



Industry Assessment: Indian Heat Exchanger Industry

July 2023

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Global Macroeconomic Landscape

After a healthy rebound in 2021, the global economy witnessed a recessionary situation in 2022, as growth across the major countries moderated and inflation remains sticky at record-high levels in the face of aggressive monetary tightening around the world.

Real GDP growth	2021	2022	2023P	2024P
World	6.0%	3.4%	2.8%	3.0%
India	8.7%	6.8%	5.9%	6.3%
China	8.1%	3.0%	5.2%	4.5%
Japan	1.7%	1.1%	1.3%	1.0%
USA	5.7%	2.1%	1.6%	1.1%
UK	7.4%	4.0%	-0.3%	1.0%
EU	5.2%	3.5%	0.8%	1.4%

Source: International Monetary Fund, April 2023 Outlook

Uncertainty related to food and energy supply emerged as major risk to stable governance, debt sustainability and business continuity across developed and emerging markets. The three economic heavyweights - the US, China, and the EU - continue to grapple with a host of challenges. Consequently, even fundamentally strong, export-oriented developing markets faced weak growth in 2022.

The slowdown in economic growth has led central banks to rethink the monetary easing, which was the preferred tool during the previous global recession. Tightening labour markets, and strong demand pressure and high inflation is complicating the policy direction. Although a full-fledged recession is yet to set in, there are clear indications of a global slowdown and businesses should remain vigilant and resilient.

Business, especially with cross border linkages should consider two key points. The timing and intensity of this economic slowdown is likely to differ as the US is on a much better footing than the EU; and some developing markets in Asia, the Middle East and Latin America will outperform the US in coming months. Secondly, businesses cannot rely on the kind of policy support that was forthcoming in the last two global recessions (2008 and 2020). With higher interest rates, government debt is now costlier, hence fiscal support, too, will likely be limited or targeted. Businesses must thus critically assess the implications of the slowdown on their operations, their subsidiaries, or suppliers.

The first month of 2023 was quite eventful - Croatia joined the Eurozone as its 20th member, Brazil witnessed a mini-insurrection, India overtook China as the world's most populous nation, and the US hit its debt ceiling.

Given where inflation levels are currently hovering (and the fact that core pricing pressures have not yet abated), more will have to be done to weather the storm. This is reflected in central bank commentaries. We expect central banks, including the US Fed, to continue hiking rates in the upcoming meetings, albeit at a slower pace. What businesses should know is that we are heading toward a synchronized global economic

slowdown, and that they should prepare for a possible recession in developed markets. Further, the logic that a central-bank-engineered recession (if at all) should be mild, might hold true for the US, but in Europe, the course that the ongoing Russia-Ukraine war takes may continue to impact outcomes. Moreover, milder than usual weather has played an important role in easing pressure on energy prices in Europe.

India's Key Economic Indicator

India's economy is showing signs of resilience with GDP estimated to grow by approximately 7.2% in FY 2023. Although this translates into a moderation in demand (compared to FY 2022), the estimated GDP growth in FY 2023 represents a return to pre pandemic era growth path. Despite this moderation in growth, India continues to remain one of the fastest growing economies in the world.

There are quite a few factors that is aiding India's economic recovery – notably its resilience to external shocks (ongoing Russia – Ukraine conflict) and rebound in private consumption. This rebound in private consumption is bringing back the focus on improvements in domestic demand, which together with revival in export demand is a precursor to higher industrial activity. Already the capacity utilization rates in Indian manufacturing sector are recovering as industries has stepped up their production volumes. As this momentum sustains, the increasing capacity utilization would lead to fresh round of capacity expansion plan. The universal vaccination program by the Government has played a big part in reinstating confidence among the population, in turn helping to revive private consumption.

Realizing the need to impart external stimuli, the Government stepped up its spending on infrastructure projects which in turn had a positive impact on economic growth. The capital expenditure of central government increased by nearly 64% during the first 8 months of FY 2023¹. This has provided the much-needed confidence to private sector, and in turn attracted private investment.

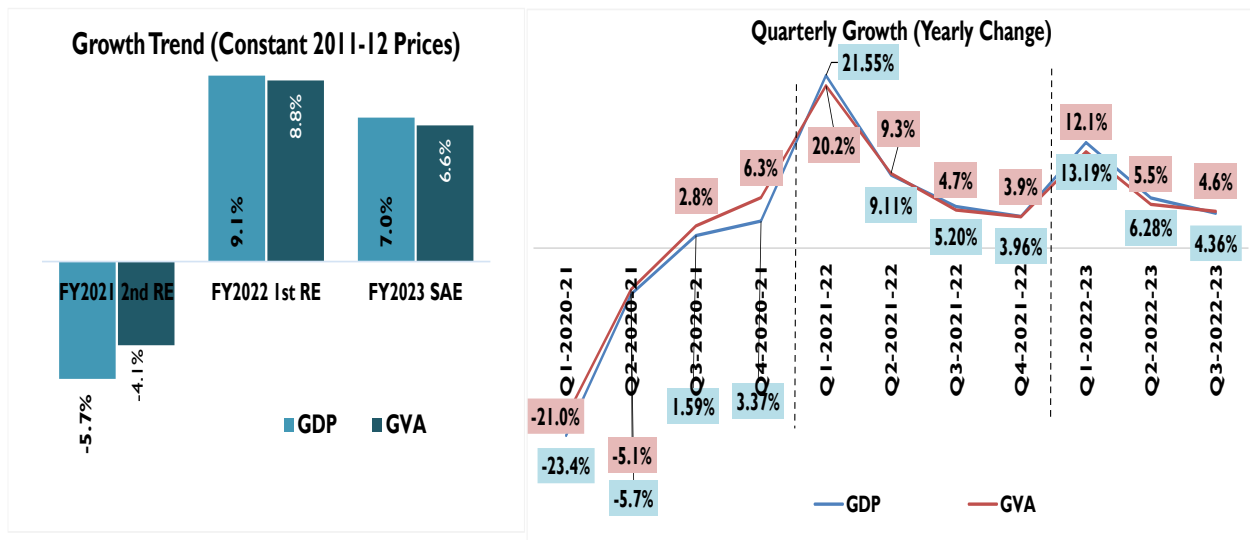
On the lending side, the financial health of major banks have witnessed an improvement which has helped in improving the credit supply. With capacity utilization improving, there would be demand for credit from corporate sector to fund the next round of expansion plans. Banking industry is well poised to address that demand. Underlining the improving credit scenario is the credit growth to micro, small and medium enterprise (MSME) sector which increased by nearly 31% in January – November 2022 period, compared to corresponding period previous year². The extended Emergency Credit Linked Guarantee Scheme (ECLGS) by the Union Government has played a major role in improving this credit supply.

India's GDP in FY 2023 is expected to grow by 7% compared to 9.1% in the previous fiscal on the back of slowing domestic as well as external demand owing to series of interest rate hikes globally to tackle high inflation. The year-on-year moderation in growth rate is also partly due to a fading impact of pandemic-induced base effects which had contributed towards higher growth in FY 2022. On quarterly basis, the country growth moderated in Q2 and Q3 of FY 2023 which highlights impact of slowing economy on the

¹ India Economic Survey FY 2023

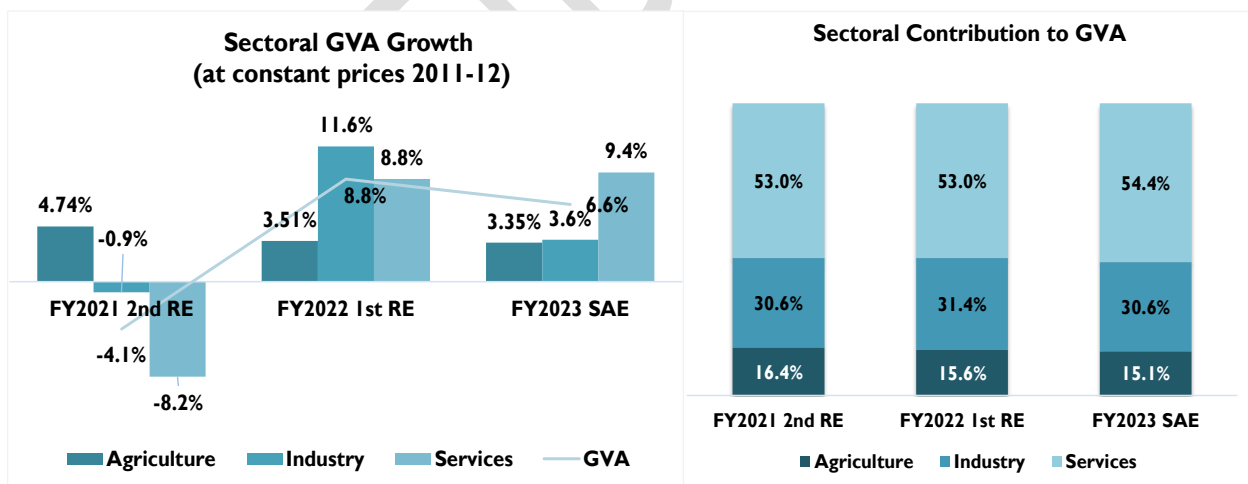
² India Economic Survey FY 2023

back of monetary tightening. During Q3 FY 2023, the country's GDP grew by 4.36% against 6.28% y-o-y increase in the corresponding quarter last fiscal.



Source: Ministry of Statistics & Programme Implementation (MOSPI)

Sectoral analysis of GVA reveals growth tapered sharply in industrial sector which is estimated to grow by just 3.6% against 11.6% in the previous fiscal. In the industrial sector, growth across major economic activity such as mining, manufacturing, construction sector slowed and it registered a growth of 3.38%, 0.56% and 9.12% in FY 2023 against a decline 7.07%, 11.05% and 14.82% in FY 2022, respectively.



Source: MOSPI

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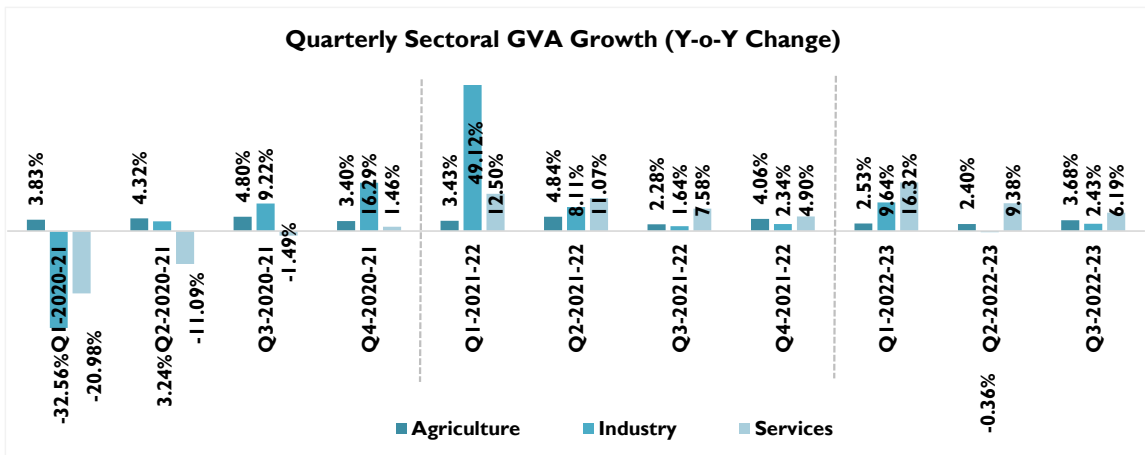
Talking about the services sectors performance, with major relaxation in covid restriction, progress on covid vaccination and living with virus attitude, business in service sector gradually returned to normalcy in FY 2022. Economic recovery was supported by the service sector as individual mobility returned to pre-pandemic level. The trade, hotel, transport, communication, and broadcasting segment continued to strengthen and grow by 14.18% in FY 2023 against 13.75% in the previous year and financial services, real estate and professional services sector recorded 6.85% y-o-y growth against 4.73%. However, overall service sector growth was curbed by moderation in public administration and defense services sector which recorded 7.12% yearly increase against 9.7% increase in the previous year.

Quarterly GVA Performance

Quarterly GVA number indicated sustained weakness in economic activity during Q3 FY 2023 with manufacturing activity being the worst hit segment amongst the industrial sectors. India's manufacturing sector shrank by 1.1% on-year in Q3 FY 2023, a second straight contraction highlighting the continuing weakness in consumer demand and exports. In Q2 FY 2023, manufacturing sector output was down by 3.57%. While quarterly growth in both agriculture and other sectors within industrial sector strengthened during Q3 FY 2023.

Agriculture sector GVA strengthen in Q3 FY 2023 to register 3.68% yearly growth compared to both corresponding quarter last year (2.28%) and previous quarter (2.4%) in FY 2022. Any growth between 3.5-4% in farm sector is considered above the long-term trend line. Construction sector witnessed 8.39% y-o-y growth in Q3 of FY 2023 against 5.85% y-o-y growth in the previous quarter, mining and quarrying sector, and Electricity, gas, water supply & other utility services sector registered 3.7% and 8.24% y-o-y growth against -0.4% and 5.96%, respectively.

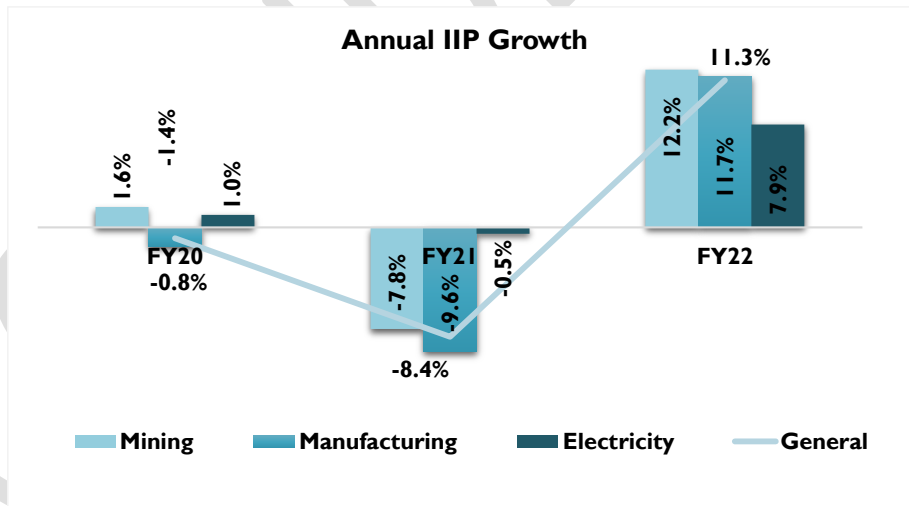
In Q3 FY 2022, yearly growth stood as 0.23%, 5.42% and 5.99% in construction, mining and quarrying and Electricity, gas, water supply & other utility services sector, respectively. Within service sector, quarterly growth moderated across all segments in Q3 FY 2023 against the previous quarter. Trade, hotel, transport, communication, and broadcasting segment observed 9.56% y-o-y growth in Q3 as compared to 15.64% growth in the last quarter. Other services sector broadly classified under Public Admin, Defence & Other Services and Financial, Real Estate & Professional Services too observed 1.99% and 5.79% growth in Q3 FY 2023 against 5.57% and 7.13% y-o-y change in Q2 FY 2023.



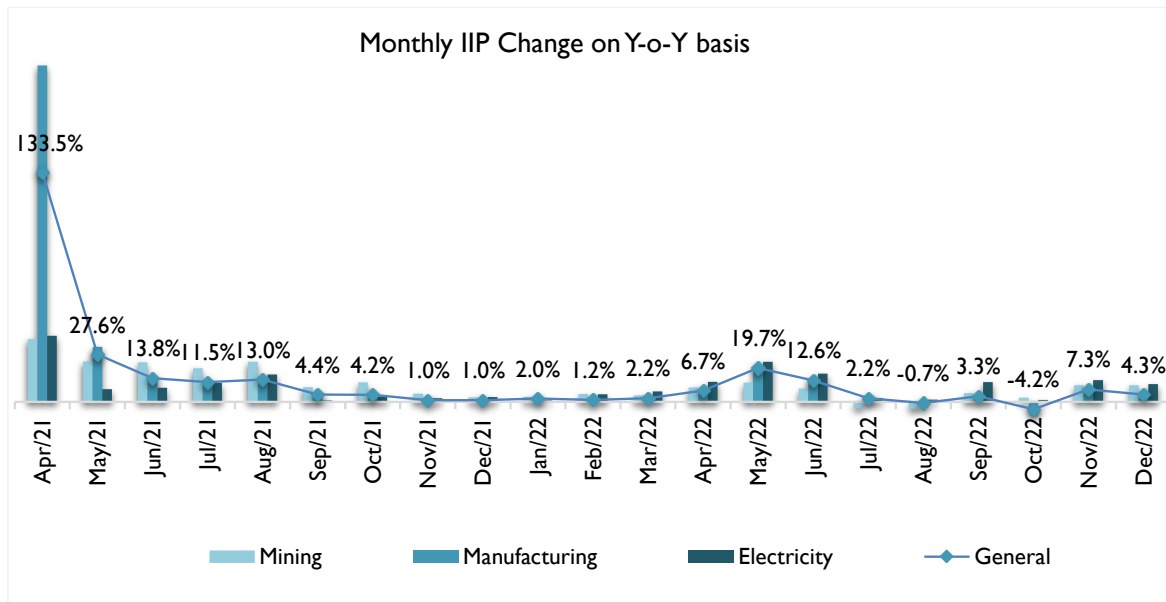
Source: MOSPI

Index of Industrial Production

After experiencing three years of deteriorating industry growth, the country's Index of Industrial Production (IIP) index registered 11.3% y-o-y growth where growth was evenly spread across all sub-segments. Manufacturing index, with 77.6% weightage in overall index, registered 11.7% y-o-y growth in FY 2022 while mining sector index registered the highest growth. On use-based classification basis, infrastructure/construction goods, capital good, intermediate good and consumer durable outperformed over the other sector and registered healthy double-digit growth.

