, while strategic investments in capacity, equipment, and materials continued.

Indian Semiconductor industry market size



Source: Nexdigm

The semiconductor market has consistently expanded nearly 2.5 times over the six-year period, reflecting increasing domestic demand and technological adoption. The industry has witnessed a healthy CAGR of 21.0% from USD 21.4 Bn in CY2020 to USD 45.9 Bn in CY2024.

Going forward, the industry is expected to maintain strong growth, supported by AI-led demand, increasing semiconductor intensity across sectors, and digital adoption. Global revenues are projected to approach USD 1 trillion by the end of the decade.

AI and HPC will be key growth drivers, increasing demand for advanced logic, HBM, and specialized accelerators, alongside growth in advanced packaging and chiplet-based architectures. Automotive and industrial sectors will remain strong contributors, driven by EV adoption, ADAS, and industrial automation, with rising demand for power semiconductors, sensors, and analog ICs. On the supply side, government-led incentives and investments are expected to diversify manufacturing and strengthen supply chains.

The semiconductor industry is estimated to grow from USD 60-61 Bn in CY2026 to USD 100-110 Bn in CY2030 reflecting a CAGR of 14-16% driven by technology upgrades, widening end-use applications etc.

Application of industrial gases in semiconductor industry

Industrial gases are indispensable to the semiconductor manufacturing ecosystem, enabling ultra-clean, highly controlled and precision-driven production environments. High-purity nitrogen, hydrogen, argon and specialty gases are extensively used in semiconductors fabrication processes, including inerting and blanketing, purging and

pressurization to prevent contamination and oxidation at critical stages of wafer processing. Applications such as line and vessel drying, atmosphere control and environmental testing ensure stable, particle-free cleanroom conditions, which are essential for achieving high device yields and consistent chip performance.

During wafer fabrication, industrial gases support high-temperature and plasma-based processes such as plasma cutting, laser processing, plasma spraying and thermal spray, as well as inductively coupled plasma (ICP) applications used in etching and deposition processes. Hydrogenation applications and low-temperature reactions are applied in advanced material treatment and surface modification, while cooling, process cooling and heat transfer systems maintain precise thermal control across fabrication equipment. Modern fabs also rely on fire suppression applications and inerting for additive manufacturing in specialized tool environments to enhance operational safety.

In the back end of semiconductor manufacturing, industrial gases play a key role in integrated circuit packaging, assembly and test, passive components manufacturing and Printed Circuit Board (PCB) assembly and test. Modified atmosphere environments, packaging, inerting and blanketing are used to protect sensitive chips from moisture and oxygen during dicing, bonding and encapsulation. Cryogenic cooling and low-temperature testing are used to validate device reliability under extreme conditions, while solvent abatement and Volatile Organic Compounds (VOC) recovery systems help fabs meet stringent environmental regulations. Industrial gas companies including INOX Air Products operating in the semiconductor and advanced manufacturing sectors must showcase their ability to adhere to stringent purity and reliability standards. This strategic positioning is crucial for their growth as India enhances its electronics manufacturing capabilities. Overall, the growing complexity of chips and increasing demand from automotive, AI and consumer electronics continue to strengthen the role of industrial gases as critical enablers of quality, safety and performance in the semiconductor industry.

Key demand drivers

Indian Semiconductor Mission (ISM)

India Semiconductor Mission (ISM) was approved by the Union Cabinet in December 2021. With an outlay of Rs. 76,000 crores, the programme aims to provide financial support for investments in semiconductor fabrication, display manufacturing & chip design to enhance India's integration with global electronics value chains. Envisioned to be led by global experts in the Semiconductor and Display industry, ISM aims to build a strong semiconductor and display ecosystem, positioning India as a global hub for electronics manufacturing and design, while serving as the nodal agency for the efficient and seamless implementation of semiconductor and display schemes.

The ISM is the Government of India's strategic initiative aimed at building a robust, globally competitive semiconductor and display manufacturing ecosystem in the country. The approved outlay is Rs. 76,000 crores across 4 categories according to modified Semicon India program. The mission focuses on attracting large-scale investments, promoting advanced technology capabilities, and reducing India's heavy dependence on semiconductor imports. The program is designed to strengthen the entire value chain from chip design to fabrication, assembly, testing, packaging, and display manufacturing. India is positioned as a trusted partner in global electronics supply chains. In addition to capital subsidies, the mission supports R&D, innovation, and talent development, which are critical for long-term ecosystem maturity.

Under the Modified Semicon India Program, the Government offers 50% fiscal support on a pari-passu basis for a wide range of *semiconductor fabs* covering all node sizes of silicon CMOS technologies. This support aims to enable large-scale greenfield fabrication facilities, catalyzing indigenous production of logic chips, memory, and other high-performance semiconductor components. Similarly, for *display fabs*, the program provides 50% project cost support

across next-generation technologies such as TFT LCD and AMOLED displays, encouraging domestic manufacturing of panels used in smartphones, TVs, laptops, automotive clusters, and industrial equipment.

To strengthen the *packaging* and advanced material ecosystem, the program also extends 50% capital expenditure support for compound semiconductor fabs, silicon photonics units, sensor fabs, and OSAT/ATMP facilities. These segments are crucial for fast-growing applications like 5G, electric mobility, power electronics, and IoT devices, enabling India to participate in high-value specialized semiconductor markets. Further, to promote a strong fabless design ecosystem, the scheme provides design-linked incentives, including reimbursement of up to 50% of eligible design expenditure, alongside *deployment-linked incentives* of 6% to 4% on net sales, supported by design infrastructure such as EDA tools, MPW access, and prototyping assistance. A total outlay of Rs. 1,000 crores allocated to promote semiconductor design startups and MSMEs by offering financial support across product development stages. Incentives up to Rs. 15 crore per company are given to encourage innovation in chip design.

2.5% of the mission outlay of these schemes has been earmarked for R&D, skill development, and training, along with custom duty exemptions on capital goods, machinery, electrical equipment, and components required for semiconductor and display manufacturing. Together, these initiatives aim to create a fully integrated semiconductor ecosystem in India enhancing manufacturing competitiveness, attracting global technology leaders, encouraging domestic innovation, and enabling India to become a long-term, reliable player in the global semiconductor supply chain.

Commitment of Rs. 234 crores to Indian startups- Since the launch of the DLI Scheme in 2022, the government had committed the support of Rs. 234 crores for the chip design projects from 22 companies with a total project cost of Rs. 690 crore. These chips will be used in CCTV cameras, mobile networks, satellites, cars, smart devices, etc.

India now has 10 approved semiconductor projects across six states, including its first commercial Silicon Carbide fab in Odisha under development and an advanced packaging unit bringing next-generation technologies. Together, these projects represent an investment of Rs. 1.60 lakh crore and position India to collaborate closely with global leaders.

Growth in electronics sector

The Indian consumer electronics market is experiencing a surge in demand for AI-powered devices, including smart speakers, smart home gadgets, and autonomous vehicles. This upward trend is projected to persist, thereby fueling the demand for AI semiconductors across the Indian market. India stands out as a prominent player in the global electronics market, as evidenced by the establishment of manufacturing facilities by numerous prominent companies like Apple, Samsung, Foxconn, Dixon Technologies etc., It is projected that electronic manufacturing output will surpass \$300 Bn by 2030 in India. Additionally, India ranks among the largest consumers of electronics globally, leading to a significant demand for semiconductors within the country.

Automotive (CASE technology)

The rapid transition of the global and Indian automotive sector toward Connected, Autonomous, Shared, and Electric (CASE) mobility is significantly expanding semiconductor intensity per vehicle. Traditional internal-combustion vehicles typically relied on limited electronic components; however, modern CASE-enabled vehicles require advanced power electronics, sensors, microcontrollers, AI processors, connectivity chipsets, and battery management systems. As OEMs integrate features such as ADAS, telematics, vehicle-to-everything (V2X) communication, digital cockpit systems, and electrified powertrains, the semiconductor content per vehicle is projected to rise multifold, driving sustained industry demand.

Electric vehicles are a particularly strong catalyst, requiring high-power semiconductors such as Silicon Carbide (SiC) and Gallium Nitride (GaN) devices for traction inverters, onboard chargers, DC-DC converters, and thermal management systems. Simultaneously, the shift toward connected mobility is accelerating adoption of telematics control units, cybersecurity chips, infotainment processors, and OTA-enabled ECUs. Autonomous technologies further push demand for advanced sensing (LiDAR, radar, camera modules), high-performance compute chips, and AI accelerators. The rise of shared and fleet-based mobility models adds another layer of semiconductor consumption through increased utilization of connected systems, predictive maintenance, and fleet analytics.

Collectively, the evolution towards CASE mobility is leading to an increase in semiconductor demand across the automotive value chain

Rising demand and government support

The global chip demand is surging, but the supply chain is vulnerable due to its concentration in limited geographies, highlighting the need for diversified manufacturing. India is poised to play a significant role, driven by initiatives like Make in India, India Semiconductor Mission, and Semicon India program, which have fostered a supportive ecosystem.

Company	Project type	Location	Technology partner	Investment	Capacity	Technology
Micron Semiconductor or Technology	ATMP	Sanand, Gujarat	In-house (USA)	Rs. 22,516 crore	1,852 MN units/yr	Flip-Chip & Wire bond
Tata Semiconductor or Manufacturing	Fab	Dholera, Gujarat	PSMC (Taiwan)	Rs. 91,528 crore	50,000 wafer starts/month	12" CMOS (28nm–10nm)
Tata Semiconductor or Assembly & Test	OSAT	Mangogon, Assam	In-house (India)	Rs. 27,120 crore	15,600 MN units/yr	Wire bond, Flip-Chip, ISP
CG Power & Industrial Solutions	OSAT	Sanand, Gujarat	Renesas (Japan), Stars Microelectronics (Thailand)	Rs. 7,584 crore	4,044k units/yr	Wire bond & Flip-Chip
Kaynes Semicon	ATMP	Sanand, Gujarat	Globetronics (Malaysia) & AOI (Japan)	Rs. 3,307 crore	2,310 MN units/yr	Wire bond, Flip-Chip, Photonics

India Chip (HCL– Foxconn JV)	OSAT	Yeida, Uttar Pradesh	Hon Hai (Foxconn, Taiwan)	Rs. 37,706 crore	432 MN units/yr	Wafer- Level Packaging (Au bump)
ASIP Technologies	OSAT	Andhra Pradesh	APACT (South Korea)	Rs. 4,650 crore	96 MN units/yr	Wirebond & Flip-Chip
SICSEM	Compound fab & ATMP	Bhubanesw ar, Odisha	Clas-SiC (UK), CDIL (India)	Rs. 27,067 crore	96 MN units/yr	SiC MOSFET & Diode Fab
3DGS	Advanced Packaging	Bhubanesw ar, Odisha	In-house (USA)	Rs. 1,940 crore	120 MN units/yr	Glass Substrate ATMP & 3D HiSi
CDIL	OSAT	Mohali, Punjab	In-house (India)	Rs. 1,180 crore	158 MN units/yr	Advanced SiC & high- voltage packages

The global semiconductor market is expected to reach \$1 trillion by 2030, with India's market occupying a substantial portion of it.

India can contribute to the three key pillars of the semiconductor supply chain: Equipment, leveraging its strong MSME base to produce components for semiconductor equipment; Materials, utilizing its rich reserves of chemicals, minerals, and gases; and Services, offering R&D, logistics, and talent in AI, big data, cloud computing, and IoT.

Recent developments include the inauguration of two cutting-edge semiconductor design facilities in Noida and Bengaluru, focusing on 3-nanometer chip design. This milestone marks a significant advancement in India's semiconductor innovation journey, with the potential to propel the country's growth in the industry.

Overview of Green Hydrogen sector in India

Executive summary

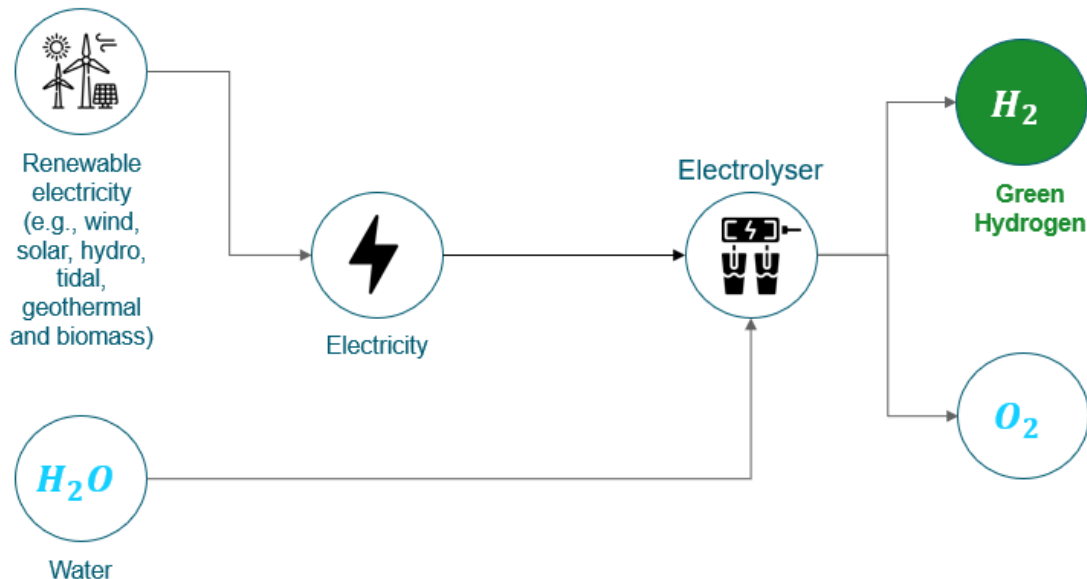
Green hydrogen is central to India's decarbonization strategy, with the National Green Hydrogen Mission (NGHM) setting ambitious targets for production, investment, and exports. India's competitive advantage lies in low-cost renewables, strong domestic demand, positioning it as a global hub.