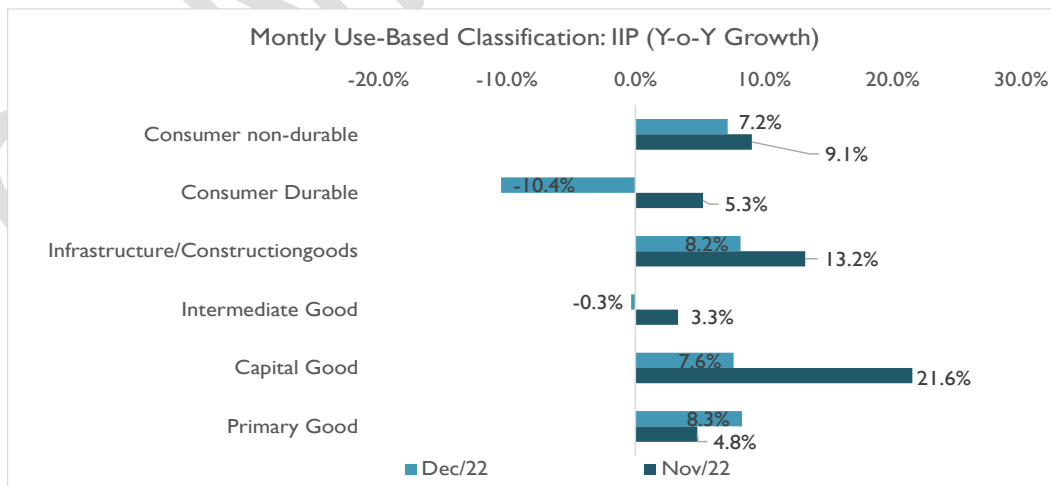


Source: MoSPI



Source: MoSPI

In current year, IIP index which improved steadily between March to May moderated sharply in the subsequent three month and it measured lowest in October 2022 while it showed temporary improvement by growing at 7.3% in subsequent. However, IIP again moderated to register 4.3% y-o-y growth in December 2022. Manufacturing activity which has 77.6% weightage in the overall index, grew by 2.6% in December 2022 while mining activity and electricity index grew by 9.8% and 10.4%, respectively. On y-o-y basis, monthly IIP growth in December 2022 was relatively higher compared to previous year due to low base effect where overall IIP was adversely affected by onset of third wave of pandemic. Low base affect and year end festive sale are likely to support IIP growth in the coming month. However, moderation in external demand and consequent decline in trade have potential to affect manufacturing sector output and putting downward pressure on overall IIP growth.



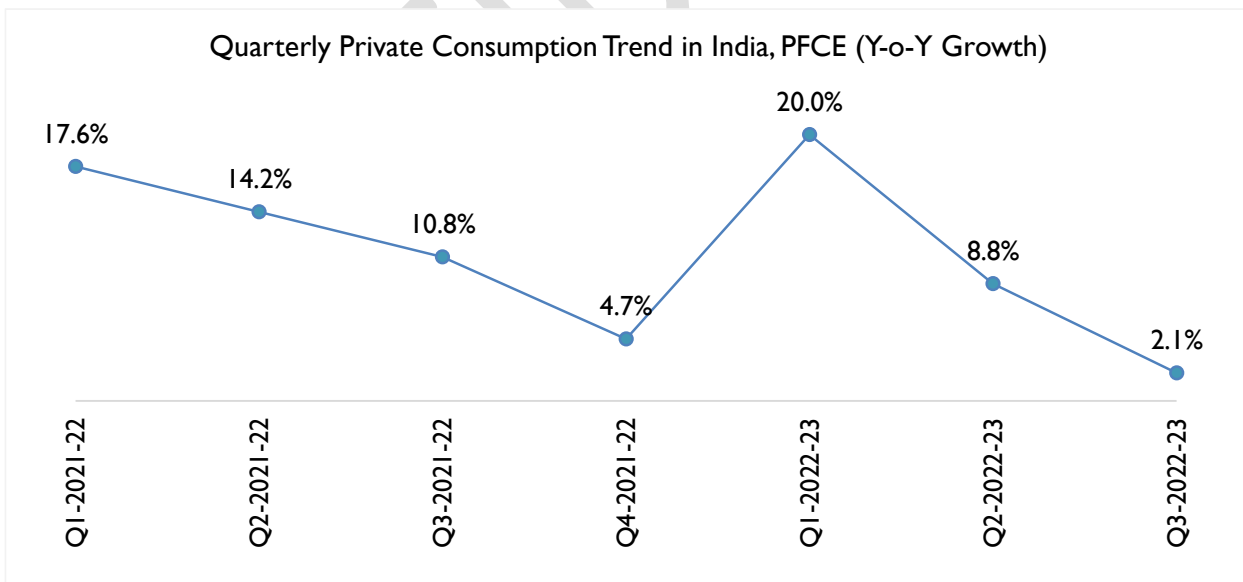
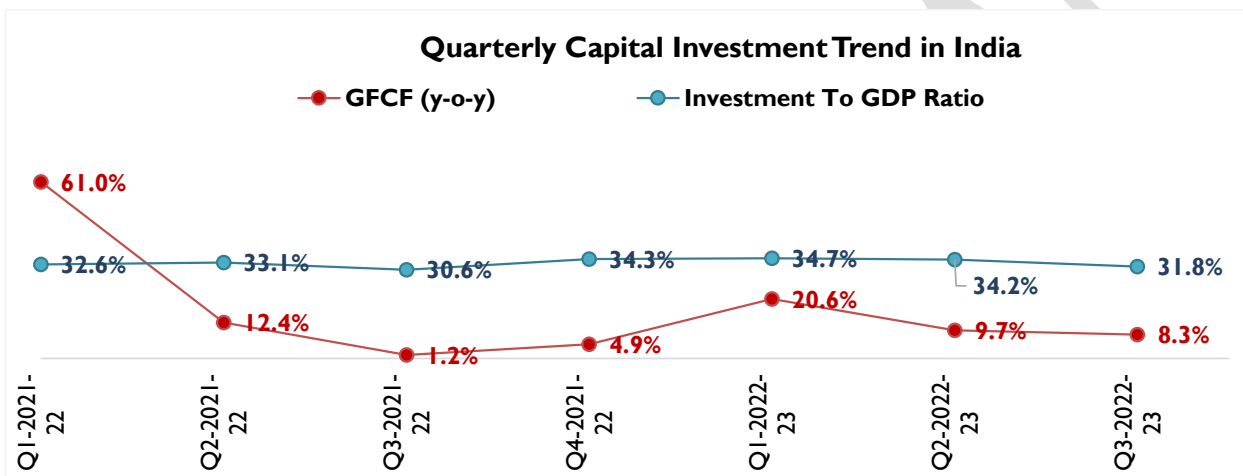
Sources: MOSPI

As per the use-based classification, growth in all segments excluding primary goods deteriorated in December 2022 against previous month. Consumer good and intermediate goods were worst hit segments. The

Contracting IIP data points towards adverse operating business climate as global headwinds, high inflation, and monetary tightening started having adverse impact on manufacturing activity.

Investment & Consumption Scenario

Other major indicators such as Gross fixed capital formation (GFCF), a measure of investments, moderated during Q2 FY 2023 and Q3 FY 2023 while 8% y-o-y growth number was encouraging against 1.2% yearly growth in Q3 FY 2022. Despite the festive season demand and largely a covid-free economy, Private Final Consumption Expenditure (PFCE) a realistic proxy to gauge household spending, observed a continued moderation in Q3 FY 2023 where yearly growth softened to 2.1% which was nearly 7% lower compared to Q2 FY 2023.

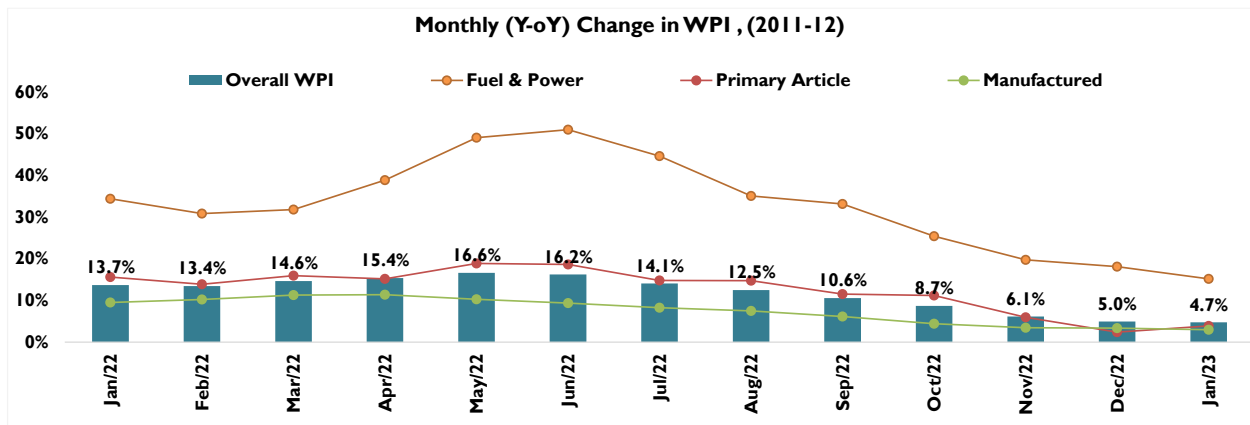


Sources: MOSPI

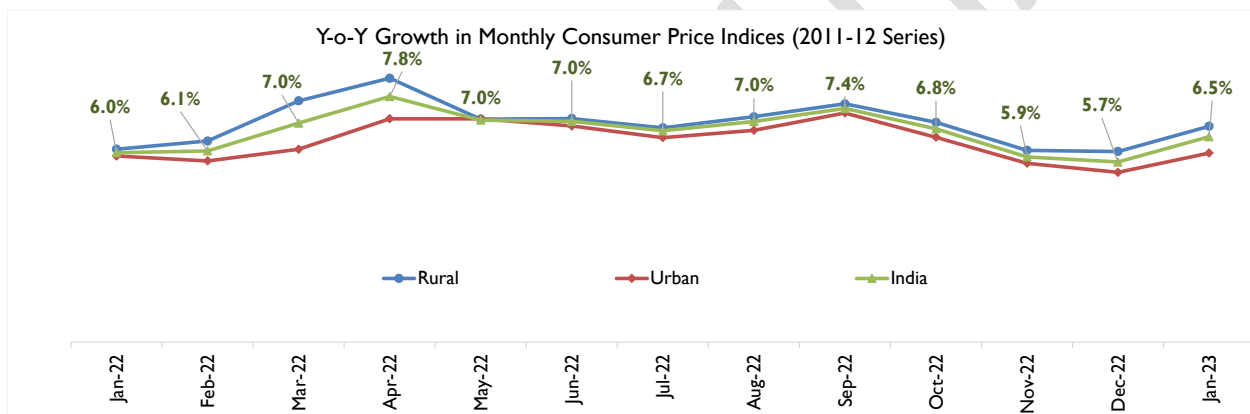
Inflation

India's inflation rate based on Wholesale Price Index (WPI) moderated to nearly 24 months low with 4.7% y-o-y change in January 2023 against 5% (y-o-y) increase in the December 2022. Softening prices of mineral oils, chemicals & chemical products, textiles, crude petroleum & natural gas, textiles, and food products.

contributed towards moderation in WPI inflation rate in January 2023. Separately, The Food Index which consisting of 'Food Articles' from Primary Articles group and 'Food Product' from Manufactured Products increased to 2.95% in January 2023 from 0.65% in December 2022.



Source: MOSPI, Office of Economic Advisor



Source: CMIE Economic Outlook

Retail inflation rate (as measured by Consumer Price Index) again jumped above 6% tolerance limit of the central bank in January 2023 after observing mild moderation in the previous two month. The overall CPI grew by 6.5% in January 2023 due to spike in food inflation and CPI food index grew by 5.9% during FY 2023 against 4.2% y-o-y growth in the previous month. Within food index, Cereals and product-led food inflation reached 16.1 per cent in January 2023 from 13.8 per cent in December 2022. As a part of anti-inflationary measure, the RBI has hiked the repo rate by 225 bps since May to current 6.25%, with latest fourth round hike announced on 8 Feb 2023. The Reserve Bank of India has estimated an average inflation rate of 6.5% for FY 2023.

However, the headline inflation is expected to decline in the coming year, to an average of nearly 5.2% in FY 2024. This forecast is based on the easing of global commodity prices and some moderation in domestic demand.

Growth Outlook

Amidst the difficult and uncertain external economic environment, the Indian government has delivered a balanced Union Budget which focuses on achieving an inclusive and sustainable growth while adhering to the fiscal glide path. Notwithstanding the external risk, there is a sustained momentum in economic activity supported by domestic drivers. The consumer confidence survey by the Reserve bank of India points towards rising confidence of households both for the current situation as well as the future expectations (for a one-year period).

Rural demand is likely to be boosted by good prospects for agricultural output and discretionary spending is expected to support urban consumption supporting. Resilient domestic financial markets, sturdy growth in credit and the government's thrust on capital expenditure is expected to drive momentum in investment activity. Capacity utilization in the manufacturing sector has surpassed its long period average. Thus, the stance taken by the government to not only emphasize on the top-down approach to growth i.e focusing on substantial capital outlay, but also to place focus on the bottom of the pyramid by trying to unleash the potential of the primary sector in the Union Budget should support India's growth momentum in 2023.

Some of the key factors that would propel India's economic growth in the coming years

Government focus on infrastructure development

Infrastructure development has remained recurring theme in India's economic development. The launch of flagship policies like National Infrastructure Pipeline (NIP), and PM Gati Shakti plan have provided the coordination & collaboration that was lacking earlier. Both NIP and PM Gati Shakti are ambitious billion-dollar plans that aims to transform India's infrastructure, elevating it to the next level. These projects are expected to improve freight movement, debottleneck the logistics sector, and improve the industrial production landscape, which would provide the incremental growth in GDP. In its Union Budget FY 2023, the Government has increased the capital expenditure by 35% to nearly INR 7.5 lakh crore – which indicates the strong Government focus on improving the overall infrastructure landscape in India.

Development of Domestic Manufacturing Capability

The Government launched Production Linked Incentive (PLI) scheme in early 2020, initially aimed at improving domestic manufacturing capability in large scale electronic manufacturing and gradually extended to other sectors. At present it covers 14 sectors, ranging from medical devices to solar PV modules. The PLI scheme provides incentives to companies on incremental sales of products manufactured in India. This incentive structure is aimed to attracting private investment into setting up manufacturing units and thereby beef up the domestic production capabilities. The overall incentives earmarked for PLI scheme is estimated to be INR 2 lakh crore. If fully realizing the PLI scheme would have the ability to add nearly 4% to annual GDP growth, by way of incremental revenue generated from the newly formed manufacturing units.

Strong Domestic Demand

Domestic demand has traditionally been one of the strong drivers of Indian economy. After a brief lull caused by Covid-19 pandemic, the domestic demand is recovering. Consumer confidence surveys by Reserve Bank / other institutions are points to an improvement in consumer confidence index, which is a precursor of improving demand. India has a strong middle-class segment which has been the major driver of domestic demand. Factors like fast paced urbanization and improving income scenario in rural markets are expected to accelerate domestic demand further. This revival is perfectly captured by the private final consumption expenditure (PFCE) metric. PFCE as a percentage of GDP increased to nearly 59.2 during the first half of FY 2023, which is the highest level it has achieved during the past few years. Although pent-up demand has played a part in this surge, this is an indication of normalization of demand.

There are two factors that are driving this domestic demand: One the large pool of consumers and second the improvement in purchasing power.

- The share of middle class increased from nearly 14% in 2005 to nearly 30% in 2021 and is expected to cross 60% by 2047. This expanding middle class household segment is fuelling India's growth story and would continue to play a key role in propelling India's economic growth.
- As per National Statistics Office (NSO) India's per capita income (in current prices) stood at INR 1.72 lakhs in FY 2023 which is nearly double of what it was in FY 2015. This increase in per capita income has impacted the purchasing pattern as well as disposable spending pattern in the country. Consumer driven domestic demand is majorly fuelled by this growth in per capita income.

Digitization Reforms

Ongoing digitization reforms and the resultant efficiency gains accrued would be a key economic growth driver in India in the medium to long term. Development of digital platforms has helped in the seamless roll out of initiatives like UPI, Aadhaar based benefit transfer programs, and streamlining of GST collections. All of these have contributed to improving the economic output in the country. Some of the key factors that has supported the digitization reforms include – the growth in internet penetration in India together with drop in data tariffs, growth in smartphone penetration, favourable demographic pattern (with higher percentage of tech savvy youth population) and India's strong IT sector which was leveraged to put in place the digital ecosystem. All these factors are expected to remain supportive, and continue to propel the digitization reforms in India.

³ India Economic Survey FY 2023, Full year data is yet to be released

⁴ As per the survey conducted by People Research on India's Consumer Economy. Households with annual income in the range of INR 5 – 30 lakh is considered as middle class households

Heat Exchanger

Product Profile

Heat exchangers transfer thermal energy from one fluid to another, while ensuring that the fluids do not mix. This process is facilitated by conduction, enabling the heat exchanger to heat or cool a substance. Heat exchangers provide a means of regulating temperature, enhancing efficiency, averting overheating, and mitigating other potential hazards, resulting in an improvement in safety standards. Heat exchangers are considered more efficient and reliable in operations wherein some parameters, like temperature differential, flow rate and installation guidelines, are evaluated successfully.

Being an efficient source of energy saving, heat exchangers find applications across a broad range of domestic and industrial applications such as steam power plants, chemical processing plants, food processing, HVAC systems, mining, pulp & paper, metallurgy etc. Heat exchangers typically are suitable for deployment in areas which have ample spaces such as industrial complexes, commercial space, hospitals, educational institutes etc. These systems are not generally preferred or feasible for smaller capacities, especially residential, as the economies of scale are difficult to overcome.

Types of Heat Exchanger

Shell and Tube Heat Exchangers

A shell and tube heat exchanger (STHE) is a heat exchanging device made up of a large cylindrical enclosure, or shell, that has bundles of perfectly spaced tubing compacted in its interior. Shell & tube products are generally used in applications that require transfer between two liquids, between liquids & gases or between two gases and a wide temperature and pressure range. Their properties of managing fluids at high temperature and pressure makes them suitable for various applications such as chemical and petrochemical plants, oil & gas and power sectors among others. These type of heat exchangers have a simple structure and are ideal for heat transfer from steam to water.

Three types of commonly used shell and tube heat exchangers are-

1. Fixed Tube Sheet Heat Exchanger

In this type of exchanger, the tube sheet is welded to the shell. This leads to a simple and economical structure, and the cleaning of tube bores can be performed mechanically or chemically. However, the outer surface of the tubes is inaccessible other than chemical cleaning. Rear headers are usually of L, M, and N types.

2. U-Tube Heat Exchanger

In a U-Tube exchanger, any type of front header may be used, and the rear header is typically M-Type. U-tubes allow unlimited thermal expansion. Also, the tube bundle can be eliminated for cleaning, and a small bundle to shell clearances can be obtained. Since it is difficult to clean inside the

tubes with mechanical tools, it is normal to use this type only where the fluids on the tube side are clean.

3. Floating Head Heat Exchanger

In the floating head exchanger, the tube sheet is not welded to the shell at the rear header end but is permitted to move or float. The tube sheet at the front header has a larger diameter than the shell and is sealed in a manner similar to that applied in the fixed tube sheet design. The tube sheet at the rear header end of the shell is somewhat smaller in diameter than the shell and allows the bundle to be drawn through the shell.

The application of a floating head means that thermal expansion is allowed, and the tube bundle can be eliminated for cleaning purposes. Several types of rear headers can be utilized, but the S-Type Rear Head is the most common.

The three flow types of shell and tube heat exchangers are parallel, counter, and cross. Due to design considerations and the applications of heat exchangers, it is rare that a heat exchanger be only one of these flow types, usually they are a combination of several flow types e.g. counter cross flow.

- Parallel flow is when the shell and tube sides enter the heat exchanger at the same end and flow directly to the opposite end. The temperature change is the same for each fluid and increases or reduces by the same amount.
- Counter flow is when the fluids are flowing in opposite directions, enter the heat exchanger at opposite ends, and discharge at opposite ends. The counter flow is the most popular and efficient type of heat exchanger.
- In a cross-flow shell and tube heat exchanger, the fluids flow perpendicular to each other at a 90-degree angle. One of the fluids in a cross-heat exchanger changes state (just as in a steam system condenser where cooling water absorbs the steam), then is absorbed by the fluid that has remained in its liquid state.

The operation of a shell and tube heat exchanger is based on the thermal exchange and flow of two different fluids. One fluid flows through the tubes while the other flows through the shell, which is divided into two sections: the shell side and the tube side.

The allocation of hot and cold fluids is a critical decision when working with a shell and tube heat exchanger. The shell side is designed to handle low-pressure fluids, while the tubes are intended for high-pressure fluids.

Shell and tube heat exchangers are used in various cooling applications and are particularly effective at cooling hydraulic fluid and oil in engines, transmissions, and hydraulic power packs. Additionally, with the appropriate choice of materials, they can be used to cool or heat other fluids, such as swimming pool water or charge air.

One of the key benefits of shell and tube heat exchangers is their ease of maintenance, particularly when a floating tube bundle is available. Due to the cylindrical design of the housing, they are capable of withstanding high pressure, making them suitable for a wide range of pressure applications.

Finned Tube Heat Exchanger / Fin and Tube Type Heat Exchanger

Finned tube heat exchanger has fins attached to the end of tubes. Such a construction increases the heat transfer area, which in turn helps in increasing the heat transfer rate. Typically, a dense liquid which is capable of transporting heat efficiently and a fluid with very little density (like gas or air) are used as heat transfer mediums. The flow pattern of fluids in this type of heat exchangers is primarily cross flow, with fluids travelling perpendicular to each other. Since air is one of the fluids used to transfer heat, finned tube heat exchanger is also called air cooled heat exchanger or air fin coolers.

Some of the advantages finned tube heat exchanger enjoys over other variants include increased heat transfer coefficient (due to higher heat transfer surface area), reduced equipment size, and compatibility with a range of materials (like copper, aluminum, carbon steel, stainless steel, and titanium).

A finned tube heat exchanger is used when air / gas is the preferred fluid used to heat up or cool down the working fluid. The presence of fins increases the overall surface area available for heat transfer. Because of this the total number of tubes required for a particular application can be lower which in turn reduces the equipment size. This enables creating heat exchanger of smaller size making it ideal for mobile refrigeration applications.

Some of the commonly used type of finned tube / air cooled heat exchanges:

1. **Forced Draft Air Cooled Heat Exchanger:** In this type, a mechanical draft fan is used to force air over the heat transfer surface of the exchanger. The fans are set below the tube bundles and push air across the tube surface. This design allows for better accessibility for maintenance and fan blade adjustment. As a result, it needs less structural support, it can have a longer mechanical life and it can lower the capital costs.
2. **Induced Draft Air-Cooled Heat Exchanger:** In this type, the air is drawn through the exchanger by an induced draft fan placed on the outlet side of the heat exchanger. Since the fans are located above the bundle, the air is pulled across the finned tube surface. This arrangement provides a more even distribution of air due to lower air velocity. Additionally, an induced draft air-cooled exchanger is less likely to recirculate exhaust air and is less susceptible to sudden temperature changes since only a portion of its surface is exposed to the elements.
3. **Natural Draft Air Cooled Heat Exchanger:** This type of exchanger relies on the natural buoyancy of hot air to move it upwards, creating a natural draft to draw cooler air in at the bottom of the exchanger. However, there may be a chimney above the tube bundle that creates the draft that drives air through the tube bundle.

Plate Heat Exchangers (PHEs)

A Plate Heat Exchanger is a heating device that facilitates the transfer of heat between two fluids that are separated by a thin metal plate, and are typically used for liquid-liquid exchange at low to medium pressures. This method allows for a high rate of heat transfer in a compact space, making it useful for a variety of applications where space is at a premium. With their compact size, high heat transfer rates, and low maintenance requirements, plate heat exchangers are becoming increasingly popular in many industries., especially in the food industry as they have multiple plates inside the frame, reducing or eliminating microbial, thereby making the product safe for consumption.

There are 4 main types of PHEs-

1. **Gasketed plate heat exchangers** – These exchangers use high-quality gaskets and designs to seal plates together and prevent fluid from leaking out. Plates can easily be removed for cleaning, expansion, or replacing purposes.
2. **Brazed plate heat exchangers** – Brazed plate heat exchangers use a process called brazing to bond the plates together. This creates a more durable and compact heat exchanger that can withstand higher pressures and temperatures than Gasketed plate heat exchangers. Used in many industrial and refrigeration applications, these exchangers can be very efficient and compact. This tends to make them a highly economic choice. A stainless-steel plate with copper brazing can be highly resistant to corrosion.
3. **Welded plate heat exchangers** – These are very similar to gasketed heat exchangers but the difference is the Welded plates can be attached together. They are very durable and are ideal when it comes to transferring fluids with high temperatures or corrosive materials. Since the plates can be welded together, cleaning the plates isn't possible compared to cleaning plate heat exchangers.
4. **Semi-Welded plate heat exchangers** – These are a combination of welded and gasket plates. The two plates are welded together and gasketed to other pairs within the heat exchanger. This results in an easy to service heat exchanger and you're able to transfer more fluids throughout the system. Semi-Welded heat exchangers are great for transferring expensive materials due to their low risk of fluid loss.

The plates in a plate heat exchanger are typically made of metal, such as stainless steel or titanium, and are corrugated to increase the surface area available for heat transfer.

When the hot and cold fluids enter the plate heat exchanger, they flow through the alternating channels between the plates. As they flow through the channels, they exchange heat through the thin metal walls of the plates, without coming into direct contact with each other. This heat exchange process continues as the fluids flow through the channels and eventually exit the heat exchanger.

The flow of the hot and cold fluids in a plate heat exchanger can be arranged in different ways, depending on the application and performance requirements. The most common flow arrangement is counterflow, where

the hot and cold fluids flow in opposite directions, which maximizes the temperature difference between the two fluids and provides the highest heat transfer rates.

In addition to this, the plate heat exchanger can also be designed with different types of channels to optimize the flow of the fluids. The most common types of channels are herringbone, chevron, and straight. Herringbone and chevron channels are designed to create turbulence in the fluid flow, which increases the heat transfer rate. Straight channels are designed for applications where low-pressure drop is important.

A plate heat exchanger comes with a compact design and offers a lower cost option wherever stainless steel is required. One of the biggest advantages of plate exchangers is the efficiency that accompanies their compact design. These heat exchangers are created with several corrugated plates on the frame of the equipment, essentially creating a design that uses the entire body during the heat transferring process.

Modern plate heat exchangers use pressed plates, which are less expensive than the welded plates and are also more resistant to corrosion and chemical reactions that weaken the product and hence require frequent maintenance or replacement.

Spiral Tube Heat Exchangers

Spiral tube heat exchangers have excellent heat exchanger properties because of far compact and high heat transfer efficiency. The heat transfer rate associated with a spiral tube is higher than that for a straight tube. Spiral tube heat exchangers consist of one or more spirally wound coils which are, in circular pattern, connected to header from which fluid is flowed. This spiral coil is installed in a shell another fluid is circulated around outside of the tube, leads to transfer the heat between the two fluids.

Spiral tube heat exchangers use single channel technology i.e. both fluids occupy a single channel, which allows fully counter-current flow. The working of this technology includes one fluid (hot fluid) entering the centre of the unit and flowing towards the periphery whereas the other fluid (cold fluid) enters the unit at the periphery and moves towards the centre. Spiral tube heat exchangers are generally used for pasteurization, heat recovery, digester heating, effluent cooling, and pre-heating.

Types of Materials Used

A wide range of metals is used in heat exchangers, depending upon the nature of the fluids handled. The type of metals used ranges from steel to rare metals like Zirconium. Some of the common materials used include carbon steel, stainless steel, aluminum, copper, and copper-nickel. The end use application of heat exchanger has a huge bearing on the type of material selected.

Type of Heat Exchanger	Common materials used
Shell & Tube	Carbon steel, stainless steel, brass, and titanium
Finned Tube/ Air cooled	Duplex stainless steel, carbon steel, aluminum, copper

Plate Heat Exchanger	Stainless steel, Titanium
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Both copper and aluminium are commonly used as materials for fins in heat exchangers, and they offer various advantages.

Aluminum based Fins and Tubes	Copper based Fins and Tubes
<p>High Thermal Conductivity: Aluminium has excellent thermal conductivity, making it an efficient material for heat transfer.</p> <p>Lightweight: Aluminium is a lightweight material compared to alternatives such as copper or steel.</p> <p>Cost Effective: Aluminium is relatively more cost effective than other materials like copper or stainless steel. The lower cost of aluminium fins can contribute to overall cost savings in heat exchanger manufacturing. Heat exchanger manufacturers save 20-25% on material costs.</p> <p>Corrosion Resistance: Aluminium has natural corrosion resistance, especially when exposed to air. This property helps protect the fins from oxidation and corrosion, extending the lifespan of the heat exchanger. No galvanic corrosion between fin and tube. Aluminium based tubes can be used in ammonia systems, while copper tubes are not recommended for such applications.</p> <p>Recyclability: Aluminium is a highly recyclable material, making it environmentally friendly.</p>	<p>Excellent Thermal Conductivity: Copper has one of the highest thermal conductivities among metals, making it an ideal choice for heat transfer applications.</p> <p>Corrosion Resistance: Copper exhibits excellent resistance to corrosion, particularly in non-acidic environments. This corrosion resistance helps protect the fins from degradation and extends the lifespan of the heat exchanger.</p> <p>High Strength and Durability: Copper is a strong and durable material, offering mechanical strength and structural integrity to withstand high operating pressures and stresses.</p> <p>Compatibility with Different Fluids: Copper tubes are compatible with a wide range of fluids, allowing for versatile use in heat exchangers across various industries.</p> <p>Longevity and Low Maintenance: Copper tubes have a long service life and require minimal maintenance. Copper's corrosion resistance, durability, and mechanical strength contribute to the longevity of the heat exchanger, resulting in reduced downtime and maintenance costs.</p> <p>Formability and Ease of Fabrication: Copper is highly malleable and ductile, allowing for easy fabrication of fins with various shapes, sizes, and configurations.</p>

Key Applications & End-Use Industries

Heat exchangers find applications in various industries where there is a requirement of transferring heat from one medium to another. Heat exchangers help to maintain the desired temperature, reduce energy consumption, and increase the efficiency of the overall process.

Different types of heat exchangers are used in different industries based on the application and requirements. The widespread use of heat exchangers in various sectors has made them an essential component of modern industrial processes.

Below are the key applications of heat exchangers across different end-use industries-

- **Chemical Processing:** Heat exchangers are used in the chemical processing industry to transfer heat between fluids in different stages of a chemical reaction. This can help to maintain temperature control and prevent unwanted reactions or changes in the properties of the fluid. In some cases, heat exchangers may also be used to recover energy from the chemical reaction.
- **Oil and Gas Industry:** Heat exchangers are used in the oil and gas industry for heating and cooling fluids during production, transportation, and processing operations. In this case scenario, heat exchangers may be used to heat crude oil to make it more viscous and easier to transport, or to cool gas after compression to reduce the risk of explosions.
- **Power Generation:** Heat exchangers are used in power generation systems, such as nuclear and fossil fuel power plants, to transfer heat from the working fluid to the environment. This helps to increase the efficiency of the power generation process. There are two types of heat exchangers commonly used in power generation systems: boilers, which produce steam by heating water, and condensers, which transfer heat from the steam to the environment.
- **HVAC Systems:** Heat exchangers are used in HVAC systems to transfer heat between the air being circulated and the fluid in the system. For example, in a heating system, the heat exchanger will transfer heat from the hot water or steam circulating in the system to the air in the building. In a cooling system, the heat exchanger will transfer heat from the air in the building to the refrigerant in the system.
- **Food and Beverage Processing:** Heat exchangers are used in the food and beverage industry for heating and cooling processes. For example, in pasteurization, heat exchangers are used to heat the product to a specific temperature and hold it there for a specific amount of time to kill bacteria and extend the shelf life of the product. In sterilization, heat exchangers are used to heat the product to a higher temperature to kill all microorganisms. In cooling, heat exchangers are used to rapidly cool the product to prevent spoilage.
- **Refrigeration:** Heat exchangers are used in refrigeration systems to transfer heat from the refrigerant to the surrounding environment. This is how refrigeration systems cool the space or object being refrigerated. There are two types of heat exchangers commonly used in refrigeration

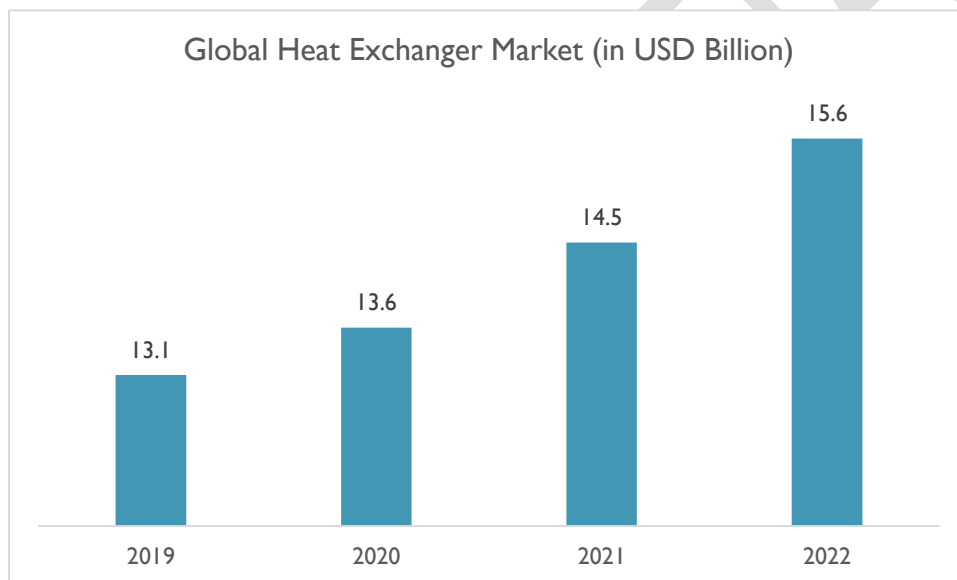
systems: evaporators, which absorb heat from the surrounding environment, and condensers, which release heat into the surrounding environment.

- **Aerospace and Defence:** Heat exchangers are used in aerospace and defence applications for a variety of purposes, such as in aircraft and spacecraft cooling systems, hydraulic systems, and fuel systems. In an aircraft cooling system, heat exchangers are used to transfer heat from the engine and other components to the surrounding air to prevent overheating. They are also used in spacecraft thermal control systems to regulate the temperature of the spacecraft and its equipment.
- **Automotive Industry:** Heat exchangers are used in the automotive industry for cooling the engine, transmission, and other vehicle components, as well as for heating and cooling the passenger compartment. They are used in components such as radiators, intercoolers, and oil coolers. In an engine cooling system, heat exchangers are used to transfer heat from the engine to the surrounding air or to the coolant in the system.
- **Renewable Energy:** Heat exchangers are used in renewable energy systems, such as solar thermal and geothermal systems, to transfer heat from the source to the working fluid. For example, in a solar thermal system, heat exchangers are used to transfer heat from the solar collector to the water or other fluid being heated. In a geothermal system, heat exchangers are used to transfer heat from the underground heat source to the fluid being circulated.
- **Pharmaceutical Industry:** Heat exchangers play a vital role in the pharmaceutical industry, where they are used for processes such as sterilization, evaporation, and crystallization. They are used in applications such as drug manufacturing, bioreactors, and vaccine production.
- **Industrial waste heat recovery:** Industrial waste heat recovery captures hot gases as they exit industrial equipment to use the heat energy. Some of these gases can be extremely hot and need specialist heat exchangers to handle them effectively. These gases can be corrosive.

Global Heat Exchanger Market

Global heat exchanger market is valued at USD 15.6 billion in 2022⁵, with annual turnover in the industry increasing a CAGR of 6.2% between 2019 and 2022. Globally, the demand for heat exchanger is driven by two key factors – increasing demand for sustainable low energy consumption as well as cost-effective solutions to achieve the same.

On the one hand, industries across the world are investing in technologies & processes that are designed to reduce cost and improve operational efficiency. This is seen as a precursor to the next stage of evolution of the industrial sector – namely Industry 4.0 which involves close integration with digital technologies. This development pathway has triggered innovations in products / hardware used as well as systems & processes. In the case of heat exchangers, the innovation is directed towards superior designs that would improve thermal efficiency which in turn will help in reducing energy cost as well as cut down their carbon footprint.