Overview of Green Hydrogen

Hydrogen, as an energy carrier, is becoming crucial for achieving decarbonization of hard-to-abate sectors. Many sectors such as iron ore and steel, fertilizers, refining, methanol production, and maritime shipping emit major amounts of CO₂, and carbon-free hydrogen will play a critical role in enabling decarbonization. For other high-emitting sectors, such as heavy-duty trucking and aviation, hydrogen is among the main options being explored with the potential to become the preferred solution for several applications. This has resulted in growing global momentum towards hydrogen and green hydrogen in particular.

Green hydrogen is hydrogen produced from renewable energy sources such as solar and wind through water electrolysis, resulting in virtually zero carbon emissions. In India, green hydrogen is positioned as a critical energy vector that can help decarbonize hard-to-abate sectors while advancing energy security and climate goals. Its potential to replace fossil fuels in industry and power systems aligns with India's clean energy transition ambitions.

Green hydrogen process flow:



Government Policy Direction

The National Green Hydrogen Mission (NGHM), launched by the Government of India in 2023, provides a long-term roadmap to make India a global hub for green hydrogen production, usage, and export. The Mission's objectives include:

- Building at least 5 million metric tonnes (MMT) of annual green hydrogen production capacity by 2030, with potential to extend beyond this based on export growth.

- Mobilizing over Rs. 8 lakh crore in investments and creating over 6 lakh jobs by 2030. Supporting the addition of approximately 125 GW of renewable energy capacity to power green hydrogen production.
- Reducing cumulative fossil fuel imports by around Rs. 1 lakh crore and abating nearly 50 MMT of CO₂ emissions annually.
- The NGHM also incorporates incentive schemes for electrolyzers manufacturing and production support under its Strategic Interventions for Green Hydrogen Transition (SIGHT) program. The Strategic Interventions for Green Hydrogen Transition (SIGHT) Programme is a major financial measure with an outlay of Rs. 17,490 crore upto 2029-30. The programme consists of two distinct financial incentive mechanisms to support domestic manufacturing of electrolyzers and production of Green Hydrogen.

India's Current Position in the Green Hydrogen Value Chain

India is currently transitioning from pilot and early commercial projects toward larger industrial deployment. Under the NGHM, as of May 2025, 19 companies have been allocated a cumulative annual production capacity of 862,000 tonnes of Green Hydrogen every year and 15 firms have been awarded a 3,000 MW annual electrolyzer manufacturing capacity. India has also launched pilot projects in steel, mobility, and shipping sectors.

While India's full 5 MMT production target is set for 2030, achievement may extend closer to 2032 due to external demand uncertainties and slower global policy coordination, Domestic demand creation remains a priority, particularly in sectors such as refining and methanol production.

The NGHM is facilitating applications across industry and mobility.

Industrial

- **Fertilizers:** Replacing fossil-fuel-based feedstocks with Green Ammonia. A recent auction for a long-term supply of green ammonia to fertilizer units was concluded, with an aggregate procurement capacity of 7.24 lakh metric tonnes per annum, at a price of Rs. 55.75 per kg.
- **Petroleum Refining:** The mission is facilitating the replacement of fossil-based hydrogen with green hydrogen in refineries, directly reducing the carbon footprint of this essential industry.
- **Steel:** Five pilot projects have been initiated in collaboration with public and private steel producers to evaluate the use of Green Hydrogen for iron reduction and other process applications. These pilots are designed to assess the technical feasibility, economic viability, and safety of hydrogen-based steelmaking in Indian operating conditions.

Mobility and Transport

- **Road Transport:** In March 2025, five major pilot projects were initiated involving 37 hydrogen vehicle (buses and trucks), and 9 refueling stations across 10 different routes. The vehicles to be deployed for the trial include 15 hydrogen fuel cell-based vehicles and 22 hydrogen internal combustion engine-based vehicles. The financial support for the project would be around Rs. 208 crore.
- **Shipping:** A port-based Green Hydrogen Pilot Project was commissioned at V.O. Chidambaranar Port in September 2025, featuring a Rs. 25 crore, 10 Nm³/hr facility that will supply green hydrogen for applications such as street lighting and an EV charging station. Equally significant, Deendayal Port Authority, Kandla has commissioned a megawatt-scale, indigenous Green Hydrogen Facility developed at a cost of about Rs. 13 crore,

with an annual production capacity of nearly 140 metric tonnes. Additionally, a Rs. 42 crore, 750 m³ Green Methanol Bunkering and Refuelling Facility is being developed to support cleaner maritime operations and establish a Coastal Green Shipping Corridor between Kandla and Tuticorin.

- **High-Altitude Mobility:** NTPC was commissioned the world's highest altitude (3,650 m) Green Hydrogen Mobility Project in Leh in November 2024, which includes 5 hydrogen intra-city buses and a fueling station demonstrating the fuel's reliability in extreme conditions. This station will mitigate the carbon emissions of approx. 350 MT/year and contribute 230 MT/year of pure oxygen into the atmosphere which is equivalent to planting of approx. 13,000 trees.

Enabling Framework:

Beyond direct incentives, a comprehensive enabling framework is being established to de-risk investments and accelerate development.

- **Policy Framework:** To facilitate the delivery of low-cost renewable energy for hydrogen production, the government has provided a waiver of Interstate transmission charges and ensured a time-bound grant of Open Access.
- **Skill Development:** A coordinated skill development programme is being implemented, which has already led to the certification of more than 5,600 trainees in hydrogen-related qualifications, building a future-ready workforce.

Export Potential of Green Hydrogen from India

Export markets are a core component of India's green hydrogen strategy. The NGHMs explicitly aims to establish India as a global exporter of green hydrogen and its derivatives, such as green ammonia and green methanol.

According to government projections, India aims to capture approximately 10% of the global green hydrogen demand for exports by 2030.

India's export strategy prioritizes hydrogen derivatives like green ammonia, which are easier to store and transport over long distances than pure hydrogen, making them viable for markets such as the European Union, Japan, and South Korea.

Large export-oriented facilities are emerging as well, such as significant hydrogen and green ammonia projects near Indian ports that aim to serve global markets.

In 2024, India made its debut in the international hydrogen community at the World Hydrogen Summit in Rotterdam with the inauguration of its first India Pavilion. This positions India as a prime partner for global investment, and key partner in the emerging global hydrogen economy.

India is advancing its green hydrogen sector through strategic international partnerships. The EU-India Trade and Technology Council is collaborating on hydrogen production from waste with over 30 joint proposals. An India-UK Standards Partnership Workshop in February 2025 focused on harmonized regulations and codes to facilitate trade. SECI partnered with Germany's H2Global Stiftung in November 2024 to support green hydrogen exports, while Sembcorp Industries signed agreements with Indian port authorities in October 2025 to develop integrated green hydrogen and ammonia hubs for production and export.

Role of the Industrial Gases Industry in India's Green Hydrogen Ecosystem

The industrial gases industry has an established presence across hydrogen production, purification, storage, and distribution, which is relevant to the development of India's green hydrogen ecosystem. Industrial gas companies currently supply hydrogen to end-use sectors such as oil refining, fertilizers, and chemicals, and operate hydrogen generation and handling infrastructure at industrial sites. This existing operational base provides a platform that may be utilized for green hydrogen production and can be gradually introduced across select applications. Industrial gas companies are not just suppliers but critical enablers of India's clean energy transition, leveraging existing infrastructure to scale hydrogen and CCUS.

Green hydrogen is produced through the electrolysis of water using renewable electricity, a process that requires controlled generation, purification, and handling of hydrogen. Industrial gas companies possess experience in operating hydrogen generation systems and supplying high-purity hydrogen on a captive and long-term contract basis. Electrolysis also results in oxygen as a by-product, for which industrial gas companies have established supply chains across industrial and medical applications. Integration of such by-product streams may support operational efficiency at green hydrogen facilities.

The industry is also involved in hydrogen compression, storage, and transportation, including the operation of high-pressure compression systems, on-site storage installations, and bulk transportation through tube trailers. These capabilities are relevant for supplying hydrogen to industrial consumers and may support the development of hydrogen distribution infrastructure as demand evolves. Industrial gas companies typically manage long-term supply arrangements with customers, which are relevant in the context of hydrogen supply due to storage and transportation constraints.

At present, green hydrogen deployment in India is limited and primarily focused on pilot-scale and captive industrial applications. In this context, industrial gas companies have begun participating in initial green hydrogen projects integrated with end-user facilities. For example, INOX Air Products has commissioned a green hydrogen plant at Asahi India Glass Limited's Soniyana facility in Chittorgarh, Rajasthan, supplying green hydrogen for captive industrial consumption. The project represents one of the early integrated deployments in the domestic market and reflects a partnership model aligned with the customer's production lifecycle. INOX Air Products is one of India's leading industrial gas manufacturers of hydrogen, with hydrogen production assets comprising seven Steam Methane Reformer (SMR)-based plants and two electrolysis-based plants, and is among the earliest participants in green hydrogen manufacturing in India, with hydrogen supplied in multiple formats, including cylinders, quads and trolleys. Company is an early mover in the green hydrogen sector, having commissioned one of India's first green hydrogen plants and actively participating in government tenders and policy development. Also, they are the first industrial gas company to supply green hydrogen to the float glass manufacturing industry. The company manufactures hydrogen at different locations across the country from its nine plants and also operates one of India's first UHP Nitrous Oxide, UHP Oxygen plant. The initial focus for many companies has been on Steam Methane Reforming (SMR)-based hydrogen production, as it remains the most commercially mature and scalable method for large-scale industrial applications in India compared to the electrolysis process.

Mandatory green hydrogen adoption requirements for refineries and fertilizer plants from FY2024, combined with projected demand from low-carbon projects is expected to drive domestic hydrogen demand, as well as export supply chain opportunities for green ammonia to key global markets. In addition, demand is expected to be supported by multiple green hydrogen tenders issued by public sector oil marketing companies on a BOO basis, with long-term contract tenures of up to 25 years, covering refinery locations across India. These tenders are expected to represent high-value hydrogen supply opportunities and may also unlock opportunities for SMR buyback or monetisation, as refiners evaluate asset-light hydrogen sourcing models through private operators.

Digitization, Data Centers, and the Opportunity for the Industrial Gases Industry

Executive summary

Data centers are emerging as critical infrastructure for India's digital economy, driven by AI, cloud computing, and 5G. Their energy intensity creates opportunities for industrial gases industry to deliver sustainable solutions.

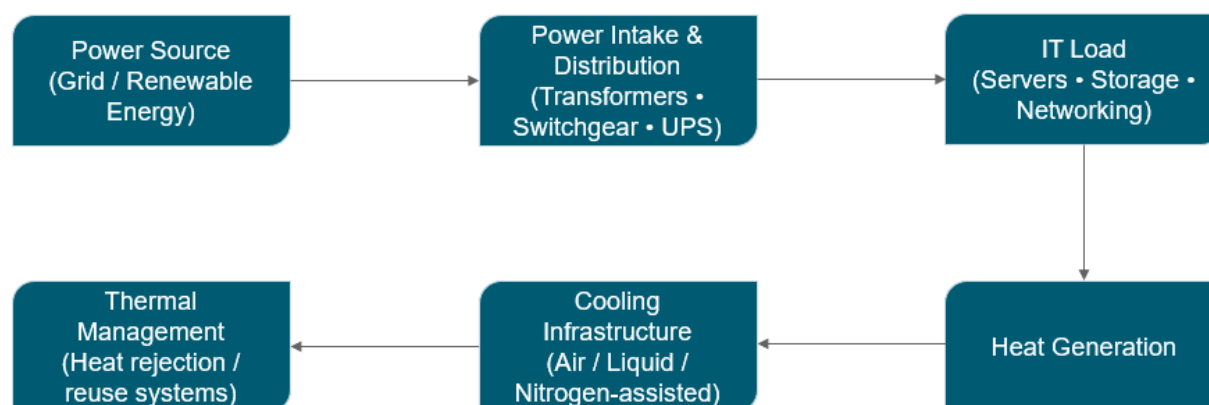
Overview

A data center is a physical facility that houses computing infrastructure, including servers, storage systems, networking equipment, and the associated power and cooling systems. These facilities form the backbone of the digital economy by enabling storage, processing, and transmission of data across a wide range of applications such as cloud computing, artificial intelligence (AI), streaming services, financial transactions, enterprise software, and digital public infrastructure.

Unlike traditional IT infrastructure, modern data centers operate on a large scale and on a continuous 24×7 basis, with extremely high requirements for reliability, uptime, and data security. Even brief power or system interruptions can lead to significant financial losses and operational disruptions for businesses that depend on digital services. As economies become increasingly digital-first, data centers are no longer a supporting utility but have emerged as critical infrastructure, comparable in importance to power plants, telecom networks, or transportation systems.

Data centre energy flow:

Data center operations involve continuous energy flow from grid or renewable power sources through intake and distribution systems that support IT equipment, cooling infrastructure, and safety systems. A significant portion of consumed energy is converted into heat, requiring dedicated thermal management systems to maintain operational stability. Advanced cooling architectures including air, liquid, and gas-assisted systems are deployed to manage high-density computing loads. Backup power systems ensure continuity during grid interruptions, while inert gas fire suppression systems protect sensitive electronic equipment without operational damage. Efficient integration of these systems is central to improving energy utilization and reliability in large-scale data center environments.



Growth of Data Centers Driven by Digitization and AI

The rapid adoption of digitization and AI has significantly increased global demand for data centers. Several structural trends are driving this growth. The widespread adoption of cloud computing by enterprises, governments, and consumers has shifted data storage and processing from on-premise systems to centralized hyperscale data centers. At the same time, AI and machine-learning workloads require substantially higher computing power, driving demand for high-density servers and more advanced infrastructure.

In parallel, the expansion of digital services including fintech, e-commerce, streaming platforms, and digital governance has increased data generation and the need for real-time processing. The rollout of edge computing and 5G networks is further increasing both the number and geographic spread of data centers. As a result of these trends, data centers are becoming larger, more power-dense, and increasingly energy-intensive, creating both operational challenges and sustainability concerns.

Energy Consumption and Power Requirements of Data Centers

Energy is the most critical input for data center operations. Power is required not only to run servers but also for cooling systems, power conditioning equipment, backup infrastructure, and safety systems. A defining characteristic of data centers is their continuous and predictable electricity demand, with facilities operating close to full load most of the time.

The International Energy Agency (IEA) states that data centers accounted for around 1% of the global electricity demand in CY2024. With digital transformation across sectors gaining momentum, the demand for data services is rising exponentially.

Current Sources of Energy and Associated Challenges

At present, data centers primarily rely on grid-based electricity, which in many regions remains significantly dependent on fossil fuels such as coal and natural gas. While leading data center operators are increasingly committing to renewable energy procurement through power purchase agreements (PPAs), renewable sources alone often cannot meet the sector's stringent operational requirements. These include continuous and uninterrupted power supply, instant backup during grid failures, and high-power quality and stability.

In India, this challenge is becoming more pronounced as the sector scales rapidly. As per PIB press release dated January 29, 2026, India's data centre capacity is projected to reach about 8 GW by CY2030 from about 1.4 GW as of second quarter of CY2025. Despite generating nearly 20% of the world's data, India hosts only about 3% of global data centres, around 150 out of 11,000 worldwide, according to Nasscom. Addressing structural constraints such as energy shortages will be critical for India to position itself as a global AI data centre hub.

As a result, most data centers continue to depend on diesel generators or gas-based systems for backup power, particularly for mission-critical operations. This creates a gap between sustainability commitments and operational realities, highlighting the need for cleaner, reliable, and scalable energy-support solutions.

Role of Industrial Gases in Improving Efficiency and Sustainability

The industrial gases industry plays an increasingly important role in addressing the energy, efficiency, and sustainability challenges faced by data centers, particularly as large hyperscale operators adopt formal decarbonization and sustainability targets. Major global cloud and data infrastructure companies such as Amazon, Microsoft, and Google have announced long-term commitments related to carbon reduction, renewable energy usage, and energy-efficient infrastructure. These commitments are influencing technology choices across backup power, cooling systems, and facility design, where industrial gases are increasingly relevant.

Industrial gases particularly hydrogen, oxygen, nitrogen, and argon enable cleaner and more efficient energy and infrastructure solutions for data centers. Hydrogen-based fuel cells are being evaluated as alternatives to diesel backup generation, offering low-emission power with high reliability and suitability for long-duration operations. As data center operators seek to reduce dependence on fossil fuels, industrial gas suppliers can act as long-term energy solution partners by providing gas supply, infrastructure, and integrated service contracts.

Industrial gases also support efficiency improvements within data centers. Gases such as nitrogen are used in advanced cooling and inert environments, helping reduce reliance on energy-intensive air-conditioning systems and supporting high-density computing operations. Nitrogen-based cooling systems work by creating controlled inert or near-inert environments and are often used in direct-to-chip cooling, enclosed cold aisle containment, or liquid-assisted cooling architectures, where nitrogen helps regulate temperature and humidity while reducing oxidation and fire risk. As data centers transition toward high-performance computing, artificial intelligence workloads, and cloud-scale operations, the need for advanced cooling solutions is expected to grow, which could increase demand for nitrogen as a supporting input. Nitrogen-based cooling systems deployed in certain high-density computing environments have demonstrated reduced reliance on conventional air-conditioning infrastructure, particularly in facilities designed for sustained high thermal loads. In parallel, clean-agent fire suppression systems using inert gases such as nitrogen and argon are increasingly preferred over water-based systems, as they suppress fires by reducing oxygen concentration without damaging sensitive electronic equipment or causing operational downtime.

Beyond direct data center operations, industrial gases are critical to the broader digital ecosystem, particularly semiconductor and electronics manufacturing. As AI-driven demand for advanced chips accelerates, the role of industrial gases extends across the entire digital infrastructure value chain, reinforcing their strategic importance in enabling the growth of data centers.

As digitization and AI continue to reshape global economies, data centers will remain central to digital growth while also becoming a focal point for energy efficiency and sustainability challenges. The industrial gases industry is uniquely positioned to support this transition by enabling cleaner power solutions, efficient cooling technologies, and high-reliability safety systems. This intersection of digital infrastructure and industrial gases represents a significant opportunity, driven by long-term structural trends rather than cyclical demand.

Overview of Carbon Capture, Utilization and Storage (CCUS) sector in India

Executive summary

CCUS is essential for decarbonizing hard-to-abate industries, ensuring energy security, and enabling circular economy outcomes.

Overview

Carbon capture, utilization, and storage (CCUS) refers to a group of technologies designed to reduce carbon dioxide (CO₂) emissions by capturing CO₂ from large point sources such as power plants and industrial facilities before it is released into the atmosphere. Once captured, the CO₂ can either be permanently stored underground or utilized in the production of useful products.

Rather than allowing CO₂ to escape into the atmosphere, CCUS involves capturing, transporting, and either safely storing or converting it into useful materials. The captured CO₂ may be used to produce building materials, fuels, or plastics.

CCUS plays a critical role in reducing emissions from industries such as steel, cement, and chemicals. It is also being explored in the power generation sector, particularly when integrated with biomass or low-carbon fuels. As global pressure to reduce emissions increases, carbon capture technologies are increasingly recognized as an essential tool for achieving climate targets.

Benefits of CCUS

- **Emission Reduction & Energy Security:** CCUS enables deep CO₂ cuts in hard-to-abate sectors (e.g., cement, steel, refining, and power) while keeping essential capacity online, helping decarbonize existing assets rather than forcing abrupt shutdowns. It also strengthens energy security by supporting a reliable low-emission transition, while maintaining system stability and moderating exposure to imported fuels during the shift to low-carbon energy.
- **Industrial Competitiveness & Circular Economy:** By retrofitting existing infrastructure, CCUS can lower the cost and disruption of decarbonization for emissions-intensive industries, helping protect jobs, domestic production, and supply chains. Captured CO₂ can also be utilized as a feedstock (e.g., in materials, chemicals, and synthetic fuels where appropriate), advancing circular carbon pathways and creating new revenue streams that improve project economics and industrial resilience.
- **Innovation & Global Climate Alignment:** Scaling CCUS drives innovation across capture materials, process efficiency, CO₂ transport/storage, and carbon-derived products, accelerating broader clean-tech progress and creating high-skilled employment. It also supports alignment with global climate goals by providing a practical pathway to reduce industrial and system-wide emissions at pace especially where alternatives are not yet technically or economically viable helping countries meet national targets and long-term decarbonization commitments.

Industrial applications of CCUS

Industrial applications of CCUS focus on decarbonizing heavy industries like cement, steel, and chemicals, producing low-carbon hydrogen, generating clean electricity, creating valuable products from CO₂ (fuels, building materials), enhancing oil recovery, and enabling negative emissions via direct air capture, all crucial for achieving net-zero targets. CCUS tackles emissions in sectors lacking other viable options, retrofits existing plants, and supports energy security while creating new markets.

Key industries are:

- **Power generation:** Thermal power plants remain significant contributors to carbon dioxide emissions due to continued reliance on coal and natural gas for baseload power. CCUS is required to mitigate emissions from existing assets while ensuring energy security. The industrial gases sector enables CCUS deployment in this sector through oxygen supply for oxy-fuel combustion, hydrogen integration for pre-combustion capture pathways, and nitrogen for inerting and safety applications. Cryogenic air separation and gas purification technologies are central to these processes.
- **Cement industry:** Cement manufacturing generates substantial process-related CO₂ emissions arising from limestone calcination, which cannot be eliminated through fuel substitution alone. CCUS is therefore essential for deep decarbonization. The industrial gases sector supports CCUS implementation by supplying oxygen for oxy-fuel kilns, facilitating CO₂ separation, purification, and liquefaction, and enabling downstream utilization of captured CO₂ in concrete curing and mineralization applications.
- **Iron and steel industry:** Conventional steelmaking processes are highly carbon-intensive due to the use of coke and coal as reducing agents. CCUS is required to reduce emissions from blast furnaces and direct reduction processes during the transition to low-carbon steel production. Industrial gas technologies underpin these efforts through the provision of oxygen for steelmaking, hydrogen for direct reduced iron routes, inert gases such as nitrogen and argon for process control, and integrated CO₂ capture and handling systems.
- **Oil and gas sector:** The sector produces concentrated CO₂ streams during natural gas processing, refining, and hydrogen production. CCUS is required to manage these emissions and to enable enhanced oil recovery while supporting long-term geological storage. Industrial gas capabilities are embedded in these applications through CO₂ compression, dehydration, and transport infrastructure, as well as the supply of nitrogen for reservoir management and cryogenic separation technologies for gas processing.
- **Chemicals and petrochemicals:** Their production is energy- and carbon-intensive, with CO₂ generated from reforming and synthesis processes. CCUS enables the capture and utilization of carbon dioxide as a feedstock, supporting circular carbon pathways. Industrial gas solutions, including hydrogen supply for CO₂ conversion, oxygen for partial oxidation processes, and high-purity CO₂ handling systems, are integral to these applications.
- **Fertilizers:** Ammonia and urea manufacturing inherently generate CO₂ as part of the production process. CCUS is required to reduce residual emissions and enable the production of low-carbon fertilizers. The industrial gases sector is intrinsically embedded through hydrogen production with integrated CO₂ capture, nitrogen supply for ammonia synthesis, and CO₂ purification and utilization within urea production or for storage.
- **Refineries:** They emit CO₂ from hydrogen production units and various fuel combustion processes. CCUS is required to meet tightening emission norms and support the transition to cleaner fuels. Industrial gas technologies support these efforts through hydrogen supply, oxygen for gasification and reforming, and CO₂ capture, compression, and storage solutions.
- **Waste-to-energy and biomass:** Waste-to-energy and biomass-based facilities generate biogenic CO₂ emissions. When combined with CCUS, these sectors can achieve negative emissions, making them strategically important for net-zero pathways. Industrial gas technologies enable oxygen-enriched combustion, efficient CO₂ capture and purification, and downstream transport or utilization of captured biogenic CO₂.
- **Direct Air Capture (DAC):** DAC is required to address legacy emissions and offset residual emissions from hard-to-abate sectors. Industrial gas expertise in gas separation, adsorption, cryogenic processing, CO₂ compression, and transport infrastructure is fundamental to the scalability and commercialization of DAC technologies.

Across all major emitting sectors, CCUS is a critical decarbonization pathway where direct emission elimination is technically or economically constrained. The industrial gases sector plays a cross-cutting and enabling role by providing essential oxygen, hydrogen, nitrogen, and CO₂ handling capabilities, alongside cryogenic separation, purification, compression, and transport technologies, thereby forming the backbone of large-scale CCUS deployment.

CCUS in India's Decarbonisation landscape

India's pathway to achieving net-zero emissions by 2070 is contingent not only on the accelerated deployment of renewable energy but also on the adoption of enabling technologies such as Carbon Capture, Utilization, and Storage (CCUS). Key national institutions, including the Department of Science and Technology (DST) and NITI Aayog, are playing a pivotal role in advancing CCUS through research support, technological development, and policy formulation. These initiatives position CCUS as a viable solution for reducing emissions in hard-to-abate sectors while simultaneously addressing the country's increasing energy requirements. Recent developments highlight meaningful progress, with NTPC initiating carbon capture operations at the Vindhyachal Super Thermal Power Station, where CO₂ is captured from flue gas and utilized in downstream applications such as methanol production. Additionally, NTPC has undertaken India's first geological carbon storage pilot at the Pakri Barwadih coal mine to assess the feasibility of long-term subsurface storage.