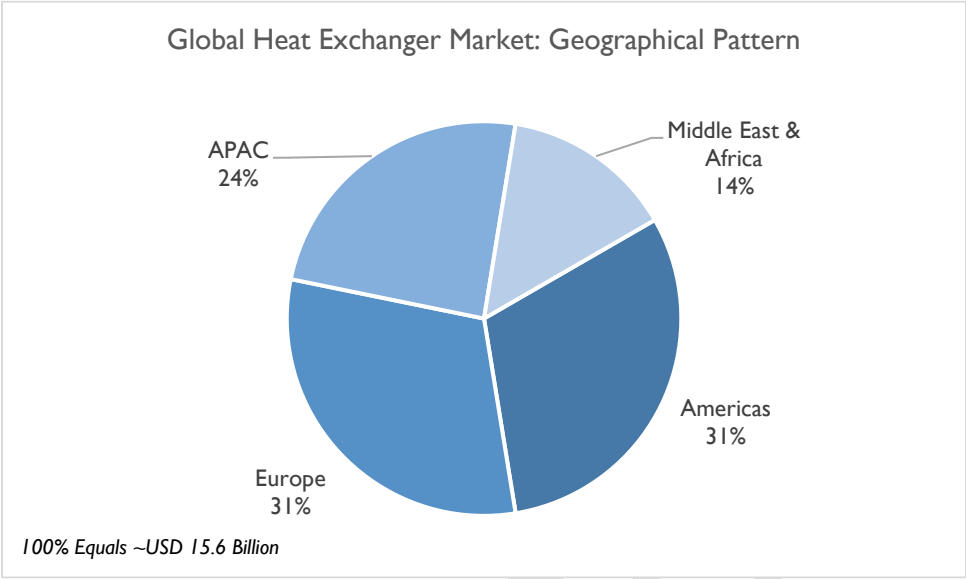
Primary Research, D&B Estimates

Traditionally North America and Europe were the two strongest market for heat exchangers, partly due to their strong industrial base and the pace of innovations in manufacturing space. However, the gradual shift in manufacturing & industrial activity from developed markets to developing economies like China and India is triggering a change in global heat exchanger market.

Large scale industrialization in China and India has transformed APAC into a key market for heat exchangers. Countries like China, India and Southeast Asian nations which have led to increased demand for energy and infrastructure development, thus driving the need for heat exchangers in various sectors such as power generation, oil and gas, and chemical processing. Further, the presence of a robust manufacturing base complementing expanding industrial sectors and supported by rising public and private investments in key industries have created a favourable market environment for heat exchangers in the Asia Pacific region

⁵ Calendar year 2022

This transformation has made APAC the fastest growing heat exchanger market. Between 2019 and 2022, the APAC heat exchanger market witnessed a compounded growth rate of 7%, higher than the growth that was registered in Americas and Europe.

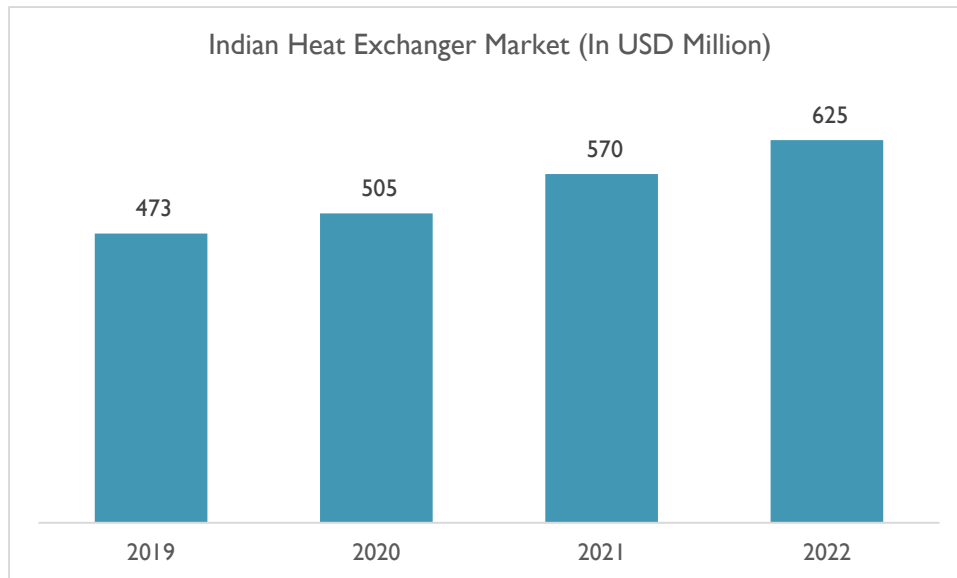


Primary Research, D&B Estimates

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Indian Heat Exchanger Industry

Indian market for heat exchanges reached USD 625 million per annum in 2022, with annual industry turnover increasing by a CAGR of 10% between 2019 and 2022. Heat exchanger industry too was impacted the spread of Covid-19 pandemic, as annual revenue growth in the industry dropped to 6% in 2020. Demand has recovered in the subsequent years, helping the industry grew its revenue by an average of 11% per annum in 2021 and 2022.



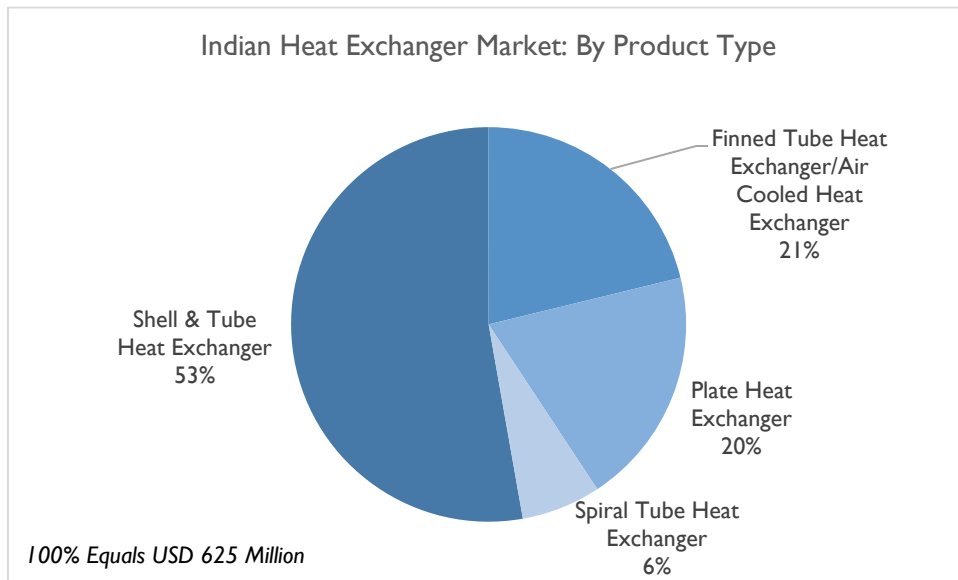
Insights from Primary Research

Rapid industrialization and urbanization, coupled with aggressive drive on infrastructure front have all accelerated the demand for heat exchangers. The strong annual growth in revenue is a result of these supporting factors. In addition, the ubiquitous nature of heat exchanger – which finds application across all major industry segments – have ensured that a general growth in industrial activity and positive economic sentiment translate into demand for the product.

Apart from these direct demand drivers, the increasing focus on efficient energy usage to contain carbon emissions is shaping up as an indirect demand driver. Heat exchangers with its ability to facilitate efficiency heat transfer helps in optimizing energy demand. Given the dominant role played by hydrocarbon energy sources, any optimization in energy demand will directly translate into lower carbon emissions. So, heat exchangers is expected to play a major part in India's sustainable development journey.

By Type of Heat Exchanger

Shell & tube heat exchanger, followed by finned tube heat exchanger are two of the largest product segments in Indian heat exchanger industry. In 2022, shell & tube heat exchanger accounted for nearly 53% of the total industry revenue while finned tube heat exchanger accounted for nearly 21%. Between 2019 and 2022, revenue growth in both these product segments has grown by a CAGR of approximately 10%.

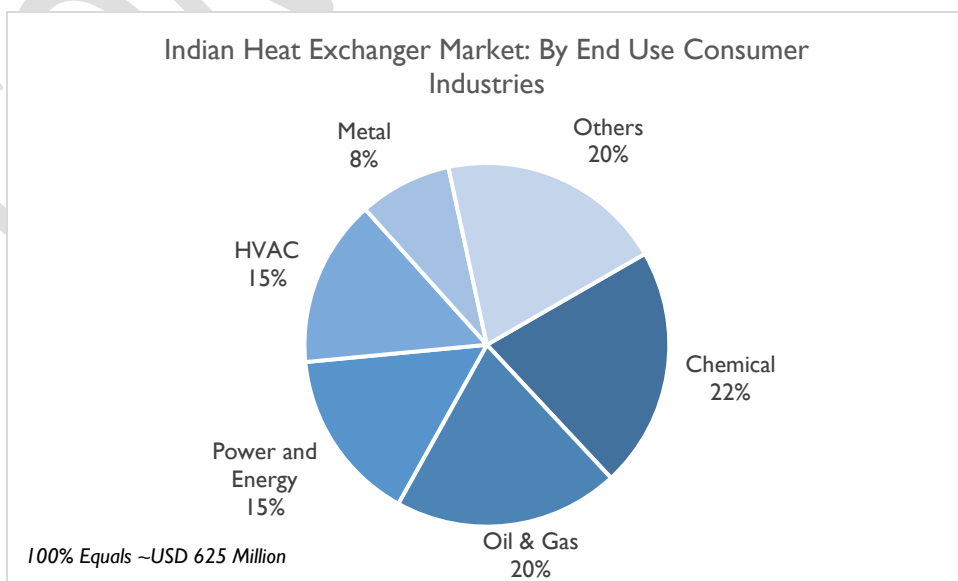


Insights from Primary Research

By End Use Industries

Chemical manufacturing and oil & gas industries are the two largest consumers of heat exchangers in India, with each accounting for nearly one fifth of total industry turnover in 2022. Other key end use consumers are power & energy, HVAC, and metallurgy. Together these five industries contributed to 80% of the heat exchanger industry revenue in 2022.

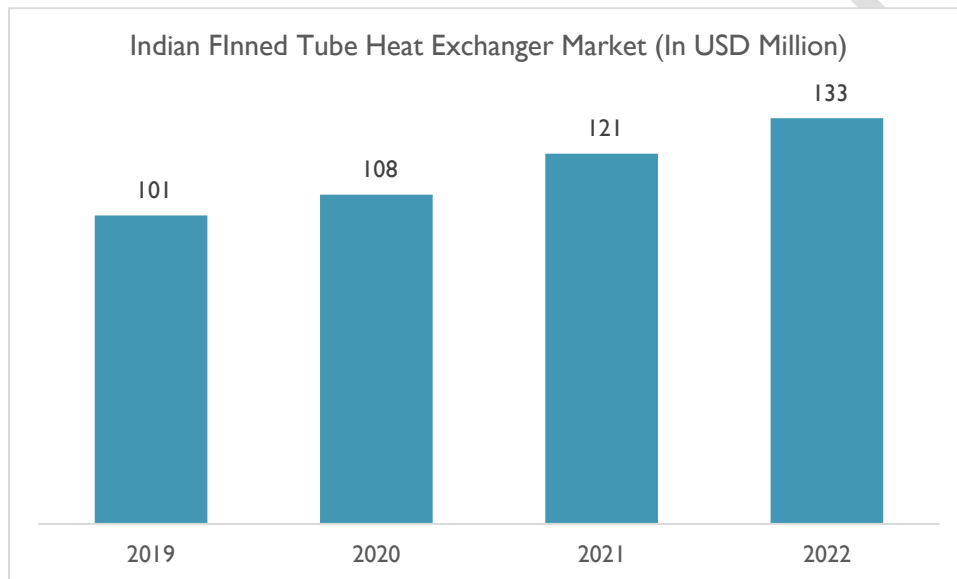
High demand for heat exchangers within the chemical industry as chemical industry frequently involves processes that necessitate precise temperature control, efficient cooling, and heat transfer. Therefore, heat exchangers play a crucial role in facilitating these operations. In addition, after COVID 19 chemical and pharmaceutical industry expanded significantly which in turn have helped generate demand for heat exchangers.



Primary Research, D&B Estimates, Others – food & beverage and paper & pulp are the notable inclusions

Finned Tube Heat Exchanger

Finned tube heat exchanger is the second largest product segment in the Indian heat exchanger market, accounting for nearly one fifth of the overall industry revenue. In 2022, finned tube heat exchanger segment realized an annual revenue of USD 133 million, increasing by a CAGR of nearly 10% between 2019 and 2022. The increasing demand for energy efficient cooling applications is one of the key factors that is driving the demand for finned tube heat exchanger. Moreover, the compact nature of finned tube heat exchanger is also an added advantage – because of the lower space requirement and lower cost, when compared to other product types.



Insights from Primary Research

Copper finned tubes are the preferred material used in finned tube heat exchangers that are used for heat exchanger applications like condensers, evaporators, chillers, oil coolers etc – mainly for all kind of cooling & heating applications. The preference for copper material is because of its superior heat transfer rate, resulting in faster cooling.

Heating, Ventilation, air conditioning (HVAC) and refrigeration are the key end use applications that are driving the demand for finned tube heat exchangers in Indian market. In refrigeration applications, heat exchangers are used as condensers or evaporators, with finned tube and plate heat exchangers finding usage. Finned tube heat exchangers are the most commonly used heat exchangers in HVAC systems, where it is used to exchange heat between air and the refrigerant / coolant. In addition, shell & tube type heat exchangers and tube-in-tube heat exchangers also find application in HVAC segment.

Heat Exchanger Usage in HVAC Systems

Heat exchangers are an integral part of the refrigeration cycle in a HVAC system. Heat exchangers, being a cold source of the central refrigeration system, can be used on the heat condenser cycle or in the evaporation refrigeration cycle. Typically, a refrigerant system comprises of one compressor, one condenser, one

expansion valve and one evaporator: wherein the condenser and evaporator both act as heat exchangers. In the evaporator the refrigerant absorbs the heat of the water, so that it remains chilled. On the other hand, in the condenser the refrigerant rejects that heat and the compressor heat to other media which is usually air or water.

The efficiency of the whole system can be increased by integrating heat exchangers with other refrigeration equipment. For example, reducing energy consumption of condensers by feeding the condensers with refrigerating fluids and gasses reduced in temperature.

Applications of heat exchangers for refrigeration can be found across diverse sectors wherever cooling or heating of different mediums such as water, coolant, gases and ammonia is required. For example, in the food industry heat exchangers are generally used for preserving the quality and for sanitizing processes. They are used to heat water to sterilize food or increase their temperature to decontaminate them or improve the longevity by quick freezing process. In the metallurgical industry, heat exchangers are used for optimizing the processes related to change in water temperature as it is used to cool the water metal molds and presses which release high levels of heat.

The Indian refrigeration equipment market is undergoing rapid development on the back of increasing household income, lower penetration, rapid urbanization and gradual shift towards nuclear families among others. It is further supported by introduction of innovative models and easy availability of consumer financing for home appliances. Advanced technology related to frost free, inverters, energy saving capabilities etc. is playing an important role in the purchasing decision of the consumer. Presence of well-established domestic and international players have led to intense competition leading to a wide range of options for the consumer. Further, the convenience of buying has become easier with heavy discounts and festive offers on e-commerce platforms

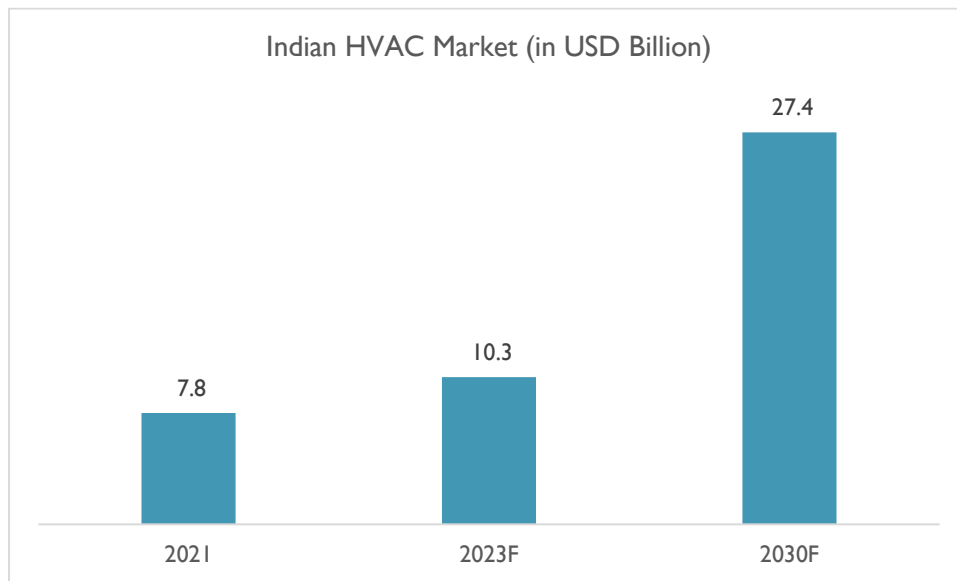
Demand from HVAC Segment

In HVAC segment, heat exchangers are used for heating, cooling, heat recovery, dehumidification, and moisture control. The focus on creating energy efficient buildings and systems has magnified the importance of heat exchangers in a HVAC system, as deploying of heat exchangers is one of the preferred techniques to reduce energy usage as well as cut back on greenhouse gas emissions. Thus, heat exchanger finds application across HVAC industry, from residential HVAC systems to large scale industrial HVAC systems.

Indian HVAC Market

Indian HVAC market generated an annual turnover of approximately USD 7.8 billion in 2021, and it is expected to grow by a CAGR of 15% till 2030 to reach USD 27.4 billion. Traditionally, commercial, and industrial applications used to lead the HVAC industry in the country. However, beginning 2000 the usage of HVAC system in residential segment, and mobile / transport application has started becoming mainstream. Substantial increase in income levels and aspirational changes drove HVAC demand in residential / retail

consumer segment. Meanwhile in traditional industrial and commercial segments, the rapid expansion in office space as well as industrialization ensured the demand for HVAC remain strong.



Insights from Primary Research, F - Forecast

The HVAC market in India experienced a shift towards energy-efficient systems, driven by rising energy costs and environmental concerns. The government's initiatives to promote energy efficiency, such as the Energy Conservation Building Code (ECBC) and the Standards and Labelling (S&L) program, played a crucial role in driving the adoption of energy-efficient HVAC systems.