In the industrial sector, Tata Steel has commissioned a carbon capture and utilization facility at its Jamshedpur plant, demonstrating the applicability of CCUS in steel production. These advancements are expected to drive demand for industrial gas solutions, including CO₂ purification and liquefaction, cryogenic separation, compression, transportation, and storage, alongside increased requirements for oxygen and hydrogen supply. Beyond power and steel, CCUS initiatives are gaining traction across cement, refining, and other emission-intensive industries. Companies such as UltraTech Cement are exploring carbon capture pathways, while Indian Oil Corporation and ONGC are pursuing integrated carbon management solutions, including hydrogen production and low-carbon fuel development. Notably, ONGC, in collaboration with Shell, is piloting CO₂ injection projects at the Gandhar field in Gujarat for storage and enhanced oil recovery. Collectively, these developments signal growing momentum towards embedding CCUS within India's heavy industry landscape, potential to foster the development of a shared ecosystem for capture, transport, utilization, and storage infrastructure over time.

India-specific policy framework for CCUS

- The Government of India recognizes CCUS as a critical technology for achieving national climate objectives and is actively promoting research, development, and pilot-scale deployment in this domain.
- The DST, along with other relevant institutions, has established dedicated programs to support innovation and technological advancement in CCUS.
- Policy efforts are increasingly focused on integrating CCUS with renewable energy expansion and broader industrial decarbonization strategies.
- India is also collaborating with international partners to strengthen domestic capabilities and adopt global best practices in CCUS development and implementation.
- While regulatory frameworks governing carbon dioxide transportation and geological storage are still evolving, the government is working towards establishing clear and comprehensive guidelines to enable large-scale deployment. The Ministry of Petroleum and Natural Gas (MoPNG) Draft 2030 Roadmap positions CCUS as a core mitigation tool for upstream E&P companies, aligning industry deployment with national climate commitments. It emphasizes establishing a clear timeline for CCUS adoption by 2030 within upstream operations, supporting gradual scaling across the sector.

- Robust policy support and institutional frameworks are essential to address key challenges associated with CCUS, including high capital costs and infrastructure constraints. With growing global emphasis on emissions mitigation, CCUS is emerging as an integral component of climate and energy policy frameworks
- Carbon Capture, Utilization and Storage (CCUS) is a critical instrument for reducing greenhouse gas emissions, particularly in sectors where direct decarbonization remains technically or economically challenging. While the deployment of renewable energy continues to expand, CCUS addresses residual emissions that cannot be readily eliminated through alternative measures.

By capturing and securely storing or utilizing carbon dioxide, CCUS supports a balanced and pragmatic energy transition. In India as well as globally, the technology is increasingly recognized as an essential enabler for achieving long-term climate objectives, including net-zero emission targets.

Although challenges related to cost and infrastructure persist, continued technological innovation and supportive policy frameworks can facilitate wider adoption. CCUS is most effective when deployed as part of an integrated decarbonization strategy alongside renewable energy expansion and energy efficiency improvements, thereby contributing to a cleaner and more sustainable future.

Role of the Industrial Gases Industry in India's CCUS Ecosystem

The industrial gases companies are emerging as a critical enabler of India's CCUS ecosystem, drawing on its long-standing expertise in gas separation, purification, compression, liquefaction, and the operation of large-scale process plants. Global industrial gas leaders such as Air Products and Linde illustrate how CCUS can be implemented as an integrated, end-to-end value chain rather than as a standalone capture activity. Their technology platforms highlight the ability to deploy post-combustion, pre-combustion, and oxy-fuel CO₂ capture solutions that are particularly relevant for India's hard-to-abate sectors, including steel, cement, refining, fertilizers, and chemicals, where retrofitting existing assets is often more practical than complete replacement.

Beyond capture, industrial gas companies play a central role in CO₂ purification, compression, and conditioning, ensuring that captured carbon meets the quality specifications required for transport, utilization, or permanent storage. The carbon management frameworks showcased by these companies emphasize advanced separation, drying, and compression technology capabilities that are already well established in their industrial gas supply operations in India. This positions the sector to support the development of shared CO₂ infrastructure, including pipelines, liquefaction facilities, and storage-ready transport systems, which are essential for scaling CCUS beyond pilot projects.

In addition, the industrial gases industry is a key driver of CO₂ utilization pathways, supplying high-purity carbon dioxide for applications such as urea and methanol production, synthetic fuels, food and beverage carbonation, and emerging e-fuel value chains. By integrating CCUS with existing gas production and distribution networks, industrial gas companies can help create early and stable demand for captured CO₂, thereby improving project economics and accelerating adoption across industrial clusters. Overall, as India advances its low-carbon industrial strategy, the industrial gases industry is well positioned to act as a system integrator and long-term partner, translating global CCUS experience into commercially viable Indian deployments while unlocking new growth opportunities in carbon management services.

Space sector and the opportunity for the Industrial Gases Industry

Propulsion stages in a rocket

A rocket is a launch vehicle that transports a spacecraft beyond the Earth's atmosphere, either into Earth's orbit or to another destination in outer space. The launch vehicles are equipped with robust propulsion systems that generate the immense energy required to overcome Earth's gravitational pull and lift heavy payloads, including satellites, into space. Satellites are integral to space missions. However, they don't make their way into space independently. Instead, they rely on launch vehicles for their journey.

Rocket propulsion involves the conversion of chemical energy stored in propellants into kinetic energy. The propulsion system primarily consists of propellant tanks, a combustion chamber, and a nozzle. Fuel and oxidizer are burned in the combustion chamber, generating high-temperature, high-pressure gases. These gases are expelled through a convergent-divergent nozzle, accelerating the exhaust to supersonic velocities and producing thrust.

Since rockets carry both fuel and oxidizer onboard, they remain independent of atmospheric conditions. This feature enables continuous operation from ground level through the upper atmosphere and into outer space.

Rocket staging is a fundamental design strategy used to enhance efficiency and payload capacity. A multi-stage rocket is divided into two or more stages, each equipped with its own propulsion system. When a stage exhausts its propellant, it is separated and discarded, reducing the vehicle's mass and allowing the remaining stages to operate more efficiently.

Launch vehicles use a combination of fuel and oxidizer, called propellant, to generate thrust. Common propellants include liquid hydrogen and liquid oxygen (LH₂/LOX).

Different stages of a rocket are:

- 1. First stage propulsion (Booster stage):** The first stage, also known as the booster stage, provides the initial thrust required to lift the rocket off the launch pad and overcome Earth's gravitational force and atmospheric drag. This stage operates in dense atmospheric conditions and is designed to generate extremely high thrust for a short duration, typically lasting two to three minutes. Propulsion systems used in this stage may include solid rocket motors, liquid engines, or semi-cryogenic engines using refined kerosene and liquid oxygen. Once its fuel is depleted, the first stage separates from the launch vehicle. Fuel used is mostly solid propellants (for boosters) or liquid propellants such as: Liquid Oxygen (LOX) + Kerosene (RP-1) or Liquid Oxygen (LOX) + Liquid Hydrogen (LH₂)
- 2. Second stage propulsion (Sustainer stage):** The second stage ignites after first-stage separation and continues accelerating the vehicle to near-orbital velocities. Operating in thinner atmospheric conditions or near vacuum, this stage emphasizes efficiency over raw thrust. Cryogenic propulsion systems are commonly used at this stage due to their high specific impulse. The second stage plays a critical role in shaping the trajectory and building the energy required for orbital insertion. Fuel used is typically liquid propellants for precise control: LOX + LH₂ or LOX + Kerosene
- 3. Third stage propulsion (Orbital injection stage):** The third stage, also referred to as the orbital injection or kick stage, provides the final velocity increment necessary to place the payload into its designated orbit or interplanetary transfer path. This stage operates entirely in vacuum and requires precise thrust control. Mostly uses liquid propellants or cryogenic fuels.
- 4. Fourth stage (Payload fairing):** The payload, such as a satellite, is enclosed within a protective shell called payload fairing. The fairing shields the payload from aerodynamic forces and heat during the initial stages of

flight. Once the rocket reaches space, the fairing is jettisoned to expose the payload, and the satellite is inserted into the intended orbit.

Technological advancements in rocket propulsion systems

1. Chemical rocket propulsion (conventional technology)

Chemical rocket propulsion relies on the combustion of fuel–oxidizer combinations to generate high thrust, with widely used propellant pairs enabling reliable performance for lift-off and early-stage ascent.

2. Solid Propellant Rocket Technology

Solid propellant rocket technology utilizes pre-mixed fuel and oxidizer formulations (e.g., ammonium perchlorate with aluminum powder), offering stable, ready-to-use energy sources with long storage life but limited control once ignited.

3. Liquid propellant technology (LOX–RP-1)

Liquid propellant rocket engines employ liquid oxygen (LOX) as the oxidizer and refined kerosene as fuel, providing a dense, stable, and easily manageable propellant combination suited for lower-stage operations.

4. Cryogenic propulsion technology (LOX–LH₂)

Cryogenic propulsion technology employs liquid hydrogen (LH₂) as fuel and liquid oxygen (LOX) as the oxidizer, delivering very high energy efficiency and specific impulse, though requiring complex storage due to extremely low temperatures and low fuel density.

5. Methane based propulsion technology (LOX–LCH₄)

Methane-based propulsion systems, use liquid methane (LCH₄) as a cleaner burning fuel paired with liquid oxygen, reducing carbon residue, improving engine reusability, and offering easier handling compared to hydrogen.

6. Hypergolic propulsion systems

Hypergolic propulsion systems use fuel and oxidizer combinations (e.g., UDMH and nitrogen tetroxide) that ignite spontaneously upon contact, ensuring reliable ignition and restart capability, albeit with high toxicity and handling risks.

7. Electric propulsion technology

Electric propulsion systems use inert gases such as xenon or krypton as propellants, which are ionized and accelerated using electrical energy to achieve very high exhaust velocities and fuel efficiency.

8. Emerging and green propulsion technologies

Emerging rocket propulsion technologies aim to improve safety, sustainability, and mission capability. They focus on greener and advanced propellants, including hydroxylammonium nitrate (HAN) as a low-toxicity alternative, nuclear-based hydrogen heating for higher efficiency, and hybrid combinations of solid fuels with liquid oxidizers to balance safety and performance.

Development of cryogenic engines and the role of industrial gases in space propulsion systems

Cryogenic engine development marks a pivotal advancement in the space sector, driven by the need for higher propulsion efficiency, increased payload capacity, and extended mission capability. Early launch vehicles relied on solid and earth-storable liquid propellants, which offered high thrust but limited efficiency. As space missions evolved toward heavier

satellites, geostationary orbits, and deep-space exploration, propulsion systems with significantly higher specific impulse became essential. Cryogenic propulsion addressed this requirement by using propellants stored at extremely low temperatures, enabling more energetic combustion and higher exhaust velocities. Over time, cryogenic engine technology became a strategic capability, with only a few spacefaring nations successfully developing indigenous systems due to the complexity of materials, manufacturing, and gas-handling infrastructure involved.

Cryogenic engines are predominantly deployed in the upper stages of launch vehicles, where efficiency, sustained thrust, and precise orbital insertion are more critical than lift-off power. Their use enables the deployment of heavier communication, navigation, and Earth-observation satellites into geostationary transfer orbit. Cryogenic propulsion is also central to deep-space and interplanetary missions, where reduced propellant mass translates into greater payload flexibility and mission longevity. In human spaceflight programs, cryogenic stages contribute to safer ascent profiles and higher mission margins. In India, the successful development and deployment of cryogenic engines by the Indian Space Research Organization has significantly enhanced autonomous access to space (indigenous technology for cryogenic engines) and increased demand for high-purity industrial gases across the aerospace supply chain.

Gases used in cryogenic engines

Cryogenic engines primarily use liquid hydrogen (LH_2) as fuel and liquid oxygen (LOX) as the oxidizer, both of which are industrial gases produced, purified, and handled using advanced cryogenic processes. Liquid hydrogen, stored at approximately -253°C , is selected for its exceptionally high energy content per unit mass and its ability to generate low-molecular-weight exhaust products, which significantly improves propulsion efficiency. Liquid oxygen, stored at around -183°C , acts as a powerful oxidizer, enabling efficient combustion in the absence of atmospheric oxygen. The LOX- LH_2 combination delivers the highest specific impulse among chemical rocket engines, making it the preferred choice for upper-stage propulsion. In addition to these primary propellants, inert industrial gases such as helium and nitrogen play critical auxiliary roles in pressurization, purging, and system safety.

Industrial gases applications in cryogenic engine systems

Liquid oxygen and liquid hydrogen, produced through air separation units and hydrogen liquefaction plants, must meet extremely high purity standards to ensure stable combustion and prevent contamination related failures. Their storage and transfer require specialized cryogenic tanks, vacuum insulation, and controlled boil-off management systems. Helium, an inert industrial gas, is widely used for tank pressurization, valve actuation, and leak detection due to its low density and chemical inertness, ensuring safe and reliable propellant feed under extreme conditions. Nitrogen, another critical industrial gas, is used extensively for purging fuel lines, inerting systems, and maintaining contamination-free environments during engine testing, assembly, and launch operations.

Role of industrial gases in manufacturing and testing

The application of industrial gases is equally critical during the manufacturing and qualification of cryogenic engines. High-purity argon and helium are used in welding and fabrication processes to prevent oxidation of critical engine components, particularly in turbopumps and combustion chambers made from advanced alloys. Cryogenic testing facilities rely on liquid nitrogen for pre-cooling systems and simulating low-temperature operational environments. During ground testing and static fire tests, controlled gas flows are essential for pressurization, chill-down of propellant lines, and emergency inerting. These applications highlight that industrial gases are not peripheral inputs but core enablers of cryogenic engine development and reliability.

The development of cryogenic engines represents a convergence of advanced propulsion engineering and industrial gas technology. Liquid hydrogen and liquid oxygen form the core propellant system; while supporting industrial gases such as helium, nitrogen, and argon enable safe handling, manufacturing, testing, and operation. Together, these gases underpin the efficiency, reliability, and scalability of modern cryogenic propulsion, making them indispensable to current and future space missions.

Dependence of SpaceX on cryogenic engines and industrial gases

SpaceX has architected its launch systems around cryogenic propulsion, positioning itself as one of the most cryogenic-intensive launch operators globally. Unlike traditional systems that rely heavily on solid or earth-storable propellants, SpaceX prioritizes cryogenic fuel combinations to enhance performance, enable reusability, and reduce launch costs. Its Falcon 9 and Falcon Heavy vehicles utilize liquid oxygen (LOX) as the oxidizer paired with refined kerosene (RP-1), with LOX stored at cryogenic temperatures to enable high thrust and stable combustion. This configuration supports efficient first-stage performance and is critical to SpaceX's rapid launch cadence and booster reusability. The company's next-generation Starship system further deepens this reliance on cryogenic technology, using liquid methane (LCH₄) and liquid oxygen in its Raptor engines. This fully cryogenic fuel combination enables higher efficiency, cleaner combustion, and improved engine reuse, aligning with SpaceX's long-term vision for scalable and interplanetary missions.

Liquid oxygen remains the most critical industrial gas across SpaceX's propulsion systems, requiring high purity and large-scale supply, while sub-cooled LOX enhances propellant density and payload capacity. Liquid methane is emerging as a strategic fuel choice, offering better performance than kerosene, reduced carbon buildup, and the potential for in-situ production on Mars, supporting long-duration missions. Although liquid hydrogen is not currently used, methane-based propulsion is viewed as a more practical alternative, balancing efficiency with operational simplicity and scalability. Additionally, gases such as nitrogen, helium, and argon play essential supporting roles in testing, pressurization, and system operations. With increasing launch frequency and a strong focus on reusability, SpaceX's operations resemble a continuous industrial process, where reliable supply, storage, and rapid handling of cryogenic gases are mission critical. This positions cryogenic fuel technology and industrial gas management as central to SpaceX's operational resilience and long-term competitiveness.

India and cryogenic engine technology

The Indian government gave formal approval to the Cryogenic Upper Stage (CUS) project in 1994. ISRO's cryogenic team completed the first 7.5-tonne engine in 2000. India is now one of only six countries, along with the United States, France (European Space Agency), Russia, China, and Japan, to have developed their own cryogenic engines. ISRO took on the task of creating cryogenic engines.

- **First test and flight:** In 2003, ISRO successfully tested its first cryogenic engine. The first successful flight occurred in 2014 when ISRO launched the GSLV-DF rocket.
- **CE-20:** For the Chandrayaan-3 mission, the CE-20 cryogenic engine was used. The CE-20 was India's first cryogenic engine with a gas-generator cycle, as well as ISRO's largest cryogenic engine. CE 20 is India's largest cryogenic engine and was developed by the Liquid Propulsion Systems Centre, ISRO.
- **Semi-cryogenic engine:** In 2023, ISRO conducted the first hot test on an intermediate configuration of the Semi-cryogenic Engine, known as the Power Head Test Article (PHTA). A semi-cryogenic engine uses refined kerosene instead of liquid hydrogen. Liquid oxygen is used as an oxidizer. The advantage of this is that refined kerosene is denser and easier than liquid hydrogen as it does not require cryogenic temperatures and can be stored at a normal temperature.
- **Integrated cryogenic engine manufacturing facility (ICMF):** The ICMF, established by Hindustan Aeronautics Limited (HAL) aims to produce cryogenic and semi-cryogenic engines needed for the Indian space programme. The ICMF brings together the manufacturing and assembly processes for these engines in one place.

Traditional launchers often use solid or fully cryogenic engines. Vehicles like GSLV Mk III (now known as LVM3), Chandrayaan-3's launch vehicle, burn liquid hydrogen and liquid oxygen. They're powerful but complex, and because hydrogen must be stored at -253°C, they require expensive insulation and precisely controlled systems.

Semi-cryogenic engines offer several advantages on that front. They also use supercooled liquid oxygen, but pair it with a refined form of kerosene called RP-1. This combination offers high thrust, lower cost, easier handling, and potential for reusability. While semi-cryogenic engines aren't new, powering rockets like SpaceX's Falcon 9 and Russia's Soyuz, India's homegrown version marks its own revolution.

Satellite launch vehicles of India

India's launch vehicle ecosystem comprises a mix of solid, liquid, and cryogenic propulsion technologies across platforms such as PSLV, GSLV, LVM3, and SSLV. The PSLV employs a four-stage configuration combining solid propellants based on HTPB and liquid stages using UH25 (a UDMH-based fuel blend) with nitrogen tetroxide, along with a final stage utilizing MMH and MON-3. The GSLV series introduces cryogenic propulsion in its upper stage, using liquid hydrogen (LH₂) and liquid oxygen (LOX), while its lower stages rely on solid HTPB and liquid UH25–N₂O₄ combinations. The LVM3 (GSLV Mk III) further strengthens this architecture with solid strap-on boosters, a liquid core stage, and a cryogenic upper stage powered by LH₂ and LOX. In contrast, the SSLV adopts a predominantly solid propulsion approach across its core stages, supplemented by a liquid-based velocity trim module using MMH and MON for precise orbital adjustments.

Historically, India's space program has leveraged cryogenic propulsion systems that utilize ultra-low temperature liquid hydrogen as fuel and liquid oxygen as the oxidizer, enabling high efficiency for upper-stage operations despite their engineering complexity. In parallel, there has been a strategic shift toward semi-cryogenic propulsion technologies that use liquid oxygen paired with refined kerosene (RP-1), offering improved performance with relatively simpler handling compared to hydrogen-based systems. India achieved a major milestone in 2014 with the successful deployment of indigenous cryogenic technology through the GSLV program, and this capability continues to underpin advanced launch vehicles such as the LVM3, whose upper stage relies on cryogenic propulsion for enhanced payload capacity and mission capability.

Opportunity for industrial gases in space sector

The space sector offers significant opportunities for industrial gas companies across the entire mission lifecycle, from manufacturing to in-space operations. Key applications include:

- **Propulsion:** Liquid hydrogen and liquid oxygen are the primary cryogenic propellants used as fuel and oxidizers for launching rockets into space. The growing frequency of commercial and government-led launches (e.g., the Artemis program to return to the Moon) is a major driver of demand.
- **In-Space propulsion:** Rare gases like xenon and krypton are used in high-efficiency electric (ion) thrusters, which provide the small but continuous thrust needed for satellites to reach and maintain their desired orbits over multi-year lifecycles.
- **Manufacturing:** Industrial gases are integral to manufacturing spacecraft components.
 - **Additive manufacturing (3D printing):** High-purity nitrogen and argon are used as inert atmospheres to protect reactive metal powders during the 3D printing of complex, lightweight engine parts like turbopumps and combustion chambers.
 - **Composite curing:** Nitrogen is used to pressurize autoclaves (large vessels) to cure carbon-fiber composites used in spacecraft structures.
- **Testing and simulation:** Components and even entire spacecraft (like the James Webb Space Telescope) are tested in thermal vacuum chambers to simulate the extreme cold temperatures and vacuum of space. Liquid nitrogen and liquid helium are used as cryogens to cool these chambers.

- **Integrity and leak testing:** Helium is a vital specialty gas used for sensitive leak detection to ensure the integrity of critical systems and components.
- **Life support:** While less publicized, gases also play a role in onboard life support systems for human spaceflight.
- **Ground operations:** Engine testing before a launch requires a significant supply of industrial gases, often more volume than the launch itself, as engines are tested repeatedly on the ground.

The general trend toward privatized space exploration and the rise of the commercial space economy are creating a rapidly expanding market for industrial gas suppliers, who must provide high purity and highly reliable products and specialized cryogenic infrastructure to meet mission-critical demands.

Conclusion

Hydrogen energy systems, Carbon Capture, Utilization and Storage (CCUS), digital infrastructure, and space-related industrial applications represent distinct areas of industrial development; however, these sectors share common infrastructure requirements, including high-purity industrial gases, cryogenic technologies, and process engineering capabilities.

The expansion of these sectors is contributing to the development of an interconnected industrial ecosystem in which industrial gases serve as a critical enabling input. Demand growth in one segment may reinforce infrastructure utilization in adjacent segments, supporting operational efficiencies and long-term capacity development.

This convergence reflects a broader structural trend in which industrial gases are becoming central to India's decarbonization initiatives, digital infrastructure expansion, and advanced industrial programs.

Waste-water treatment and the opportunity for the Industrial Gases Industry

The sector of wastewater management is increasingly becoming a key end-use market for industrial gases in India. Rapid urban growth, expanding industries, and escalating water scarcity issues have elevated the importance of efficient wastewater treatment and secure disposal at the national level. In response, the Indian government has launched several large-scale initiatives such as the Namami Gange Programme, AMRUT 2.0, and the Swachh Bharat Mission which are collectively fostering significant investments in sewage treatment infrastructure for both municipal and industrial sectors.

From a regulatory perspective, the Central Pollution Control Board (CPCB) reclassified multiple industrial segments including breweries, food processing units, and bulk-drug manufacturing facilities into the 'red category' in October 2024, thereby mandating Zero Liquid Discharge (ZLD) compliance. Additionally, states like Maharashtra have implemented real-time effluent monitoring systems integrated with automated penalty dashboards, making non-compliance a direct and immediate financial liability for industries. These regulatory advancements are propelling the widespread adoption of sophisticated, gas-dependent treatment technologies nationwide.

The primary industrial gases employed in wastewater treatment are oxygen, ozone, and carbon dioxide. Each of these gases fulfills a unique function at various stages of the treatment process.

Role of Industrial Gases

Oxygen: Aerobic Biological Treatment

Oxygen plays a vital role as the most essential industrial gas in wastewater treatment, being used in large and continuous amounts. The most common form of secondary treatment worldwide is aerobic biological treatment, also known as the activated sludge process, which depends entirely on a steady supply of dissolved oxygen to maintain aerobic microbial populations. These microbes decompose organic pollutants, transforming them into carbon dioxide, water, and stable biomass, which helps lower the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels in the treated effluent.

To improve the efficiency of this biological process, high-purity industrial oxygen is often injected directly into the aeration tanks. Oxygen-enhanced aeration systems can significantly boost the oxygen transfer capacity of existing facilities by several times compared to traditional air diffusers allowing plants to manage higher organic loads or increase their processing capacity without extensive civil modifications..

The oxygen requirement in this context is directly linked to the organic load present in the incoming wastewater. Industrial effluents with high strength, such as those from the food and beverage, pharmaceutical, textile, and petroleum refining industries, demand much greater oxygen inputs than municipal sewage, making these sectors major consumers of industrial oxygen.

Ozone: Disinfection and Advanced Oxidation

Ozone is employed during the tertiary phase of wastewater treatment to achieve disinfection, remove coloration, and decompose persistent organic substances that are resistant to traditional biological processes. As a potent oxidizing agent, ozone surpasses chlorine in strength and is effective against a wide range of pathogens, including bacteria, viruses, and protozoa such as *Cryptosporidium* and *Giardia*, which are typically resistant to chlorine-based disinfection methods.

In addition to its disinfectant properties, ozone-based Advanced Oxidation Processes (AOPs) which may involve combining ozone with hydrogen peroxide or ultraviolet (UV) light are utilized to degrade pharmaceutical residues, dye molecules, endocrine-disrupting chemicals, and other micropollutants present in industrial effluents. The adoption of these processes is increasing as regulatory standards for effluent discharge become more stringent and industries are required to implement reuse or ZLD strategies.

Ozone is produced on-site using ozone generators that convert oxygen or air into ozone. For large-scale applications, high-purity oxygen is the preferred feed gas because it yields significantly higher ozone concentrations with lower energy consumption compared to air-fed systems, thereby reducing both capital and operational expenses. This creates a continuous demand for industrial oxygen in facilities utilizing ozone-based treatment methods.

Carbon Dioxide: pH Control and Process Stability

Carbon dioxide is primarily employed in wastewater treatment for pH regulation. Wastewater from industrial and municipal sources, especially those containing strong alkaline substances, often requires pH adjustment prior to safe discharge or entry into biological treatment processes. Using carbon dioxide for dosing offers a safe, accurate, and manageable alternative to mineral acids like sulfuric acid. It acts as a self-buffering agent, minimizing the risk of pH overshoot and simplifying process control for operators.

Additionally, carbon dioxide plays a vital role in anaerobic digestion systems, where maintaining optimal pH and alkalinity levels is essential for the health of methanogenic bacteria. In these processes, the availability of carbon dioxide and the carbonate equilibrium directly influence digestion efficiency and the production of biogas.

Nitrogen: Safety and Inert Blanketing

Nitrogen is mainly employed in wastewater treatment plants to ensure safety. In systems such as anaerobic digesters and biogas management, nitrogen is utilized to purge and blanket the headspace within storage tanks and pipelines, thereby preventing the buildup of explosive gases. This safety measure is essential in facilities that produce and store biogas (biomethane) from sludge digestion.