Additionally, there is a growing awareness of indoor air quality and the need for improved ventilation and air purification, leading to increased demand for HVAC systems that can address these concerns. The industry is witnessing a shift towards technologically advanced HVAC solutions, including smart controls, remote monitoring, and energy management systems, providing enhanced comfort and energy efficiency.

The sectors that employ HVAC systems most in India include commercial buildings, hospitals, hospitality (hotels and restaurants), retail spaces, educational institutions, and industrial facilities. These sectors require efficient HVAC systems to maintain comfortable and healthy indoor environments for occupants.

The Indian government's focus on infrastructure development, smart cities, and sustainable building practices further boosts the demand for HVAC systems. Initiatives like Make in India, promoting domestic manufacturing, have also contributed to the growth of the HVAC industry by encouraging local production and reducing dependency on imports.

Emerging Trends in Indian HVAC Industry & Impact on Heat Exchangers

Sustainable development, and efforts to cut down carbon footprint are two of the key factors that are reshaping the overall industrial landscape in India. HVAC industry is also adopting technologies and processes to reduce its carbon footprint. Geothermal heat pumps, and smart thermostats are two of the technologies that is gaining traction as the HVAC industry makes the transition. The HVAC industry is expected to see

large scale investments to upgrade its technology. This investment in new technologies highlights the industry's commitment to improving energy efficiency and sustainability.

With rising energy costs and increasing environmental concerns, there is a growing demand for HVAC systems that consume less energy while providing optimal performance. The adoption of advanced technologies such as smart controls, IoT integration, energy management systems, and improved insulation materials will drive the industry further towards greater efficiency and reduced carbon footprint.

Demand for HVAC system from Building Segment

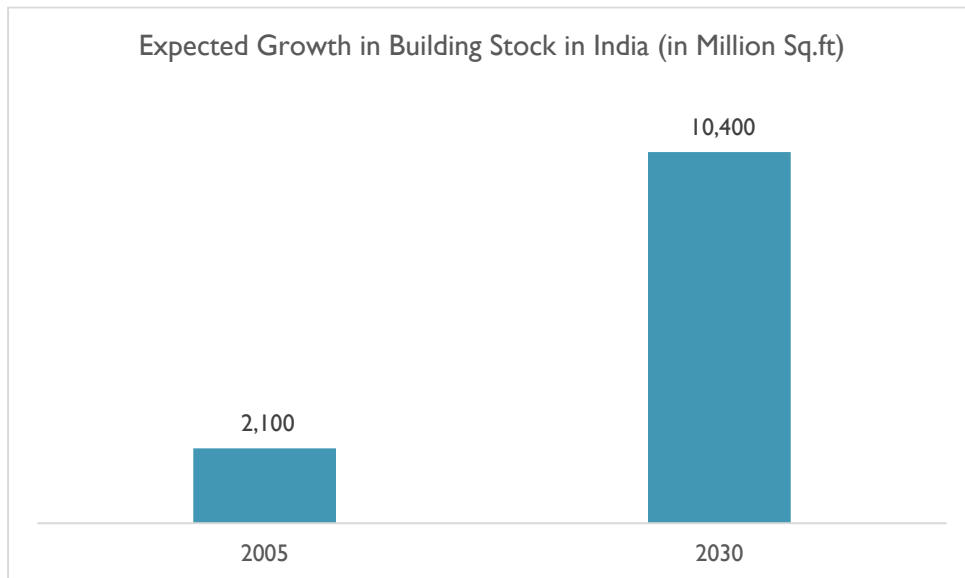
Building sector is the key demand driver for HVAC systems, with adoption level spread across residential, commercials, industrial and infrastructure sub sectors. Apart from ensuring comfortable conditions, HVAC usage is also gaining traction because of the need to improve energy efficiency. Thus, a growth in building stock - backed by regular addition of new building - plays a direct role in promoting the demand for HVAC system. At present buildings account for approximately 20% of energy usage in India, with the share as high as 31% in commercial buildings. With Indian Government promoting efficient energy usage, the need for installing HVAC system that optimise energy usage has become important now. Against this rising demand, the current penetration of HVAC system in Indian building sector is less than 5%.

Such a low penetration of HVAC system in Indian building segment, along with pressing need to optimize energy usage in building sector points towards an aggressive growth in HVAC adoption in the coming years. It is this scenario that has promoted many industry players and associations to paint an optimistic growth forecast - with several stakeholders predicting a compounded growth rate in the range of anywhere between 15 to 30% during this decade. This optimistic demand scenario bodes well for finned tube heat exchanger, which is the most prominent heat exchanger used by the HVAC industry.

Growth in Building Stock in India:

The total building stock in India (residential & commercial) which stood at nearly 2,100 million square meters in 2005 is expected to reach approximately 10,400 million square meters by 2030, increasing by a CAGR of 6.6%⁶. This growth in overall building stock is expected to translate into higher demand for HVAC. The demand will be driven not only by the growth in volume of building stock, but by the increasing need for developing energy efficient buildings. This growth in building stock would be driven by aggressive growth in office space (commercial segment), and residential segment.

⁶ Findings by PACE-D TA Program



Although both these segments would drive the growth in building stock, the commensurate demand for HVAC will be mostly come from commercial segment. This is because, energy usage for heating & cooling application accounts for nearly 30% of energy usage in commercial building while it is less than 10% in the case of residential building. As a result, the need for superior HVAC system to improve energy efficiency would be higher in commercial real estate sector.

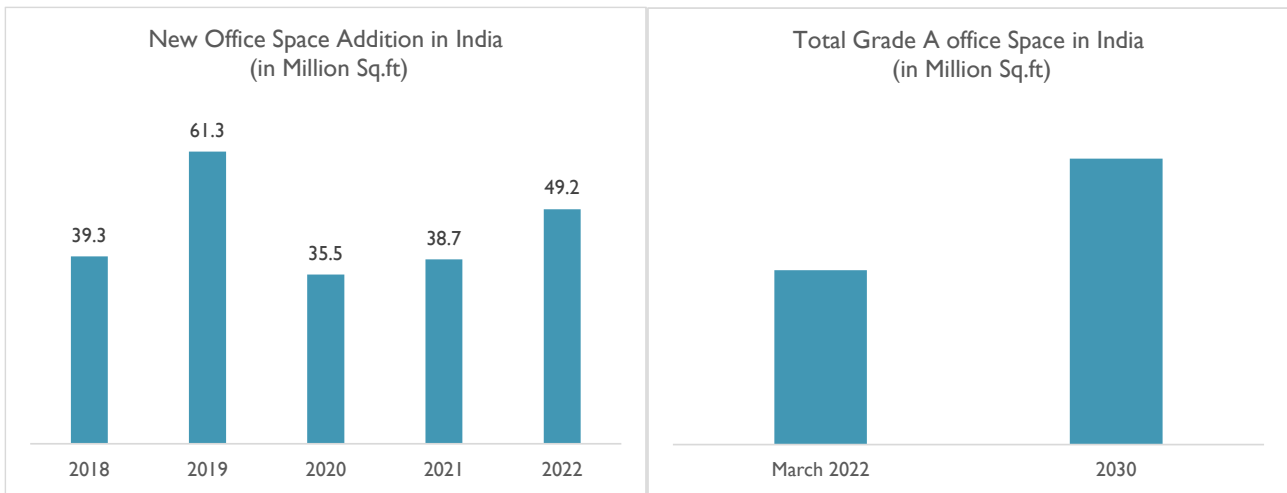
Indian Commercial Real Estate: Current Scenario & Growth Prospect

Indian commercial real estate space is dominated by office space, and absorption of office space sets the tone for demand in Indian commercial real estate market. HVAC system is an integral part of modern office space, and any expansion in office space (in terms of new addition) will create a direct demand for HVAC systems.

It is estimated that HVAC systems account for nearly 30% of energy consumed by a commercial building. Given the ongoing focus on optimizing energy usage & reducing carbon footprint, there is an increasing demand from the commercial real estate segment for superior HVAC systems.

Approximately 49.4 million of office space was added across top 8 cities in India in 2022 alone, increasing by nearly 27% over previous year. After a steep decline in new capacity addition in 2020 – owing to pandemic induced disruptions – the construction activity in commercial real estate segment almost normalized in 2022. As Corporate sector is slowly moving from work from home to hybrid to normal office based working style, the demand for office space is picking up. Apart from returning workforce, the growth in economic activity and positive growth forecast has surged the demand for innovative office spaces. According to JLL, Grade A office space⁷ in India is expected to reach 1.2 billion square feet by 2030, up from nearly 732 million square feet in 2022.

⁷ Most sought-after office space, mostly new or recently developed in key business locations.



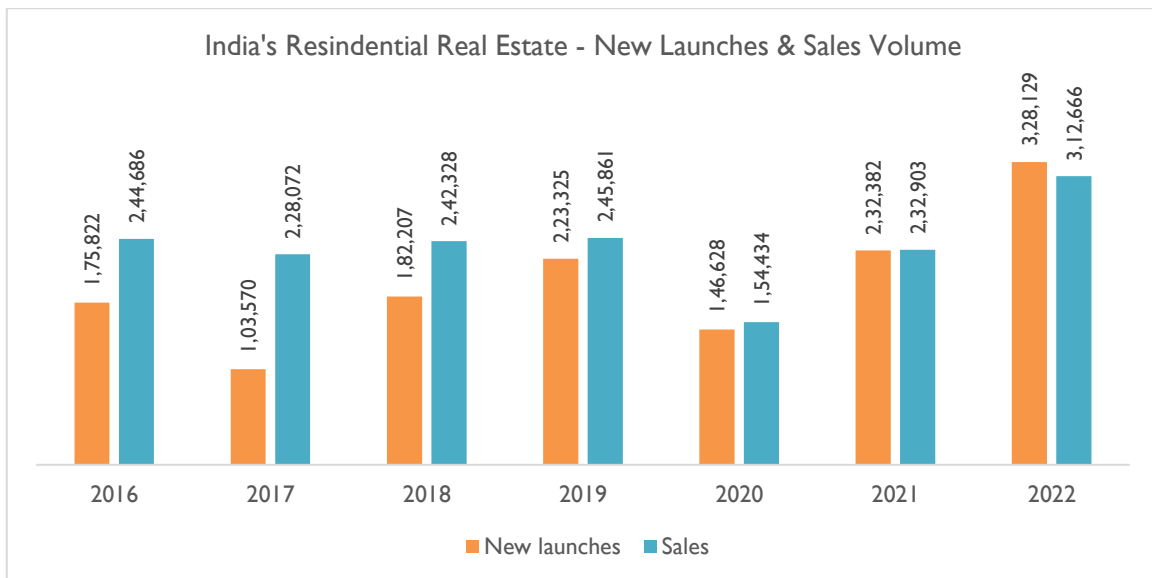
Industry Sources (Knight Frank, JLL)

Given the direct correlation of office space construction with HVAC system demand, the strong growth in construction in 2022 would have created a robust demand for HVAC system. This development bodes well for finned tube heat exchanger, which is the preferred heat exchanger used in HVAC system. Furthermore, the strong growth in Grade A office envisaged points to the stable long term demand growth for HVAC system (and by extension finned tube heat exchanger) from commercial real estate (office) segment.

Indian Residential Real Estate: Current Scenario & Growth Prospect

For India’s real estate sector, 2022 was the year of a new high. Both home sales and new launches improved significantly, and this strong momentum will most likely last through 2023, with sales doing even better than in 2022, which were higher than in 2014. The year 2022 (January-December) witnessed unprecedented growth in residential sales in India and recorded 3,28,129 launches of housing units and sales of 3,12,666 units. This shows a y-o-y increase of whopping 41% and 34% respectively. Of the total sales of residential units in 2022, 63% were dominated by three cities: Mumbai, NCR and Bengaluru.

During 2021, 232,382 new residential units were launched across the top 8 cities, highest since 2016, registering a robust growth of 58.5% y-o-y. During the year, number of residential units sold reached 232,903, up by 50.8% compared to previous year.



Source: Knight Frank Report on Indian Real Estate Sector (Statistics for Top 8 Cities in India)

Demand momentum remained strong across markets in y-o-y terms in CY 2022. During the period, new launches reached 328,129, increasing by 41% y-o-y. Similarly, number of residential units sold reached 312,666, up by 34% y-o-y. This upward trend can be attributed to the changing preferences of homebuyers, low interest rates, and comparatively low home prices along with the renewed need for home ownership sparked by the pandemic.

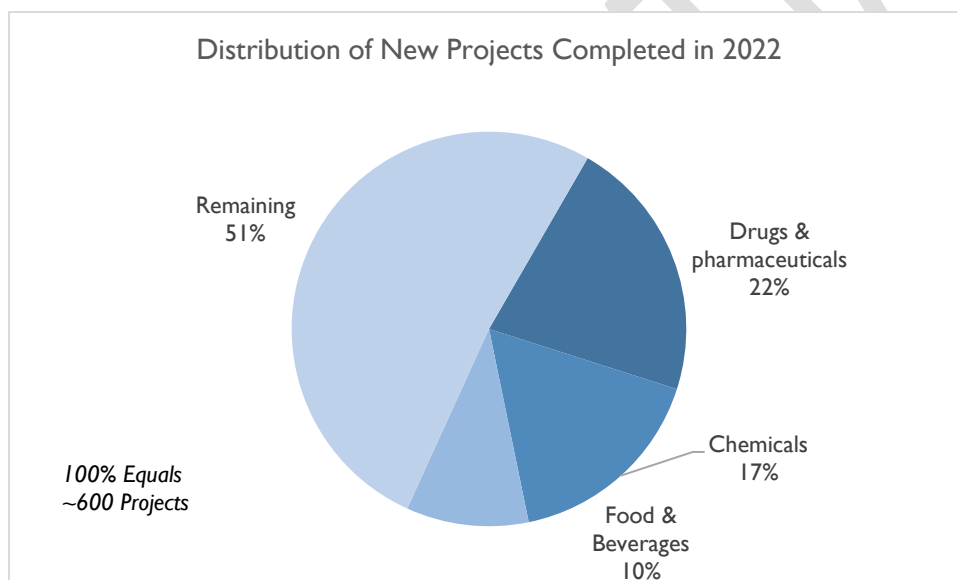
Development activity has risen in tandem with the improved demand, mostly unaffected by the increasing costs of input materials and labour across markets. The growth in sales volume during CY 2022 is more significant considering that it has occurred along with very encouraging price growth across all markets. Prices have increased year-on-year across all markets in the range of 4-7%. Increasing instances of developers offering greater value adds such as furnished apartments, better interiors were also observed during 2022.

For heat exchanger & HVAC segment, the demand from residential segment arises from the cooling / temperature control requirements. Most of the new apartments coming up in metros have extensive HVAC systems built in. Depending upon the building / apartment, HVAC system could be either centralized or decentralized. These HVAC systems are responsible for regulation of heat, airflow, air conditioning, and ventilation in apartments. Hence a growth in build up space in residential real estate segment would convert to market opportunities for HVAC system (and by extension finned tube heat exchanger).

Demand for HVAC system from Industrial & Segment

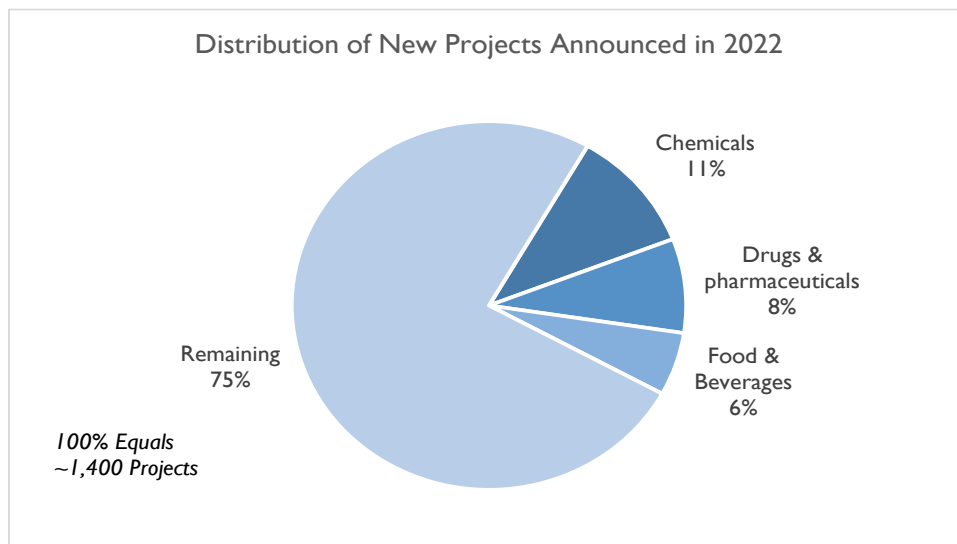
In a manufacturing plant, HVAC system is used for controlling humidity, temperature, and air quality – for improving the working condition of employees as well as maintaining the optimum ecosystem that supports the manufacturing process (especially in industries like pharmaceuticals etc). Industrial air conditioning is most crucial in sectors like pharmaceuticals, food & beverage, electronic manufacturing, and medical equipment manufacturing.

The capex growth in manufacturing – which indicates the new projects coming up in the space – is a key indicator of HVAC demand emerging from manufacturing sector. In 2022, nearly 600 projects were completed in manufacturing sector – ranging from setting up pharmaceutical plants to agriculture machinery manufacturing unit. Of these Pharmaceuticals and food & beverages – two of the sectors where HVAC deployment is crucial – accounted for nearly 32% (approximately 185 – 190) projects. Such a strong capacity addition in pharmaceutical and food & beverage space have benefitted the HVAC industry.



Center for Monitoring Indian Economy Database

Approximately 1,000 new projects have been announced in the manufacturing sector with nearly 140 projects coming up in pharmaceuticals and food & beverage space alone. All these projects were announced in 2022, and its execution is expected to happen in the coming years. These upcoming projects is an indication of new capacity (in the form of brownfield & greenfield facilities) coming up in manufacturing space. Since setting up of a new space is accompanied by the deployment of HVAC, the strong project pipeline indicates a stable growth demand forecast for HVAC system from industrial segment.



Center for Monitoring Indian Economy Database

Indian manufacturing landscape is witnessing a rapid transformation, especially on the infrastructure front. Through a series of policy measures – like Make in India, and Production Linked Incentive (PLI) scheme – Indian Government is attractive corporate sector to set up manufacturing facilities in India. The attractive regulatory policy measures are designed to attract both domestic and multinational industrialists. As these policy measures gains traction, there would be a commensurate increase in the number of new manufacturing plants coming up in the country, which bodes well for HVAC demand emerging from industrial segment.