Government Programmes Creating Demand

Namami Gange Programme: India's flagship river rejuvenation project, the Namami Gange Programme, has a total approved budget of Rs. 26,825 crore and has approved 502 projects as of July 2025. Among these, 136 Sewage Treatment Plants (STPs) with a combined capacity of 3,780 million liters per day (MLD) are now operational. Each of these STPs consistently consumes oxygen, ozone, and CO₂ depending on their specific treatment configurations.

AMRUT 2.0: The second phase of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT 2.0) has allocated substantial funds toward upgrading tertiary treatment facilities in urban areas, with a requirement that the treated water complies with IS 10500 standards for industrial reuse. Tertiary treatment is notably the most gas-intensive stage of water purification.

Zero Liquid Discharge Mandate: ZLD regulations extended to a wider range of industries under the CPCB's October 2024 notifications, mandate that industrial facilities treat and recycle all effluent internally. Achieving ZLD standards typically involves advanced oxidation and polishing processes that heavily rely on ozone and oxygen consumption.

Water purification and the opportunity for the Industrial Gases Industry

India faces a substantial and growing disparity between its freshwater availability and consumption needs. As per World Bank report, India accounts for approximately 18% of the world's population but has access to merely around 4% of the planet's freshwater resources, underscoring the urgency of implementing advanced water purification solutions as both a critical infrastructure requirement and a strategic long-term goal.

In response, the Indian government has launched several large-scale initiatives that are fundamentally transforming the water treatment sector. The Jal Jeevan Mission, with an estimated budget of about Rs. 3.6 lakh crore, aims to provide piped drinking water to all rural households. The AMRUT 2.0 program promotes tertiary water treatment in urban centers, while the Smart Cities Mission supports water quality monitoring and the development of sophisticated treatment facilities across 100 cities. Coastal regions are also increasing investments in seawater reverse osmosis (SWRO) desalination plants to mitigate groundwater scarcity.

Every new water treatment facility established under these initiatives generates a sustained, long-term demand for industrial gases, primarily ozone for disinfection, carbon dioxide for pH adjustment, and oxygen as the feed gas for ozone generation systems.

Role of Industrial Gases

Ozone: Primary Disinfection of Drinking Water

Ozone is increasingly being adopted as the primary disinfectant for municipal drinking water treatment worldwide, including in India. Its higher effectiveness compared to chlorine, especially against chlorine-resistant pathogens such as *Cryptosporidium* and *Giardia*, makes it the preferred choice at water treatment facilities where pathogen elimination is critical. Unlike chlorine, ozone does not produce harmful disinfection by-products (DBPs) in the treated water, which is an important consideration for regulatory compliance and public health, since the risks associated with chlorine-formed DBPs were first officially recognized in 1970 and have led to stricter regulations globally.

Ozone is generated on-site from ambient air or oxygen, removing the need to transport and store hazardous liquid chlorine at water treatment sites. The contact time required for effective disinfection is typically between 10 and 30 minutes, after which ozone naturally breaks down into oxygen, leaving no residual chemicals in the water. This feature makes ozone particularly suitable for treatment plants that directly supply water into distribution networks.

Additionally, ozone is highly effective in removing taste and odour issues, reducing colour, and degrading organic micropollutants in raw water sources. This capability is becoming increasingly important as surface water quality in India declines due to agricultural runoff and industrial pollution.

Carbon Dioxide: pH Correction and Remineralisation

Reverse osmosis (RO) is the primary water treatment method in India, dominating the market share for water purification equipment. While RO membranes efficiently eliminate dissolved solids, contaminants, and minerals from water, the resulting permeate (or product water) tends to be mildly acidic, with a pH generally ranging from 5.5 to 6.5, and is often deficient in essential minerals required by drinking water standards.

To adjust the pH of this permeate prior to distribution, carbon dioxide dosing is considered the most practical and economical approach. When CO₂ is introduced into water, it forms carbonic acid, which interacts with existing alkalinity compounds to re-establish the carbonate equilibrium. This process is naturally self-buffering and prevents the risk of over-correction or pH overshoot. Such pH adjustment is especially critical in large-scale RO and desalination facilities, as distributing water that is too acidic could lead to corrosion of pipelines and storage systems.

In seawater reverse osmosis (SWRO) desalination plants, CO₂ also plays a vital role in the remineralization process. It helps reintroduce minerals like calcium and magnesium into the purified water while simultaneously adjusting the pH to meet drinking water quality standards. As India's coastal regions continue to develop new desalination capacities, each new plant contributes to a steady, increasing demand for CO₂.

Nitrogen: Specialty and High-Purity Water Applications

In industrial water treatment processes, particularly for generating ultrapure water (UPW) utilized in semiconductor fabrication, pharmaceutical production, and high-precision electronics, nitrogen is essential for establishing an inert environment. It helps inhibit the re-dissolution of oxygen and carbon dioxide into the purified water, which must meet rigorous purity requirements. With the growth of India's semiconductor and electronics industries, the demand for high-purity industrial-grade and electronics-grade nitrogen in water applications is anticipated to increase.

Government Programmes Creating Demand

Jal Jeevan Mission: Seeks to deliver piped water connections to all rural households across India. The establishment of new village-level or cluster water treatment plants has historically depended on chlorine for disinfection; however, there is an increasing shift towards or addition of ozone-based disinfection methods. Given the program's extensive scope, even a limited move towards ozone disinfection will create significant ongoing demand for industrial oxygen and ozone-related equipment.

AMRUT 2.0: Supports upgrades to tertiary treatment in urban water supply networks, with the requirement that treated water complies with IS 10500 standards for safety and suitability for industrial reuse. Tertiary treatment processes at the drinking water stage typically involve ozonation and activated carbon filtration, both of which depend on industrial gases.

Desalination Expansion: Coastal states such as Tamil Nadu, Gujarat, and Andhra Pradesh are expanding seawater desalination capacity to combat groundwater shortages. Each seawater reverse osmosis (SWRO) plant necessitates CO₂ for pH adjustment and remineralization, as well as ozone for primary disinfection, thereby creating a dedicated industrial gas demand tailored to each facility.

Competitive profile

Key player profiles

Key players are INOX Air Products, Linde India, Air Liquide India, Air Water India Pvt. Ltd, and Ellenbarrie Gases Ltd.

INOX Air Products

Brief information: Established in 1963, INOX Air Products is a leading manufacturer of industrial and medical gases in India. The company supplies atmospheric and processed gases to a broad range of end-use industries, including metals, glass, chemicals, tyres, healthcare, electronics and food and beverage, serving customers across the country.

It is India's largest industrial gas company (by revenue) as of fiscal 2026, and among the leaders in on-site, merchant, hydrogen and packaged gas segments, with a growing presence in new economy segments, including semiconductor manufacturing, solar cell manufacturing and advanced electronics.

INOX Air Products operates more than 55 facilities nationwide and offers a comprehensive portfolio of gases, equipment, and services. The company has a substantial manufacturing capacity exceeding 5,000 tonnes per day of liquid gases, supported by an extensive operational network and a diversified client base. It serves over 1,800 small, medium, and large manufacturing enterprises across multiple sectors, enabling customers to achieve their operational and strategic objectives. In FY 2025, INOX commissioned one of India's first electronic-grade nitrous oxide manufacturing facilities at Manali, Chennai, Tamil Nadu catering to the requirements of the advanced electronics and semiconductor industries. The plant produces nitrous oxide meeting ultra-high purity specifications required for semiconductor applications. As at the date of this Draft Red Herring Prospectus, this remains among the few electronic-grade nitrous oxide manufacturing facilities in India.

INOX Air Products have been operating in India since incorporation in April 1963, making it one of the longest-standing participants in the Indian industrial gases industry. Company is jointly owned since 1999 by two shareholder groups: the INOX Group, one of India's leading diversified conglomerates with interests spanning across industrial gases, fluorochemicals, entertainment and renewable energy sectors; and Air Products Group, a global industrial gases company headquartered in the United States, operating in approximately 50 countries and serving more than 30 industries. In 1999, the company entered into a joint venture with Air Products & Chemicals Inc., USA, leading to the formation of INOX Air Products. This partnership remains one of the longest-standing Indo-American collaborations in the manufacturing sector. Additionally, Air Products Group (Prodair Corporation), the joint venture partner with 49.74% shareholding in INOX Air Products, is one of the world's leading industrial gas companies and contributes to company's success.

The track record of sustained expansion, supported by the complementary strengths of the INOX Group and Air Products, has enabled the company to develop in-house capabilities across engineering, project management, plant operations, logistics and safety, which are critical in the capital-intensive and highly regulated industrial gases industry.

Key facts	Brief profile
Year of incorporation	1963
End use / industries catered	Iron & Steel, healthcare, automotive sector, chemicals, glass/ ceramics, pharma, solar, electronics, engineering, tyre, pulp/ paper, oil & gas, cutting & welding, defence, etc. Company is one of India's leading electronic-grade gas suppliers to the Indian solar cell manufacturing industry. In packaged and specialty gases segment, company is one of the leading suppliers of specialty gases in select applications.
Range of Products	Argon, Carbon Dioxide, Carbon Monoxide, Food Gases, Helium, Hydrogen, Nitrogen, Oxygen, Rare Gases (Neon/Krypton/Xenon), Syngas etc. The product portfolio spans the full spectrum of industrial and medical gases, including oxygen, nitrogen, argon, hydrogen, carbon dioxide, nitrous oxide, helium, and ultra-high purity specialty gases including silane, ammonia, phosphine mixtures, TMA, etc., enabling the company to cater to a diverse range of end-use industries with varying purity, reliability and delivery requirements, including steel, healthcare, chemicals, electronics, solar,

	pharmaceuticals and advanced manufacturing. This breadth of product range and supply mode coverage differentiates the company from competitors, and enables them to offer integrated, multi-product solutions that address diverse end-use applications. Atmospheric gases constitute the highest volume of products produced by the company. They produce oxygen, nitrogen and argon through several air separation processes of which cryogenic air separation is the most prevalent. Other gases, including hydrogen, dissolved acetylene, nitrous oxide and specialty gases are produced by other production methods.
Capacity	The company has a substantial manufacturing capacity exceeding 5,000 TPD of liquid gases, of which approximately 3,400 TPD are allocated to merchant sales through bulk containers and cylinder distribution and capacity exceeding 16,000 TPD of onsite gases, supported by an extensive operational network and a diversified client base. Large Air Separation Plants Capacity: • 2,150 TPD ASU at Bokaro • 1,250 TPD ASU at Bokaro • 10,000 TPD (multiple ASU) at AM/NS India • 2 X 1800 TPD ASU under commissioning at Tata Steel, Meramandli and 1 X 280 TPD ASU at Tata Steel, Ludhiana • 14 Nitrogen Generators, 1 VPSA Oxygen Plant INOX commissioned a 2,150 TPD ASU at Steel Authority of India Limited (SAIL) Bokaro in January 2025, one of the highest-capacity units across SAIL's facilities. They also commissioned one of India's first electronic grade N₂O facility at Chennai and commissioned one of India's first electronic grade Ultra High Purity Oxygen facilities in Hosur. INOX commissioned a 700 TPD on-site oxygen plant for ArcelorMittal Nippon Steel India Private Limited, one of India's leading integrated steel manufacturers, within approximately 15 months of commencement — one of the fastest commissioning timelines for a plant of this scale and complexity in the Indian industrial gases industry.
Supply capability	INOX Air Products offers integrated gas solutions through on-site production, pipeline supply, bulk tankers and cylinders. Company is also one of the largest helium distributors in India and distributing it through their pan-India network to serve customers across electronics, healthcare, aerospace and other industries requiring high-purity helium supply
Geographical positioning	Company operates across 15 states, 1 UT and 57 locations in India as of March 2026, providing geographic diversification that reduces regional concentration risk and position it to serve customers' pan-India requirements INOX Air Products operates manufacturing facilities and air separation units across key industrial regions including Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Telangana, West Bengal, Odisha, and Uttar Pradesh. Its presence spans industrial clusters such as Dahej, Hazira, Savli, Pune, Nagpur, Sriperumbudur, Hosur, Manali, Visakhapatnam, Kalinganagar, and Kolkata, among others. INOX Air Products are a significant argon manufacturer in India, with 26 manufacturing locations across the country and an aggregate argon manufacturing capacity of approximately 426 TPD as of March 2026, supporting diversified supply to industrial customers. In addition to standalone plants, the Company owns and operates multiple on-site facilities located at customer premises, enabling integrated supply to large industrial consumers. Its diversified footprint supports supply through pipelines, bulk tankers, and cylinders across major manufacturing corridors in India.