Hence, apart from existing pipeline of new projects, supportive policy measures like Make in India, and PLI scheme is expected to enrich the new project pipeline. This would translate into a stable long-term demand for HVAC systems from industrial segment.

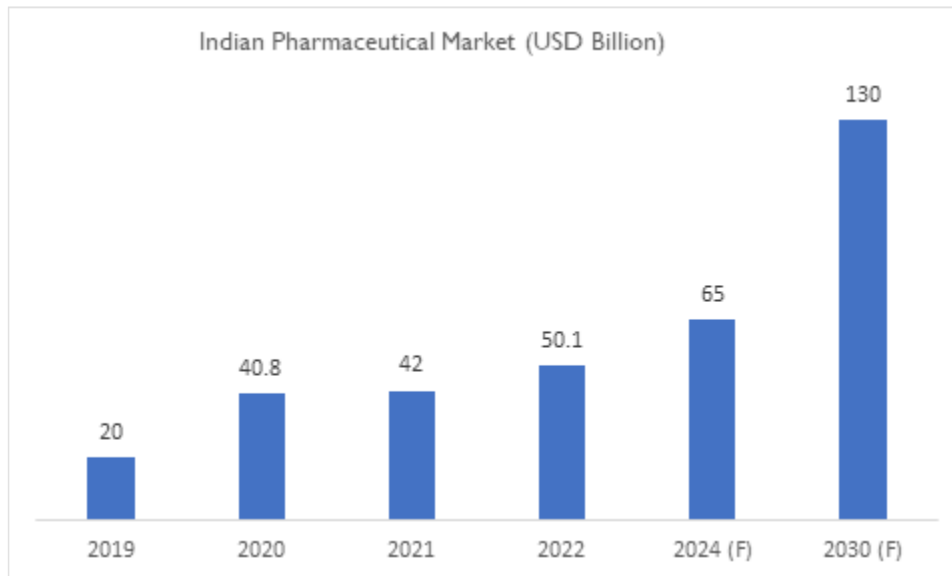
Demand from Pharmaceutical Sector

In FY 2022 the Indian pharmaceutical industry held a significant value of approximately USD 50 billion with exports contributing over USD 25 billion. This positioning India as the third largest producer of pharmaceuticals in terms of production volume and securing the fourteenth spot in terms of production value.

Moreover, India is actively working towards establishing a comprehensive policy framework that encompasses various aspects, including intellectual property rights, technology commercialization, government procurement, and scientific research. For instance, in response to the COVID 19 pandemic, the Department of Biotechnology and the Biotechnology Industry Research Assistance Council (BIRAC) collaborated to establish the 'DBT BIRAC COVID 19 Research Consortium. This initiative supports indigenous research solutions for combating COVID 19. Additionally, the 'Mission COVID Suraksha - The Indian COVID 19 Vaccine Development Mission' was introduced as part of the Atmanirbhar Bharat 3.0 stimulus package Its objective is to promote Indian vaccine research and development, enhancing the nation's capacity to address pandemic challenges and achieve self-sufficiency. This effort includes increasing the production of essential

drugs like Remdesivir, vitamins, minerals, and other supplemental products, as well as manufacturing made in India vaccines to fight COVID 19.

By FY 2030 the annual turnover in Indian pharmaceutical industry is expected to reach USD 130 billion. The growth in pharmaceutical industry would be driven by an increase in production of bulk drugs, key starting materials, and formulations. The expansion in production capacity, together with upgradation of manufacturing capability would create strong demand for capital goods, including heat exchangers.



Industry Sources

Demand from Food & Beverage Segment

Food & beverage (F&B) industry in India contributes to nearly 3% of nation’s GDP and is an integral part of Indian economy. F&B sector underwent a transition, with demand shifting to packaged & processed food. This shift in demand created the necessity to set up state of the art F&B manufacturing plants. Over the past decade, India has witnessed a rapid growth in the number of products units dedicated for manufacturing a whole variety of food products. These new plants range from large units to small units in MSME sector. Apart from domestic demand, the growth in export of processed foods has also helped in this growth of manufacturing infrastructure.

This growth in F&B manufacturing infrastructure in India has helped in stimulating demand for HVAC system, which is integral to create a sanitized space for the production of food products. As the production of processed food & beverages increased, so did the demand for refrigeration & cold chain equipment. In addition, F&B manufacturing workspace also need to maintain superior air quality, which requires the necessity of air filtration, controlled ozone treatment, and other similar processes. Thus HVAC system plays a huge part in ensuring both air quality, and refrigeration conditions required to manufacturing F&B products.

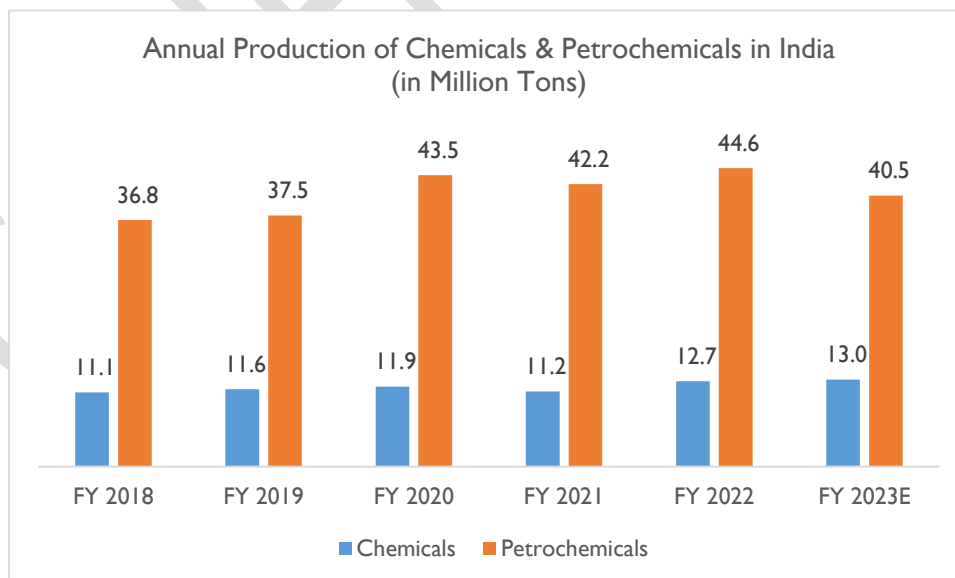
Demand from Chemical Manufacturing:

Heat exchangers are used in the chemical processing industry on account of their properties such as design flexibility and high corrosion resistance which provide them with the ability to handle a variety of fluids. Heat exchangers are necessary for nearly every process that involves solvent condensation, hydrocarbons cooling and reactor heating and cooling in the manufacturing of chemicals and petroleum. These products are now becoming highly efficient, and the need for sophisticated heat exchangers that can improve efficiency is gaining pace.

Indian chemical market holds a prominent position globally and is ranked sixth worldwide, in terms of the global sales of chemicals. India's chemical sales account for 2.5% of the global market with exports reaching over 175 countries. According to the Indian Chemical Council, India is expected to account for more than 20 percent of the incremental global consumption of chemicals over the next two decades. Moreover, with an increasing domestic output which is projected to rise from USD 232.8 billion in 2022 to USD 304 billion in 2025 and eventually reaching USD 1,000 billion by 2040.

The strong industry dynamics is playing out in petrochemical sector too. Rapid industrialization has created strong demand for almost all the petrochemical products. Polymers, which forms an integral part of the petrochemical industry, is witnessing a demand boom – on the back of higher demand for consumer and industrial end use applications.

In FY 2023, approximately 13 million tons of chemicals were manufactured in India while the volume of petrochemicals manufactured were nearly 40.5 million tons. During FY 2018 – 23 period, volume of chemicals and petrochemicals manufactured in India grew by a CAGR of nearly 3% and 2% respectively



Primary Research, D&B Estimates

Private and public players are investing heavily in the petrochemical sector. In 2021 Nayara Energy announced plans to establish 15-20 new petrochemical plants in India within a decade, aiming to meet the growing

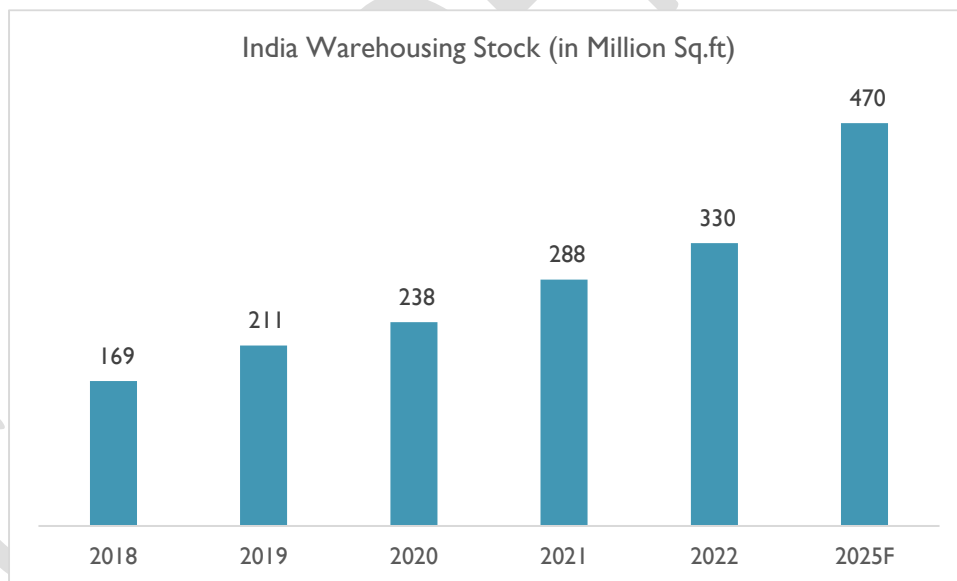
demand for raw materials in the plastics and textiles industries. Additionally, Bharat Petroleum Corporation (BPCL) expressed its intention to invest USD 4.05 billion in enhancing petrochemical capacity and refining efficiencies over the next five years.

Moreover, the government of India has set a vision for 2034 actively pursuing opportunities in the petrochemical sector. With the projected growth of the petrochemical market in India, there will be a significant increase in the demand for heat exchangers in the forthcoming years as heat exchangers play a crucial role in various stages of the petrochemical industry, including heat recovery systems and the production of final petrochemical products.

Demand from Warehousing: Cold Storage

In logistics sector, heat exchangers find application in HVAC system that are deployed in storage as well as transport infrastructure. The requirement is highest in cold chain industry (comprising of temperature-controlled storage as well as temperature-controlled truck/ transport vehicles).

The total warehousing stock in the country reached nearly 330 million sq. ft by the mid of 2022, increasing by a CAGR of nearly 18% between 2018 and 2022. The total stock is expected to reach 470 million sq.ft by 2025. According to this forecast, nearly 140 million sq.ft of warehousing space would be added to Indian warehousing market between 2022 and 2025.



Industry Sources (Knight Frank, JLL, Assoc hem)

There are nearly 8,300 cold storage facilities in India, with nearly 36% having storage capacity less than 1,000 tons. Meanwhile the demand for cold storage facilities is nearly ten times the existing infrastructure. The increasing focus on agro processing industry and growing demand for food products is creating this demand. According to the Ministry of Food Processing Industries, as on 31st Dec 2022, cold storage capacity of 8.38 lakh MT has been created under the Scheme for Integrated Cold Chain and Value Addition Infrastructure.

Apart from the deficit in capacity, the existing cold chain infrastructure in India is also skewed. Nearly 60% of capacity is concentrated in two states (Uttar Pradesh & West Bengal) while 75% of total capacity is dedicated to a single commodity (Potatoes)⁸. Thus, there is a strong requirement for expanding the capacity of the cold chain infrastructure as well as modernize it to make it suitable for storing the wide range of vegetables, horticulture, and meat products produced in the country.

According to the Ministry of Food Processing Industries, as on 31st Dec 2022, 376 integrated cold chain projects had been taken up for implementation; of which 269 projects have been completed and 107 are at various stages of implementation.

This strong policy led growth in cold chain infrastructure have benefitted the HVAC industry, which is critical in maintaining the controlled temperature. The large-scale addition going on in the industry is a pointer towards the continued demand generation for HVAC systems.

Demand from Data Centers

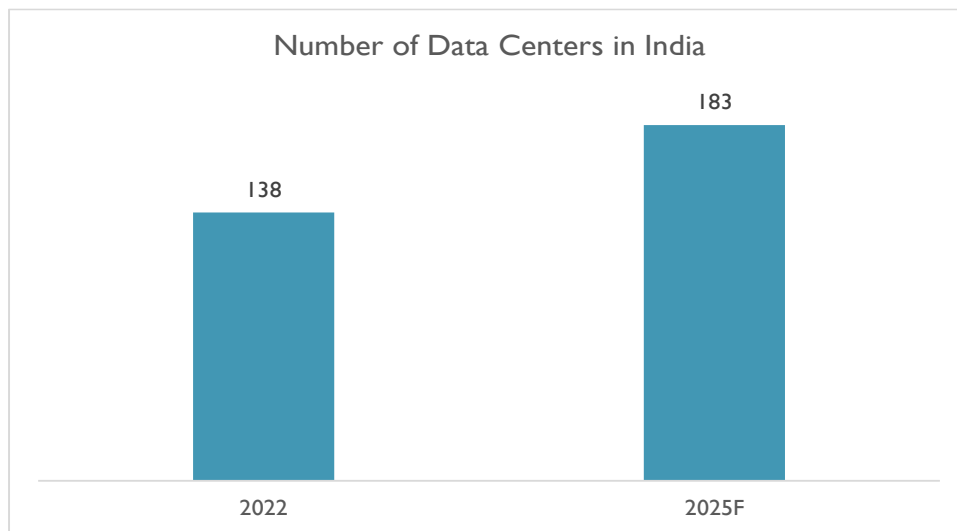
Data centers are critical components of the information technology industry as voluminous amount of data is stored and distributed at regular intervals. However, the energy consumption of these data centers has increased rapidly with the advancements of high density and high-power large servers. It is estimated that cooling systems account for nearly 40% of energy consumption in a data center.

Globally nearly 1.3% of electricity consumption is accounted by data centers, with bulk of it going towards maintaining ambient temperature & air quality inside the premises. Consequently, efficient thermal management as emerged as a key factor in managing the cost and operations of the data centres. Heat exchangers enable HVAC system is used in data centers to ensure ambient temperature in the premise, which is integral to the smooth functioning of a data center.

India is currently the 13th largest data center market in the world, with nearly 138 data centers in operation. Penetration of internet, growth in internet subscribers, and large scale digitization initiatives are all driving the demand for data centers. Between 2022 and 2025, 45 new data centers (totalling 13 million sq.ft) are expected to come up⁹, which will take the total number of data center in operation in the country to 183. Such a strong growth would transform into higher demand for HVAC systems & heat exchangers used in HVAC systems.

⁸ Report by Ministry of Food Processing Industries, Confederation of Indian Industry & Yes Bank

⁹ ANAROCK – Binswanger Research



Secondary Research, F – Forecast

The demand is primarily being driven by large players such as Amazon web services, Google, Microsoft, Facebook, IBM, Uber etc. that are outsourcing their storage needs to third party DC providers. Further, major Indian players such as Adani and Hiranandani are building data centre infrastructure with the help of technology partners through the co-location or colo model; in which the data centre players construct the various elements namely the building, power supply, cooling, physical racks, security and other support measures and the clients bring their own IT hardware and expertise. With high level of involvement from all major stakeholders i.e. government, Indian and global players, the future of data centre seems promising thus supporting the demand for heat exchangers in the coming years.

Demand from Transportation Segment

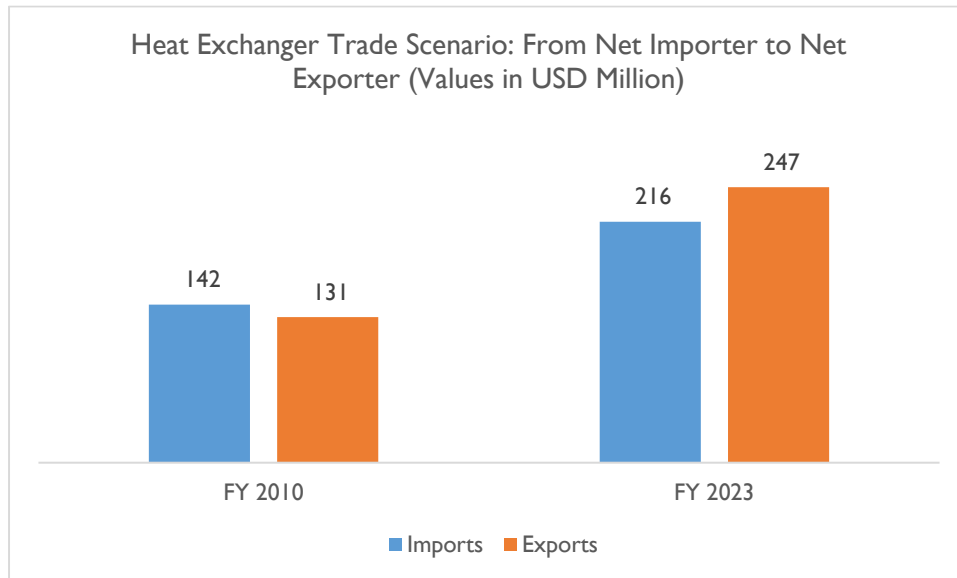
In metro trains, usage of heat exchangers can be found for removing large quantity of heat dissipated by the train equipment like traction motors, braking units, compressors, removing heat from air conditioning plant and sub-station and other equipment, if provided inside the underground station etc.

Driven by strong government support, metros have emerged as the country's fastest growing mass transit system with approved metro rail projects having a projected expenditure of nearly Rs 3 trillion till 2026. 13 Indian cities have functioning metro railway networks and 5 cities have upcoming metro rail services. The National Railway Plan 2030 envisages to increase the modal share of railways to 45% in freight traffic. Further, the introduction of 25 Vande Bharat Express trains which is India's indigenously manufactured semi-high-speed train, has given a boost to the Railways.

The government has set a target of 475 Vande Bharat trains to be introduced within the next four years. There are also plans to launch Vande Metro by 2023. All such positive development of the Railways auger well for the heat exchanger industry.

Trade Scenario¹⁰

India has been traditionally a net importer of capital goods. Although capital production capability in India has improved in the past few years, imports continue to play a key role in fulfilling the domestic demand. This was true in the case of heat exchangers too. Over the last decade, the domestic production capability (in terms of technical capability and production volume) in heat exchanger industry has improved significantly. As a result, India moved from a net importer to a net exporter of heat exchangers.



Source: Directorate General of Foreign Trade

Exports

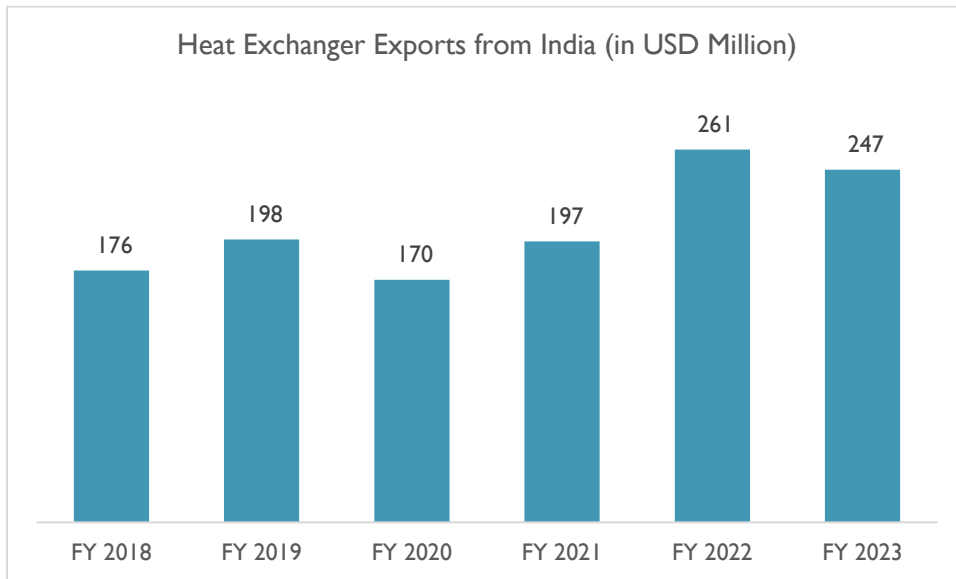
Annual export of heat exchangers from India reached USD 247 million in FY 2023. This includes shell & tube type, plate type as well as spiral type heat exchangers. Between FY 2018 and 2023, the value of heat exchangers exported from India increased by a CAGR of 7%. Compared to FY 2022, the value of heat exchangers exported from India dropped by nearly 6%. Muted demand growth in key export markets contributed to this decline in exports.

In FY 2023, nearly 51% of heat exchanger exports from India was concentrated in 5 markets, namely Thailand, USA, China, UAE, and Indonesia. Among these Thailand was the largest export market for Indian heat exchanger industry, accounting for nearly one fifth of total exports. Outside of these five markets, Indian heat exchanger industry has made rapid strides into African market, as well as middle east regions.

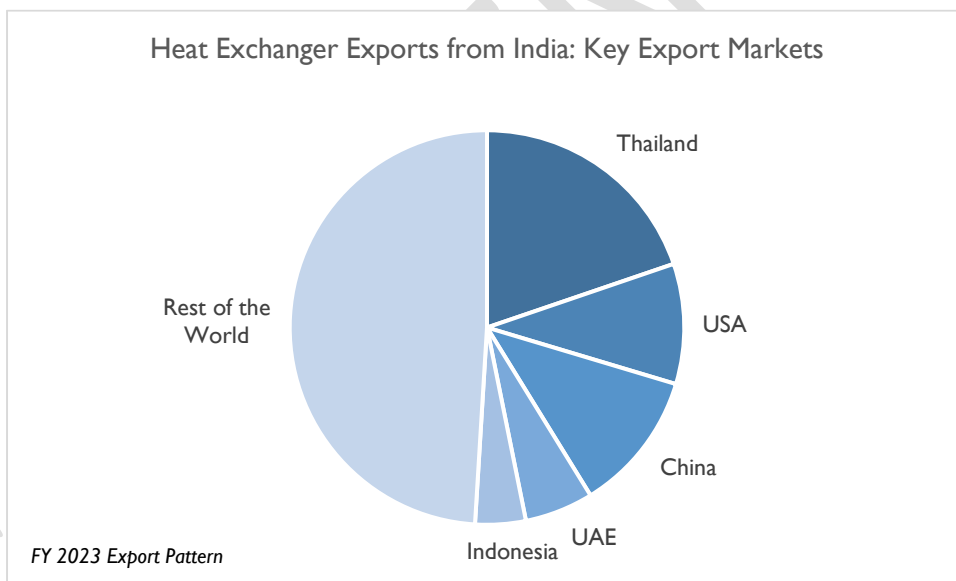
Although India is yet to become a key player in global heat exchanger market, the domestic industry has made rapid strides in global market – penetrating developed markets as well as developing markets alike. This highlights the unique capability of the industry to develop products that meet global quality standards at a

¹⁰ HS Codes 84195010, 84195020, 84195030, 84195090

competitive price. The lower cost of production, while adhering to global quality standards has helped several industries in India to penetrate global market, and heat exchangers to appears to be benefitted by this model.



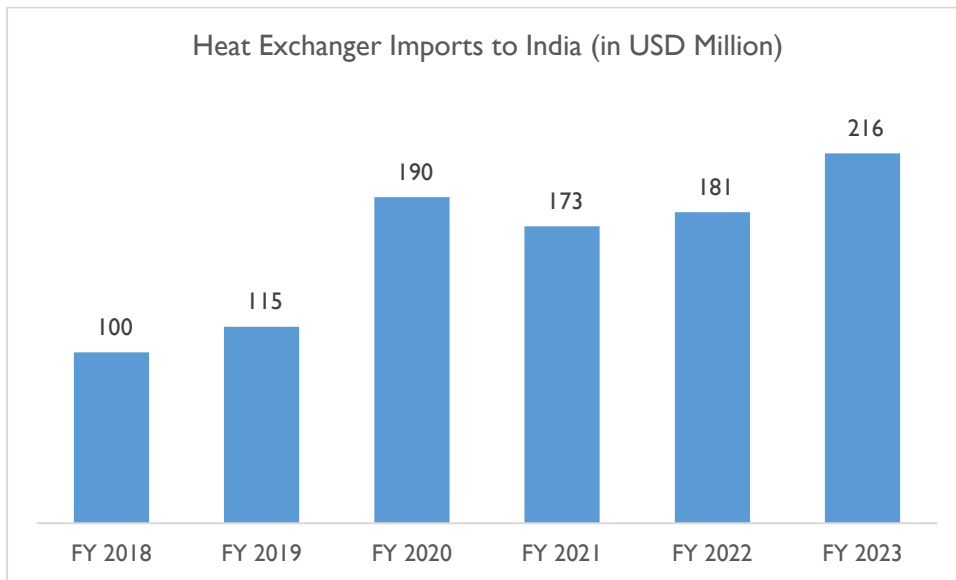
Source: Directorate General of Foreign Trade



Source: Directorate General of Foreign Trade

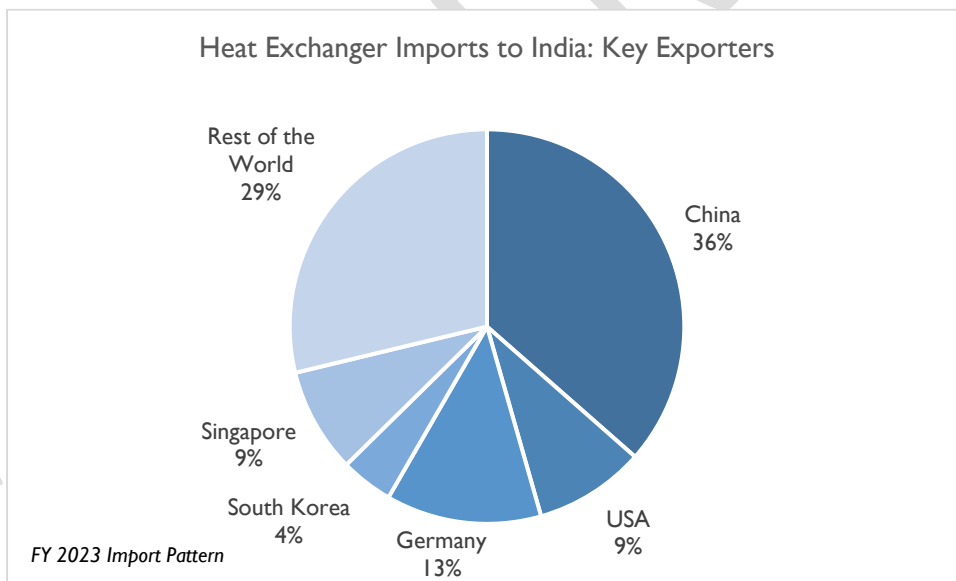
Imports

Approximately USD 216 million worth of heat exchangers were imported to India in FY 2023. While heat exchanger exports from India have witnessed a steady increase, the growth path has not been linear for imports. From approximately USD 142 million in FY 2010, the annual value of heat exchangers imported to India dropped to nearly USD 100 million in FY 2018 before recovering in subsequent years.



Source: Directorate General of Foreign Trade

Nearly 70% of value of heat exchangers imported to India in FY 2023 came from five markets – China, USA, Germany, South Korea, and Singapore. Among these China was the largest exporter, accounting for nearly 36% of total heat exchanger imports.



Source: Directorate General of Foreign Trade

Emerging Trends & Challenges in Indian Heat Exchanger Industry

Trends

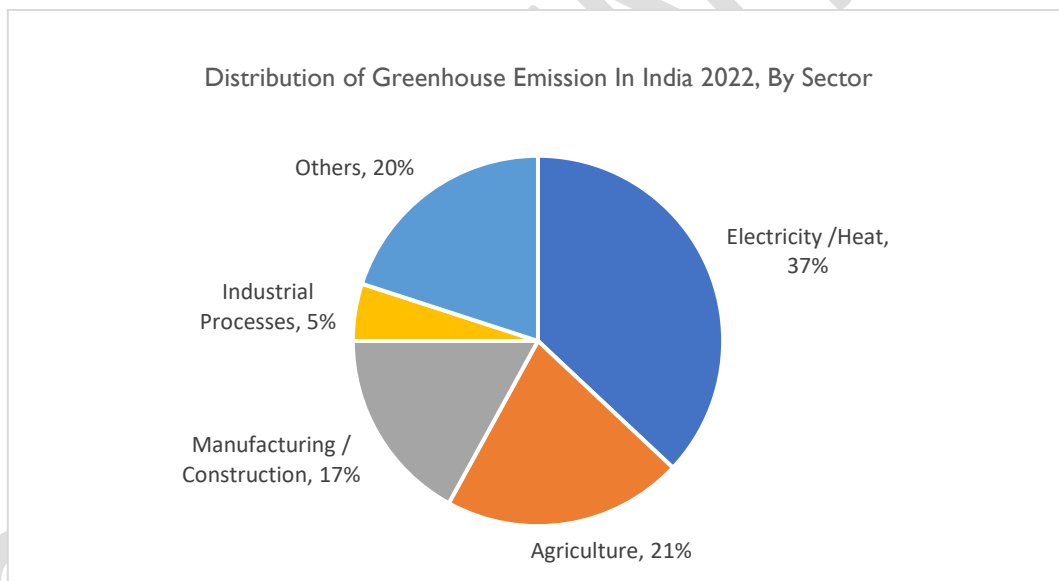
- **Hybrid heat exchangers:** There is also the growing trend of adopting hybrid heat exchangers which are more efficient and flexible than the traditional models. These are based on a multi-flexible configuration platform and designed to operate under extreme conditions where other heat exchanger technologies can fail or reduce operational efficiency. They are designed for easy cleaning as the fouling medium can flow through the tube side, which is accessible for mechanical cleaning. Heavy-duty or customized heat exchangers are generally utilized by large industrial consumers whereas portable heat exchangers generally cater to the residential or small commercial establishments.
- **Better energy efficient models:** With a growing emphasis on energy conservation and sustainability, heat exchangers have seen advancements in energy efficiency. This includes improved designs, better fluid dynamics, and the integration of advanced heat transfer technologies to minimize energy consumption and optimize heat recovery. Further, technological advancements such as tube inserts in heat exchangers and advances to improve energy efficiency, life cycle cost, durability, compactness and other features will complement the growth of the market.
- **Smart heat exchangers:** The integration of sensors, controls, and automation technologies has led to the development of smart heat exchangers. These systems can monitor performance, detect anomalies, and optimize heat transfer processes in real time, resulting in improved efficiency, reduced downtime, and predictive maintenance.
- **Modular heat exchanger:** Such designs have gained popularity due to their flexibility and ease of installation. Modular units can be combined and customized to suit specific heat transfer requirements, enabling scalability and easier maintenance.
- **Usage of new materials:** Advancements in materials science, including the use of new alloys and composites materials that offer greater corrosion resistance, higher strength, and better heat transfer properties.

Challenges

Fouling on heat exchangers reduces heat transfer efficiency, leading to higher energy consumption and greenhouse gas emissions, which could hamper the growth of the heat exchanger market in India in the upcoming years. Raw material price fluctuations could also affect the growth of the heat exchanger market due to economic conditions, exchange rates, and supply chains.

Environmental Impact of Fouling on Heat Exchangers

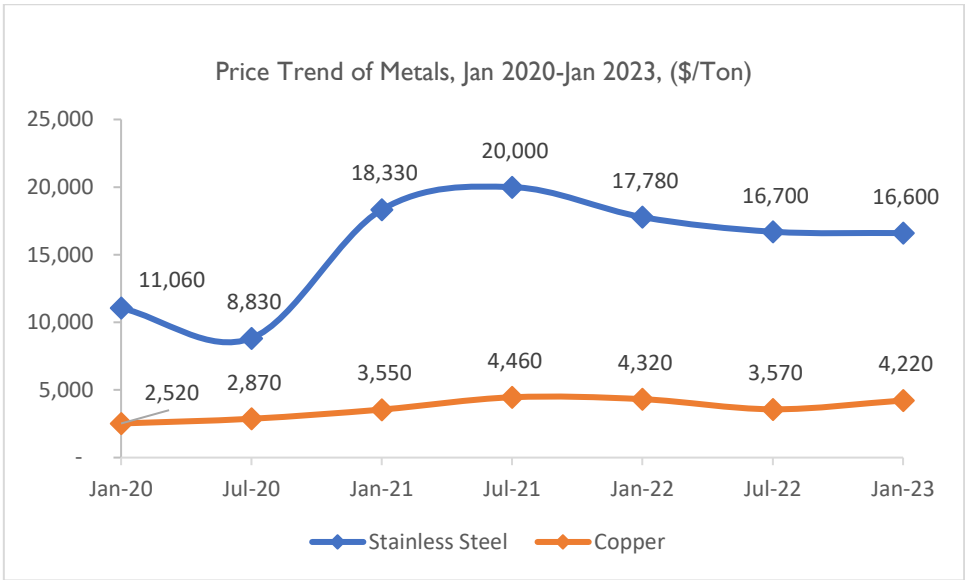
Fouling on heat exchanger could occur due to various factors, including the properties of the fluids being processed, the temperature and pressure conditions, the presence of impurities or contaminants in the fluid, and the design and operation of the heat exchanger itself resulting in decrease in efficiency of heat transfer which leads to increased energy requirements and this increased energy consumption contributes to higher greenhouse gas emissions, as the additional energy is often derived from fossil fuel based sources. Furthermore, fouling needs to be cleaned or maintained more frequently, which requires additional resources, such as water, energy, and cleaning equipment, which could have additional environmental implications.



Industry Sources, Primary Research

Fluctuation in Raw Material Prices

Heat exchanger manufacturers are susceptible to the ever-changing prices of raw materials, encompassing copper, aluminium, steel, and other metals. The prices of these raw materials are subject to volatility, influenced by a range of factors like economic conditions, exchange rates, and supply conditions. Such factors can potentially exert adverse effects on manufacturers. Additionally, these price fluctuations have the potential to trigger delays or cancellations of substantial capital projects, thereby hindering the growth of the heat exchanger market.



Industry Sources, Primary Research

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Regulatory Landscape

Capital Goods

The phasing out of concessional import duty on a wide range of capital goods and project imports in the Union Budget 2022-23 is a boost for the domestic capital goods industry by protecting it from low-cost imports and in turn help in creating a level playing field for domestic manufacturers. Additionally, import concessions for select raw materials will make it easier for the domestic manufacturers to access input materials in a cost-effective manner.

Continued investment on infrastructure development, anchored by PM Gati Shakti Master Plan would create strong demand for a wide range of capital and engineering goods from various sectors, especially from roads, railways, and waterways, where capacity expansion programs announced would trigger a demand for construction equipment and heavy machinery. The proposed battery swapping policy could create demand for specialized capital goods from electric mobility ecosystem, for which domestic manufacturing capability is nascent, and thus, such demand would be largely met through imports in near-term, supported by the continuation of exemption on import of specialized machinery. However, given the long-term demand generating potential of the industry, the domestic capital goods industry will have to invest in expanding its technical capabilities.

National Goods Policy 2016

National Capital Goods Policy, released in 2016, is considered to be the major policy measure that would shape capital goods sector in the coming years. This policy is in line with the Government's objective of increasing the contribution of capital goods to manufacturing output from the current 12% to 20% by 2025. Achieving this objective would result in the value of production of capital goods increased from the current level of INR 230 thousand crores to INR 750 thousand crores by 2025.

Atmanirbhar Bharat Abhiyan

According to the announcement by Prime Minister Narendra Modi, the Atmanirbhar Bharat economic package is worth INR 20 lakh crore, equivalent to nearly 10% of the country's GDP. The policy focuses on five key aspects: economy, infrastructure, system, vibrant demography, and demand. The core theme of the package is to be vocal about local products by promoting consumption of local products as well as making them global. The package has five phases, with each phase focusing on specific sector/ aspect. Phase I focuses on MSMEs, Phase II on migrants & poor, phase III on agriculture, phase IV on new growth horizons and phase V on government reforms & enablers.