Recent investments	The company has been awarded a contract valued at approximately USD 150 million by Tata Steel for the installation of two Air Separation Units (ASUs) at Tata Steel's Meramandali plant in Odisha. INOX Air Products has made targeted investments in green hydrogen and specialty gas technologies alongside its core industrial gas business. In March 2025, INOX Air Products announced the commissioning of its green hydrogen manufacturing facility (producing 190 TPA of green hydrogen) at Asahi India Glass Limited's (AIS) greenfield float glass plant in Soniya, Chittorgarh district, Rajasthan. In October 2025, INOX AP also announced plans for a dedicated electronics specialty gas hub in Dholera, Gujarat, with an estimated initial investment of ~Rs. 500 crore to produce ultra-high purity gases for semiconductor and advanced manufacturing segments.
Key clients	Apollo Hospitals, BOSCH, CEAT, Indian Oil, Jindal Steel & Power, JSW, Lupin, MRF, Piramal, SAIL, Micron, TP Solar, Tata Steel, Tata Electronics, ReNew, CG Power, JK Tyre, Biocon, Fortis Healthcare, Narayana Hrudalaya, First Solar, Premiere Energies, St Gobain, SLR Metallics

Source: Company website

Linde India

Linde India Limited has maintained a strong presence in India since 1935 and has evolved into one of the country's leading industrial gases and engineering companies. The company offers a comprehensive portfolio of industrial, specialty, and medical gases, supported by an extensive direct sales and distribution network across India, serving a wide range of industrial sectors.

Linde India provides diverse gas supply systems and end-to-end solutions, along with the supply of industrial, medical, and specialty gases. Its strategically located cylinder filling facilities across the country, complemented by a robust fleet of cryogenic bulk tankers, enable the company to play a significant role in delivering a complete spectrum of industrial gas solutions nationwide.

Key facts	Brief profile
Year of incorporation	1935
End use / industries catered	Chemicals, electronics, construction, food and beverage, healthcare, steel and other metal manufacturing, oil & gas, metal fabrication, etc.
Range of Products	Argon, Carbon Dioxide, Helium, Nitrogen, Oxygen, Rare Gases (Krypton/Xenon) etc.
Capacity	As stated on its website, Linde operates India's largest air separation plant and manages more than 35 operational facilities across the country.
Supply capability	Linde India offers supply through on-site production, pipeline supply, bulk tankers and cylinders. Company had a fleet of 187 cryogenic tankers as of March 2026 according to PESO data.
Geographical positioning	Linde India operates production facilities across major industrial regions including Bengaluru, Hyderabad, Kalinganagar, Bhadrachalam, Jajpur, Kolkata, Bhiwadi, Dahej, Jamshedpur, Ludhiana, Pune, Rourkela, Selaqui, Sri City, Taloja, Tiruchirappalli (Trichy), Uluberia, and Visakhapatnam.

	In addition to its standalone plants, the Company owns and operates multiple small on-site plants at customer locations, strengthening its proximity to key industrial clusters and enabling integrated supply to large manufacturing and metals customers across India.
Recent investments	Linde has outlined plans to invest approximately USD 1 billion in India over the next three to five years. The company has already deployed significant capital toward the production of key industrial gases, including nitrogen, oxygen, hydrogen, and argon. More recently, it announced an investment of USD 60 million to expand capacity at the Steel Authority of India facility. In May 2025, Linde India further announced an investment of Rs. 425 crore to establish a new Air Separation Unit (ASU) at the Kalinganagar Industrial Complex in Odisha's Jajpur district. To further increase its presence, the Company has entered into a long-term pipeline supply agreement with Asian Paints (Polymers) Private Limited for its upcoming Dahej facility in Gujarat. To support this contract, it will install its third Air Separation Unit (ASU) at Dahej with a capacity of 245 TPD (liquid) and 100 TPD of gaseous oxygen, further strengthening its industrial gas pipeline cluster in the Dahej region.
Key clients	TATA Steel, SAIL, HPCL, BPCL, ONGC, GAIL, Unilever, ITC Limited, etc.

Source: Company website

Air Liquide India

Air Liquide India is the Indian subsidiary of the French multinational industrial gases group, Air Liquide. The company supplies industrial gases including oxygen, nitrogen, argon, and hydrogen along with associated technologies and services to sectors such as healthcare, electronics, welding, chemicals, and petrochemicals. Established in India in 1992, Air Liquide India has expanded steadily, supported by the development of modern production facilities across the country.

Key facts	Brief profile
Year of incorporation	1992
End use / industries catered	Healthcare, electronics, chemicals, automotive, water treatment, oil & gas, metal fabrication, steel & other metal manufacturing, etc.
Range of Products	Argon, Carbon Dioxide, Helium, Hydrogen, Nitrogen, Oxygen, etc
Capacity	The company's production capacity comprises multiple Air Separation Units (ASUs) and filling stations. Recent capacity expansions have significantly enhanced output, including the commissioning of a 200 TPD ASU in Gujarat, which has doubled regional capacity, and the expansion of the Mathura facility, adding over 300 TPD of liquid oxygen and nitrogen. These investments support the rising demand for industrial and medical gases.
Supply capability	Air Liquide India provides supply through on-site production, pipeline supply, bulk tankers and cylinders. Company had a fleet of 96 cryogenic tankers as of March 2026 according to PESO data.
Geographical positioning	Air Liquide India has an established presence across key industrial regions in India, with corporate and engineering operations in New Delhi, manufacturing and medical systems facilities in Tamil Nadu (including the Kanchipuram district and Chennai), and specialty and affiliate operations in Mumbai. Through its associated entities such as Cryolor Asia Pacific, Air Liquide Global E&C Solutions India, Air Liquide Medical Systems India, SEPPIC India,

	and NovaAir, the Company maintains a diversified footprint spanning northern, southern, and western India, supporting its industrial, healthcare, engineering, and specialty solutions businesses.
Recent investments	The company has invested over USD 210 million in India toward the establishment of six industrial gas plants, with an aggregate production capacity exceeding 1,400 tonnes per day. It has also announced an investment of USD 40 million in Kosi, Uttar Pradesh, for the development of a new Air Separation Unit (ASU) catering to the industrial merchant market, with a planned capacity of 350 tonnes per day. Additionally, the company has invested more than USD 14 million in Nagpur, Maharashtra, for the development of an ASU with a capacity of 70 tonnes per day.
Key clients	NA

Source: Company website

Ellenbarrie Industrial Gases Ltd. (EIGL)

Incorporated in 1973, EIGL manufactures a wide range of industrial gases, including oxygen, nitrogen, argon, helium, hydrogen, carbon dioxide, nitrous oxide, and acetylene. The company serves a diverse set of end-use industries such as shipbuilding, glass manufacturing, steel production, pharmaceuticals, welding, and fabrication, among others.

EIGL operates manufacturing facilities across multiple locations, including Kalyani, Panagarh, Uluberia, and Kharagpur in West Bengal; Parwada and Kurnool in Andhra Pradesh; and Jadcherla in Telangana. The company has been a key supplier to India's space and defence programs. In addition, EIGL offers synthetic air a controlled, homogenized mixture of oxygen and nitrogen which is used as a zero gas for the operation and calibration of environmental monitoring and testing equipment, owing to its low impurity levels.

Key facts	Brief profile
Year of incorporation	1973
End use / industries catered	Steel, pharmaceuticals and chemicals, healthcare, engineering and infrastructure, railways, aviation, aerospace and space, petrochemicals, defence, semi-conductors, etc
Range of Products	Argon, Acetylene, Carbon Dioxide, Dry Ice, Helium, Hydrogen, Nitrogen, Oxygen, etc.
Capacity	As of March 31, 2025, EIGL has a total installed operational capacity of 3,870 tonnes per day. As of March 31, 2025 EIGL has 220 TPD capacity under construction in North India and also has an upcoming facility at Durgapur of 320 TPD and Uluberia ASU capacity expansion of 220 TPD.
Supply capability	Ellenbarrie offers supply through on-site production, bulk tankers and cylinders. Company had a fleet of 80 cryogenic tankers as of March 2026 according to PESO data.
Geographical positioning	Ellenbarrie Industrial Gases has established a multi-location manufacturing and distribution footprint across eastern, southern, and central India, enabling proximity-led supply to key industrial clusters. Company operates manufacturing and distribution facilities across West Bengal (Uluberia, Kalyani, Panagarh, Kharagpur), Andhra Pradesh (Parawada, Kurnool), Telangana (Jadcherla), and Chhattisgarh (Naganar).

Recent investments	The company has announced an investment of approximately USD 60 million for the establishment of new industrial gas plants in Kurnool, Andhra Pradesh, with a planned capacity of 600 tonnes per day, and in Uluberia, West Bengal, with a capacity of 220 tonnes per day. In addition, the company plans to undertake a capacity expansion at the Tata Steel facility in Kharagpur.
Key clients	Vizag Steel, LAURUS Labs, Dr. Reddy's, GMM Pfaudler, ASTEC, neuland, Jupiter, AI Engineering Services Limited

Source: Company website

Air Water India Pvt. Ltd.

Air Water India Private Limited (AWIPL) is a wholly owned subsidiary of Air Water Inc., Japan. The Air Water Group is a diversified conglomerate headquartered in Osaka, Japan, with business interests spanning industrial gases, marine minerals, medical and chemical products, agricultural inputs, and related segments.

In 2019, Air Water Inc., through its subsidiary AWIPL, acquired Praxair India Private Limited's East Region divestment business. This was subsequently followed by the acquisition of Linde India Limited's South Region divestment business, thereby establishing Air Water India as a key participant in the Indian industrial gases market.

The company is engaged in the manufacturing, storage, distribution, transportation, trading, sale, purchase, and leasing of industrial gases, including oxygen, nitrogen, argon, and helium. It also owns and operates two large Air Separation Units (ASUs), supported by multiple filling stations across eastern and southern India.

Key facts	Brief profile
Year of incorporation	2014
End use / industries catered	Steel, healthcare, electronics, chemicals, automotive, oil & gas, metal fabrication, etc
Range of Products	Argon, Carbon Dioxide, Oxygen, Nitrogen, etc.
Capacity	Air Separation Units 3 x 875 TPD (Jamshedpur) 1800 TPD (Bellary) 65 TPD (Hyderabad)
Supply capability	Air Water India offers supply through on-site production, bulk tankers and cylinders. Company had a fleet of 132 cryogenic tankers as of March 2026 according to PESO data
Geographical positioning	Air Water India has a significant presence in India with its Air Separation Units located in Jamshedpur, Bellary, and Hyderabad. The company has substantial storage facilities for LOX, LIN, and LAR with capacities of 6000 MT, 5000 MT, and 700 MT respectively. Its product distribution network is supported by filling stations strategically located in Parbangla (Kolkata), Asansol, Hyderabad, and Chennai, enabling the company to cater to the needs of its customers across eastern, southern, and western India. This geographical positioning allows Air Water India Pvt. Ltd. to effectively serve a wide range of industries and customers across the country.
Recent investments	In fiscal year 2019, the company invested USD 194 million to acquire Linde India's South India business. During the same year, it also acquired Praxair India's East India operations engaged in the manufacture, sale, and distribution of oxygen, nitrogen, and argon.

	Subsequently, in fiscal year 2022, the company invested USD 26 million toward the development of its third production facility in southern India. In October 2025, the company acquired a large-scale gas plant currently under construction at Tata Steel's Jamshedpur plant in Jharkhand, Eastern India, and entered into a 20-year long-term operation and maintenance contract.
Key clients	Tata Steel, JSW Steel, SAIL, Manipal Hospitals, Fortis Hospital, etc.

Source: Company website

Financial profiling of key players

Revenue from operations (INR Million)

	FY26	FY25	FY24
INOX Air Products	30,339.28	27,897.81	25,899.35
Linde India Ltd.	25,306.40	24,853.76	27,686.69
Air Water India Pvt. Ltd.	NA	10,391.90	10,819.40
Air Liquide India Holding Pvt. Ltd.	NA	2,069.14	2,738.33
Ellenbarrie Industrial Gases Ltd. (EIGL)	3,415.82	3,124.83	2,694.75

Highlight: INOX Air Products had the highest Revenue from Operations among its peers in fiscal 2025 and fiscal 2026. It had the second highest Revenue from Operations in fiscal 2024 after Linde India Ltd.

Source: Company audited results, Crisil Intelligence

Note:

- Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
- For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
- Revenue from operations does not include other income
- All financials are standalone except for Linde India Ltd
- Fiscal 2025
For INOX Air Products details of sale of major products and other operating revenue in INR million are as: Finished goods as 20,610.1, Traded goods as 2,040.6, Lease rent received as 2,709.2, Operation and maintenance charges on leased plants as 2,100.4, Charges for delayed return, repairs & testing of cylinders etc. as 164.4, Other operating receipts as 260.4, Scrap sales as 12.7
For Linde India details of sale of major products and other operating revenue in INR million are as: Sale of Products as 17,750.5, Lease rentals as 1,232.5, Sale of Services including Operation & Maintenance charges as 1,287.3, Others as 135.63, Construction contracts as 4,446.26.
For Ellenbarrie Industrial Gases details of sale of major products and other operating revenue in INR million are as: Sale of manufactured products as 2,167.0, Sale of stock-in-trade as 187.6, Sale of services including facility fees, operation and maintenance charges as 523.6, Revenue from construction contracts as 200.3, Interest income on finance lease arrangement as 46.2.
- Fiscal 2024

For INOX Air Products details of sale of major products and other operating revenue in INR million are as: Finished goods as 18,980.9, Traded goods as 1,879.5, Lease rent received as 2,663.9, Operation and maintenance charges on leased plants as 2,014.7, Charges for delayed return, repairs & testing of cylinders etc. as 147.1, Other operating receipts as 204.6, Scrap sales as 8.5

For Linde India details of sale of major products and other operating revenue in INR million are as: Sale of Products as 17,453.9, Lease rentals as 1,222.5, Sale of Services including Operation & Maintenance charges as 1,197.0, Others as 129.46, Construction contracts as 7,680.9.

For Ellenbarrie Industrial Gases details of sale of major products and other operating revenue in INR million are as: Sale of manufactured products as 2,015.1, Sale of stock-in-trade as 56.3, Sale of services including facility fees, operation and maintenance charges as 260.5, Revenue from construction contracts as 332.7, Interest income on finance lease arrangement as 30.2.

Revenue from operations growth y-o-y (%)

	FY26	FY25	FY24
INOX Air Products	8.75	7.72	18.16
Linde India Ltd.	1.82	(10.23)	(11.70)
Air Water India Pvt. Ltd.	NA	(3.95)	4.39
Air Liquide India Holding Pvt. Ltd.	NA	(24.44)	32.04
Ellenbarrie Industrial Gases Ltd. (EIGL)	9.31	15.96	31.38

Source: Company audited results, Crisil Intelligence

Note:

1. Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
2. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
3. All financials are standalone except for Linde India Ltd
4. Revenue from operations growth (%) is the percentage increase/decrease in revenue from operations over the previous year.

EBITDA (INR Million)

	FY26	FY25	FY24
INOX Air Products	16,477.85	15,196.47	13,311.21
Linde India Ltd.	9,763.78*	8,329.30*	7,793.35*
Air Water India Pvt. Ltd.	NA	1,904.00	2,000.40
Air Liquide India Holding Pvt. Ltd.	NA	(57.09)	448.03

Ellenbarrie Industrial Gases Ltd. (EIGL)	1,166.00	1,119.00	615.30
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Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. EBITDA refers to earnings before interest, taxes, depreciation and amortization, and is calculated as sum of Profit for the year, total tax expense, depreciation and amortization expense and finance cost
5. *Standalone figures

All financials are standalone except for Linde India Ltd

EBITDA Margin (%)

	FY26	FY25	FY24
INOX Air Products	51.29	49.85	47.99
Linde India Ltd.	NA	33.50*	28.00*
Air Water India Pvt. Ltd.	NA	18.09	18.45
Air Liquide India Holding Pvt. Ltd.	NA	(2.70)	16.05
Ellenbarrie Industrial Gases Ltd. (EIGL)	34.00	36.00	22.83

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. EBITDA Margin (%) = percentage of EBITDA divided by total income
5. All financials are standalone except for Linde India Ltd
6. Ellenbarrie EBITDA Margins are as per Company Annual Reports/Investor Presentations and EBITDA Margin (%) is calculated as EBITDA divided by Revenue from Operations.

Adjusted ROCE (%)

	FY26	FY25	FY24
INOX Air Products	24.45	27.58	30.24

Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	4.38	5.30
Air Liquide India Holding Pvt. Ltd.	NA	(5.28)	2.15
Ellenbarrie Industrial Gases Ltd. (EIGL)	NA	NA	NA

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. Adjusted ROCE is calculated as EBIT divided by Adjusted Capital Employed, where EBIT is Profit before tax minus Other Income plus Finance Cost. Adjusted Capital Employed has been calculated as the average of the aggregate of Total Equity and Net Debt less capital advances and Capital Work in Progress for the current financial year and the immediately preceding financial year.
5. All financials are standalone except for Linde India Ltd

PAT (INR Million)

	FY26	FY25	FY24
INOX Air Products	9,138.70	8,809.45	7,656.86
Linde India Ltd.	5,489.65	4,548.45	4,340.86
Air Water India Pvt. Ltd.	NA	826.40	925.20
Air Liquide India Holding Pvt. Ltd.	NA	(863.24)	(72.89)
Ellenbarrie Industrial Gases Ltd. (EIGL)	1,044.00	832.89	452.89

Highlight: INOX Air Products has achieved the highest PAT among its peers for the last three years.

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. PAT: Profit after tax for the financial year
5. All financials are standalone except for Linde India Ltd

PAT Margin (%)

	FY26	FY25	FY24
INOX Air Products	28.44	28.90	27.60
Linde India Ltd.	21.54	17.81	15.25
Air Water India Pvt. Ltd.	NA	7.85	8.53
Air Liquide India Holding Pvt. Ltd.	NA	(40.85)	(2.61)
Ellenbarrie Industrial Gases Ltd. (EIGL)	26.66	23.90	15.61

Highlight: INOX Air Products has achieved the highest PAT margin among its peers for the last two years

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. PAT margin = calculated as Profit after tax divided by total Income

Net Debt to equity ratio

	FY26	FY25	FY24
INOX Air Products	(0.12)	(0.10)	(0.18)
Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	(0.06)	(0.12)
Air Liquide India Holding Pvt. Ltd.	NA	1.41	0.91
Ellenbarrie Industrial Gases Ltd. (EIGL)	0.03	0.32	0.15

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)

3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. Net Debt to equity ratio = Net Debt divided by Tangible Net worth
5. All financials are standalone except for Linde India Ltd

Net Debt (INR Million)

	FY26	FY25	FY24
INOX Air Products	(8,497.53)	(6,411.08)	(9,637.21)
Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	(1,781.4)	(3,421.70)
Air Liquide India Holding Pvt. Ltd.	NA	3,994.27	3,380.79
Ellenbarrie Industrial Gases Ltd. (EIGL)	NA	2,604.86	1,952.49

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. Net Debt/Total Debt is sum of Non-current Borrowings and Current Borrowings, minus Cash and Cash Equivalents, Other Bank Balances and Current Investments
5. All financials are standalone except for Linde India Ltd

Cash flow from operations

	FY26	FY25	FY24
INOX Air Products	12,642.41	8,614.93	8,937.21
Linde India Ltd.	7,855.03	5,835.95	4,403.97
Air Water India Pvt. Ltd.	NA	1,765.70	2,145.40
Air Liquide India Holding Pvt. Ltd.	NA	22.23	181.56
Ellenbarrie Industrial Gases Ltd. (EIGL)	1,325.46	42.75	437.47

Source: Company audited results, Crisil Intelligence

Note:

1. For Linde India Ltd and Ellenbarrie Industrial Gases Ltd, financials are sourced from annual report/ investor presentation/financial statements
2. Linde India Ltd fiscal 2023 financials are for the 15 months period ended 31 March 2023 (1 January 2022 to 31 March 2023)
3. For Air Water India Pvt. Ltd. and Air Liquide India Holding Pvt. Ltd. financials are sourced from MCA reports
4. Cash flow from operations is net cash generated from operating activities/operation as stated in the annual reports/MCA
5. All financials are standalone except for Linde India Ltd

Operational profiling of key players

Number of operating locations (units)

	FY26	FY25	FY24
INOX Air Products	57.00	53.00	49.00
Linde India Ltd.	26.00	39.00	18.00
Air Water India Pvt. Ltd.	NA	NA	NA
Air Liquide India Holding Pvt. Ltd.	NA	NA	NA
Ellenbarrie Industrial Gases Ltd. (EIGL)	9.00	9.00	NA

Note:

1. For INOX Air Products- Number of Facilities Operated as at the end of each period.
2. For Linde India Ltd- Number of locations where plants of the entity are situated at the end of each period as stated in the annual report
3. For Ellenbarrie industrial Gases Ltd- Number of operational facilities as stated in the annual report for fiscal 2025 and [investor relations](#) for fiscal 2026

Source: Company annual report, Crisil Intelligence

Total Operational Capacity – Onsite (TPD)

	FY26	FY25	FY24
INOX Air Products	16,074.00	15,585.00	12,280.00
Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	NA	NA
Air Liquide India Holding Pvt. Ltd.	NA	NA	NA

Ellenbarrie Industrial Gases Ltd. (EIGL)	698.00	706.00*	NA
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Note:

1. For Ellenbarrie Industrial Gases Ltd- the total installed operational capacity was 3,870 TPD as of fiscal 2025 as stated in the annual report. The capacities for fiscal 2026 are taken from [investor presentation](#) for FY 2026.
2. For onsite: Work order awarded by NMDC Steel Limited (NSL) for the operation and maintenance of two 1,250 TPD ASU plants at Nagarnar on October6, 2023. The agreement was for a five-year term. Being an O&M order, it is excluded from total capacity calculation for Ellenbarrie Industrial Gases Ltd
3. *Onsite gross capacity as reported in page number 18 of the [investor relation](#) is added to arrive at the capacity for fiscal 2025.

Source: Company annual report, Crisil Intelligence

Total Operational Capacity – Merchant (TPD)

	FY26	FY25	FY24
INOX Air Products	5,106.00	4,779.00	4,425.00
Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	NA	NA
Air Liquide India Holding Pvt. Ltd.	NA	NA	NA
Ellenbarrie Industrial Gases Ltd. (EIGL)	911.00	655.00*	NA

Note:

1. For Ellenbarrie industrial Gases Ltd- the total installed operational capacity was 3,870 TPD as of fiscal 2025 as stated in the annual report. The capacities for fiscal 2026 are taken from [investor presentation](#) for FY 2026.
2. *Bulk distribution gross capacity as reported in page number 18 of the [investor relation](#) is added to arrive at the capacity for fiscal 2025.
3. According to Linde India Ltd fiscal 2024 annual report- at 1713 tpd, liquid loading for FY 2024 was higher than FY 2023.

Source: Company annual report, Crisil Intelligence

Number of Bulk Customer Installations (units)

	FY26	FY25	FY24
INOX Air Products	1,679.00	1,591.00	1,509.00
Linde India Ltd.	NA	NA	NA
Air Water India Pvt. Ltd.	NA	NA	NA

Air Liquide India Holding Pvt. Ltd.	NA	NA	NA
Ellenbarrie Industrial Gases Ltd. (EIGL)	257.00	257.00	197.00

Note:

1. This metric represent the number of storage tanks installed and owned by the Company within the premises of its Bulk customer
2. For Ellenbarrie industrial Gases Ltd- the bulk customer installations are sourced from fiscal 2025 annual report and [investor relation](#)

Source: Company annual report, Crisil Intelligence

Number of Transport Tankers Owned (units)

	FY26	FY25	FY24
INOX Air Products	739	730	657
Linde India Ltd.	180-200	NA	NA
Air Water India Pvt. Ltd.	120-140	NA	NA
Air Liquide India Holding Pvt. Ltd.	80-100	NA	NA
Ellenbarrie Industrial Gases Ltd. (EIGL)	70-90	NA	NA

Note:

1. This metric represent the number of Transport Tankers Owned as at the end of each period

Source: PESO, Crisil Intelligence

Threats and Challenges to the Industrial Gases Industry

There are certain potential challenges that players in the Industrial gases industry could face in the near future. These challenges will affect players differently based on their respective strategies:

Demand-side challenges

- **Sensitivity to Industrial Activity and Sectoral Demand:** Demand for industrial gases is closely linked to activity levels across various industries like automotive, chemicals, consumer durables, metals, healthcare sectors etc. Any slowdown in industrial production, project execution delays, or reduced capacity utilisation in end-user industries may result in lower consumption of industrial gases.
- **Reliance on Continuous Availability for Critical Applications:** Certain industrial gases, such as oxygen and other medical or process-critical gases, require uninterrupted supply. Constraints in availability due to logistical or operational issues may affect customer operations and could lead to loss of business or contractual disputes.
- **Pricing Pressure in a Cost-Sensitive Market:** Customers in industrial segments often operate with cost sensitivity and limited ability to absorb price increases. Rising input or logistics costs may not always be fully recoverable through pricing, particularly during periods of weak demand or heightened competition.
- **Regulatory Influence on End-Use Consumption:** Changes in safety, environmental, or healthcare regulations may influence demand patterns for specific gases. Compliance-driven adjustments by end-users may alter consumption volumes or usage practices over time.

Supply-side challenges

- **Infrastructure and Distribution Limitations:** The production and delivery of industrial gases depend on specialised infrastructure for storage, handling, and transportation. Constraints related to road connectivity, availability of cryogenic tankers, cylinders, and storage facilities may create bottlenecks and increase operating costs.
- **Operational Complexity and Skilled Workforce Dependence:** Manufacturing and handling of industrial gases require technical expertise and strict process discipline. Limitations in availability of trained personnel or gaps in continuous skill development may affect operational efficiency and safety performance.
- **Exposure to Supply Chain Disruptions:** Supply chains for industrial gases may be affected by external disruptions such as public health emergencies, geopolitical developments, or interruptions in the availability of critical equipment and containers. Such events may impair production schedules and distribution capabilities.
- **Stringent Safety and Environmental Compliance:** Operations involving cryogenic and high-pressure gases require compliance with rigorous safety and environmental standards. Meeting these requirements necessitates ongoing investments in systems, training, and monitoring, and non-compliance may result in penalties or operational restrictions.
- **Energy-Intensive Nature of Production:** Production processes such as air separation, compression, and purification involve substantial energy consumption. Volatility in electricity and fuel prices may lead to fluctuations in operating costs and impact profitability. While efficiency improvements and contractual arrangements may mitigate such risks, they may not fully offset cost variability.

- **Regulatory Approval and Certification Requirements:** Establishment and operation of gas production facilities, storage tanks, and transportation equipment are subject to approvals and certifications from regulatory authorities such as Petroleum and Explosives Safety Organization (PESO). Delays or changes in regulatory requirements may affect project timelines, increase compliance costs, and limit operational flexibility.

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

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About Crisil

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