The primary objective of this economic policy is to make India self-reliant. It could be termed as an extension of the Make in India program, which again was focusing on attaining self-sufficiency in the manufacturing sector

The phase IV of the economic package includes governance measures like fast tracking of investment clearances, ranking of states in terms of investment attractiveness, and ranking of industrial parks. These

measures are expected to showcase the investment potential to foreign investors and help facilitate investments in the country. The anticipated impact of the measures outlined in this phase is a pick-up in capital investment, which in turn would trigger economic growth. The easing of investment norms and clearances would help revive corporate investments, which in turn would be a key factor in driving up the demand for capital goods.

Key Regulations

The Indian Boiler Regulations (IBR): The Indian Boiler Regulations (Administered by the Central Boiler Board (CBB), IBR sets guidelines for the design, construction, operation, and maintenance of boilers and pressure vessels, which includes heat exchangers. Compliance with IBR is mandatory for heat exchangers operating above specified pressure and temperature limits.

Bureau of Indian Standards (BIS): BIS is the national standards body responsible for the formulation and implementation of various Indian standards. Relevant standards for heat exchangers in India include:

- IS 4503: Indian Standard for shell and tube heat exchangers
- IS 10787: Indian Standard for plate heat exchangers
- IS 6034: Indian Standard for air cooled heat exchangers

Energy Conservation Act (EC Act)

The EC Act and the associated Bureau of Energy Efficiency (BEE) regulate energy efficiency in India. Heat exchangers may need to comply with BEE's energy efficiency labelling requirements or specific energy saving guidelines to promote energy conservation.

EN 12255

EN12255 is the European standard that provides guidelines for the design, construction, and testing of shell and tube heat exchangers. It covers both the mechanical and thermal aspects of heat exchanger design, including materials, pressure, temperature, dimensions, and performance.

Tubular Exchanger Manufacturers Association (TEMA)

TEMA standards are recognized as the authoritative source for the design and manufacturing of shell and tube heat exchangers. The TEMA standards are classified into three categories -

- Class B: For Chemical Process Service
- Class C: For General Commercial Application
- Class R: For Severe Requirements of Petroleum Processing

ASME Section VIII

- The American Society of Mechanical Engineers (ASME) publishes the Boiler and Pressure Vessel Code, which includes ASME Section VIII. The specifications for pressure vessel design, fabrication, inspection, testing, and certification are set out in Section VIII. Under ASME Section VIII, Division

I the construction of heat exchangers falls under the general requirements for pressure vessels; this specifies design and construction details for heat exchangers, including tube sheets, tubes, headers, and other components, are covered within the appropriate sections and subsections of Division I.

- The design of tube sheets is typically addressed in UG 34 of ASME Section VIII, Division I which covers the requirements for tube sheets, flanges, and tube sheet joints.
- UHX-1 UW-2 provides guidelines for the design, construction, welding of heat exchangers

Pressure Equipment Directive (PED)

The Pressure Equipment Directive (PED) applies to various types of pressure equipment, including heat exchangers. Heat exchangers are considered pressure equipment under the PED if they operate with a maximum allowable pressure greater than 0.5 bar and meet the criteria defined by the directive

Heat Exchanger under PED should Consider -

- **Design and Manufacturing:** Heat exchangers must be designed and manufactured in accordance with the essential safety requirements (ESRs) outlined in the PED. These requirements cover aspects such as design calculations, material selection, fabrication methods, welding procedures, and non destructive testing.
- **Conformity Assessment:** Heat exchangers must undergo a conformity assessment procedure to demonstrate compliance with the PED. The assessment typically involves the involvement of a Notified Body, which is a third party organization designated by an EU Member State.
- **Documentation and Technical File CE Marking:** Manufacturers of heat exchangers must prepare a technical file that includes all relevant documentation related to the design, manufacture, and conformity assessment of the equipment. This file should be kept available for inspection by the authorities. Moreover, after heat exchanger successfully completes the conformity assessment and complies with the PED's requirements, it can be affixed with the CE marking.

AD-2000

AD-2000 is not a specific standard for heat exchangers but a German technical regulation that provides guidelines for the design and fabrication of pressure equipment, including heat exchangers. AD-2000 provides detailed requirements for materials, design calculations, manufacturing processes, testing, and certification of pressure equipment, including heat exchangers.

Central Pollution Control Board (CPCB)

CPCB is responsible for regulating environmental aspects related to industrial processes, including heat exchangers. Compliance with CPCB guidelines for emissions, effluents, and waste management is crucial to ensure environmental protection.

ISO 9001: 2015

ISO 9001 2015 is a globally acknowledged standard that defines the requirements for establishing, implementing, maintaining, and continuously improving a robust quality management system (QMS) within an organization.

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Competitive Landscape

Heat exchanger industry is capital and technology intensive, which creates a steep entry barrier. The industrial landscape in India (and across the globe) is changing at a fast pace as digital technology are integrating into mainstream manufacturing. This has created the need for superior capital goods & industrial machinery which can fit into this evolving landscape as well as delivery superior output. In the case of heat exchanges, the demand is for superior efficiency and heat capture. Hence, now more than ever, the manufacturers need to invest in R&D to improve their manufacturing capability. This exercise translates into higher capex, which deters new entrants.

Even among existing players, there is a high pressure to innovate and widen their product offering. As conventional manufacturing techniques make way to newer methods, consumers are increasingly demanding better products which can deliver tangible results. To stay relevant heat exchanger manufacturer will have to engage with their consumers, identify the emerging trend, and devise a future growth strategy. These developments are changing the nature of the industry, making it more dynamic. Under this changing scenario, existing players have to invest in capital, skill / talent, and innovation to stay relevant and maintain / increase market share.

Key Global Players

Company	Profile
Alfa Laval AB	Alfa Laval is a Sweden based capital goods manufacturer. The Company manufactures & sells boilers, decanters, water treatment systems, fluid handling systems, and heat exchangers. The Company focuses primarily on energy, environment, food and marine industry. Globally, the Company has nearly 37 manufacturing units.
Kelvion Holdings GmbH	Kelvion is one of the leading manufacturer of heat exchangers in the world. The Company manufactures compact fin heat exchangers, shell & tube heat exchangers, and plate heat exchangers. In addition, Kelvion also supplies transformer cooling system, and diesel & gas engine cooling.

Indian Landscape

Key Factors	Level	Description
Supplier's Power	Low	Supplier power is low in the Indian heat exchanger market as OEMs can easily source necessary raw materials from numerous local suppliers; thus, not creating a supplier monopoly in the market.
Entry Barriers	High	High entry barriers exist in the heat exchanger industry owing to the significant capital investment required for manufacturing facilities, machinery, and equipment procurement, along with the requirement of vast sales and service network to penetrate the market.
Buyer's Power	High	India has numerous companies that offer heat exchangers. Multiple suppliers provide similar products, thereby offering buyers a wide range of options at competitive prices. As a result, buyers have a high bargaining power in the market.
Substitutes	Moderate	The threat of substitutes in the market is moderate since cooling towers and heat pumps could be used as alternatives. However, these substitutes cannot completely replace the use of heat exchangers.
Competitive Rivalry	High	Competition is intense in the market due to the presence of numerous international players, along with well-established players such as Alfa Laval, Danfoss, Heatex Industries Limited, and HRS Process Systems Ltd among others.

Key Players in India

Company	Profile
Alfa Laval India Private Limited	Wholly owned subsidiary of Sweden based Alfa Laval AB. The Indian arm, established in 1937, manufactures and sells industrial boilers, heat exchangers, decanters, separators and other related industrial equipments. The Company has two manufacturing plants (in Pune & Satara).

	<p>In heat exchanger segment, their product offerings include: Shell & tube type, plate type, finned type, and tube in tube type.</p> <p>Alfa Laval India cater to HVAC, pharmaceuticals, power generation, food & beverages, marine & transportation, and steel sector.</p> <p>Annual installed manufacturing capacity of heat exchangers is estimated to be nearly 10,000 units per year.</p>
<p>REX Heat Exchanger Private Limited</p>	<p>The Company is based in Vadodara Gujarat and sells industrial products like pressure vessels, condensers, oil coolers, apart from heat exchangers.</p> <p>In heat exchangers, the Company manufactures air cooled, U tube bundled, double pipe, and shell & tube type heat exchangers.</p> <p>The key consumer segment catered to include power generation, oil & gas, and chemical manufacturing.</p>
<p>Danfoss Power Solutions India Private Limited (Danfoss India)</p>	<p>The Company is a wholly owned subsidiary of Denmark based Danfoss. In India the Company manufactures and sells power solutions, climate solutions for heating & cooling, and drivers. Heat exchangers are sold under the climate solutions for heating & cooling vertical.</p> <p>The Company manufactures Brazed, welded, gasketed, and micro channel heat exchangers. They cater to HVAC, food & beverage, and industrial refrigeration segment.</p> <p>Danfoss India has the capacity to manufacture nearly 2,500 heat exchangers per annum.</p>
<p>Kelvion India Private Limited (Kelvion India)</p>	<p>Kelvion India is the subsidiary of Germany based Kelvion Holdings GmbH. The Indian subsidiary, based in Mumbai, manufactures a wide range of heat exchangers – brazed, shell & tube, compact fin, single tube, and exhaust heat exchangers.</p> <p>In India Kelvion supplies heat exchangers primarily to oil & gas, petrochemicals, food & beverage, and HVAC industries.</p> <p>Annual production capacity of Kelvion – specific to heat exchangers – is approximately 2,500 units per annum</p>

Growth Forecast:

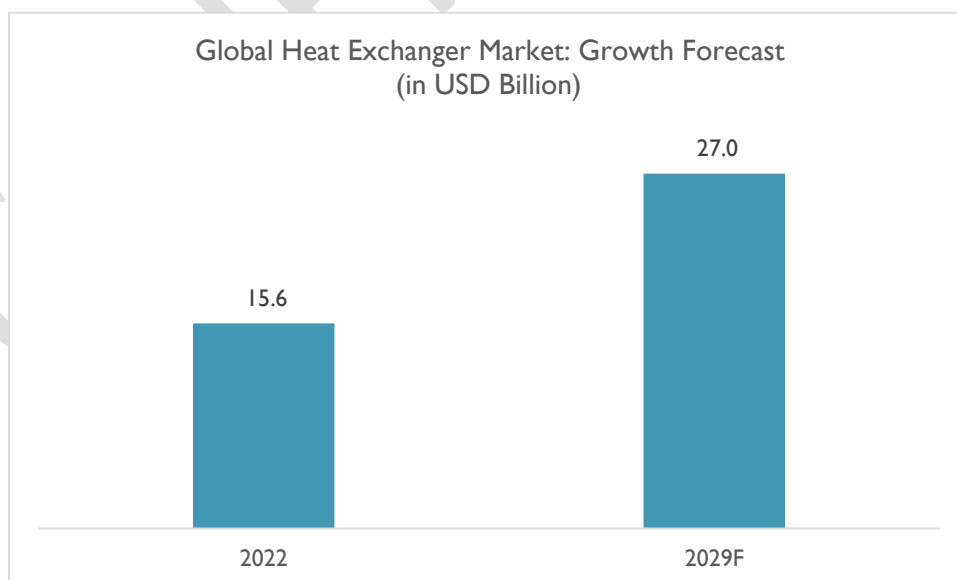
Heat exchanger is one of the widely used machinery within the broader capital goods industry, finding application across a broad range of process industries. Due to this ubiquitous nature of the product, its demand is closely linked to the industrial activity happening in an economy, as well as the capital investment landscape. Hence, capital expansion projects in the manufacturing sector as well as industrial activity tends to be a good barometer to identify the demand for heat exchangers.

Global Scenario

Consolidated capital expenditure spending of S&P 500 companies grew by nearly 20% in 2022, over the previous year. For the year 2023, the capex spending by this segment is expected to be nearly 6%, with the lower growth rate attributed to the evolving uncertainties and recessionary fears across key developed economies. Despite this, the long-term outlook with respect to capital spending appears to be optimistic. Factors like transition to clean energy, increase in automation in manufacturing, and integration of digital technologies to industrial sector are all expected to favour capital spending.

Capital investment pattern in the coming years, specifically in developed markets, would be characterized by upgradation in manufacturing infrastructure. Capital spending is expected to be strongest in Asia Pacific market, led by increased spending in China and India.

By 2029, the global heat exchanger market is expected to reach USD 27 billion, up from the current size of USD 15.6 billion. This translates into a CAGR of 8%, higher than the historical growth that was recorded during 2017 – 2019. Growth would be strongest in APAC market, which is expected to increase by a CAGR of nearly 8.9%.



D&B Analysis, Insights from Primary Survey

India Scenario

Indian economy recovered strongly from the impact of Covid-19 during the second half of FY 2022, and this recovery continued in FY 2023. The Country has once again become one of the fastest growing economies in the world. Although there are recessionary fears arising across major developed economies, the economic growth story in India is expected to continue.

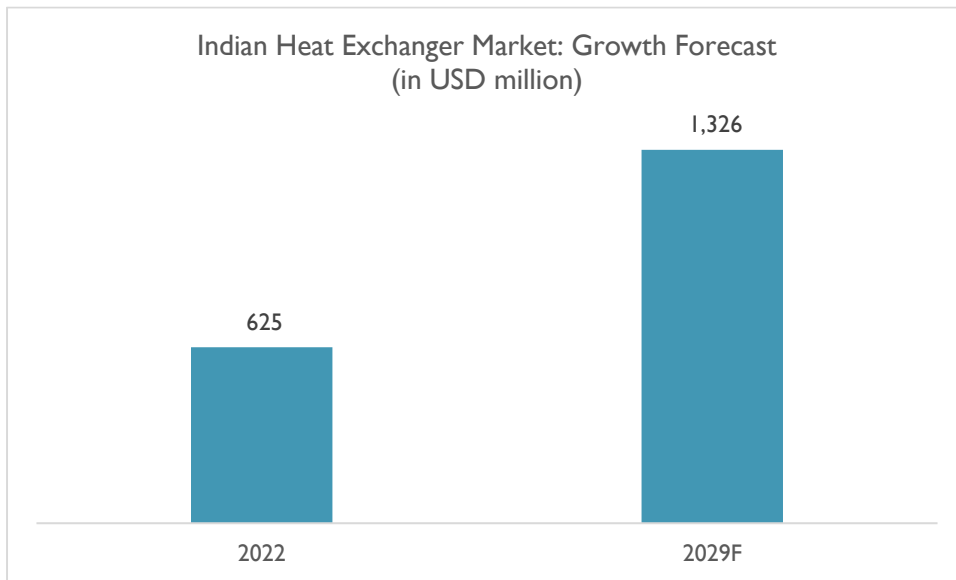
Economic growth in India in the coming years would be underpinned by following factors – Government focus on improving the manufacturing infrastructure, and improvement in credit availability for the corporate sector. In addition, the revival in demand – for consumer & industrial products – post Covid-19 pandemic would further accelerate economic growth. All these factors are expected to strengthen the industrial activity and encourage capital spending.

Government focus on improving manufacturing capability

Indian Government is taking steps to modernize and develop the domestic manufacturing capability, with the intention of increasing its contribution to GDP, from the current 15% to 25% by FY 2025. Flagship schemes like Make in India, Production Linked Incentive (PLI) scheme and Atmanirbhar Bharat was launched with the intention of meeting this goal.

The primary objective of these policies to import substitution (substituting imports with domestically manufactured goods), and later on become an export hub. This would involve substantial expansion in domestic manufacturing capabilities – across a wide range of industries. Schemes like Make in India and PLI is focused on multiple industries, hence the capacity expansion anticipated would be industry wide and not concentrated in select sectors.

These developments, together with improvement in capital investment scenario is expected to translate into modernization & expansion of domestic manufacturing capability. This expansionary phase would create demand for a wide range of capital goods, and heat exchangers – because of its ubiquitous application in process industries – is one of the major product segments to benefit. These developments would help the domestic heat exchanger market to increase from its current size of USD 625 million to USD 1,326 million by 2029. This would translate into a compounded growth rate of 11.3%.

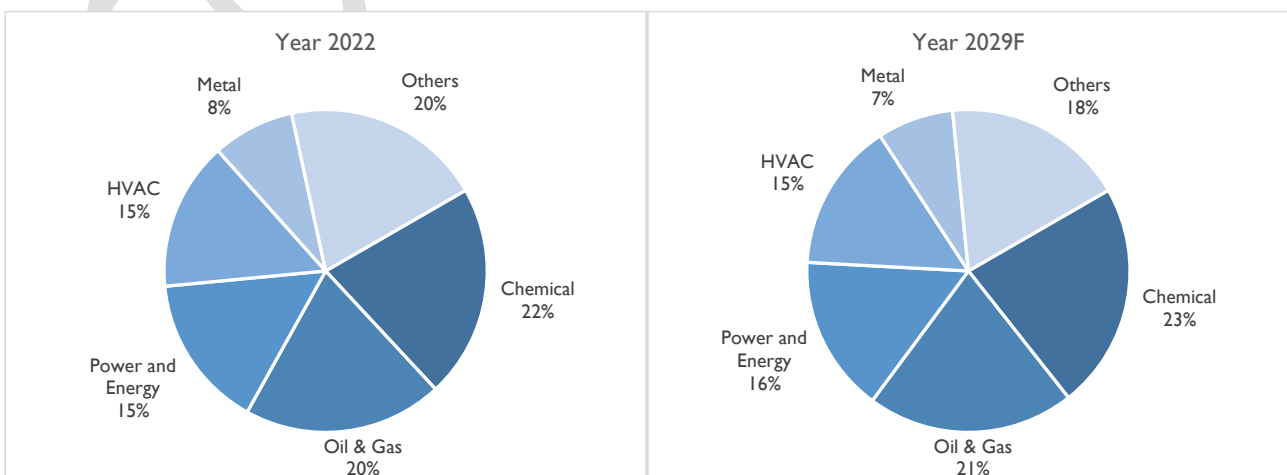


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By End Use Industry

Chemical manufacturing is the predominance consumer of heat exchanger in India, followed by oil & gas industry. Chemical industry is expected to remain the largest consumer of heat exchangers, as the ambitious capacity expansion programs planned in chemical industry would translate into higher demand for heat exchangers. India already posses a strong chemical manufacturing hub – from basic chemicals to petrochemicals to specialty chemicals. The Government is focusing on strengthening India’s position as a global chemical manufacturing hub and increase the country’s share in global chemical trade. Multiple policies targeted various segments of the chemical industry – pharmaceuticals / specialty chemicals – has been announced and the coming years would witness strong activity in terms of capacity expansion.

Backed by these factors, the value of heat exchangers consumed by Indian chemical industry is expected to reach nearly USD 300 million in 2029, translating into a CAGR of 12.3%.



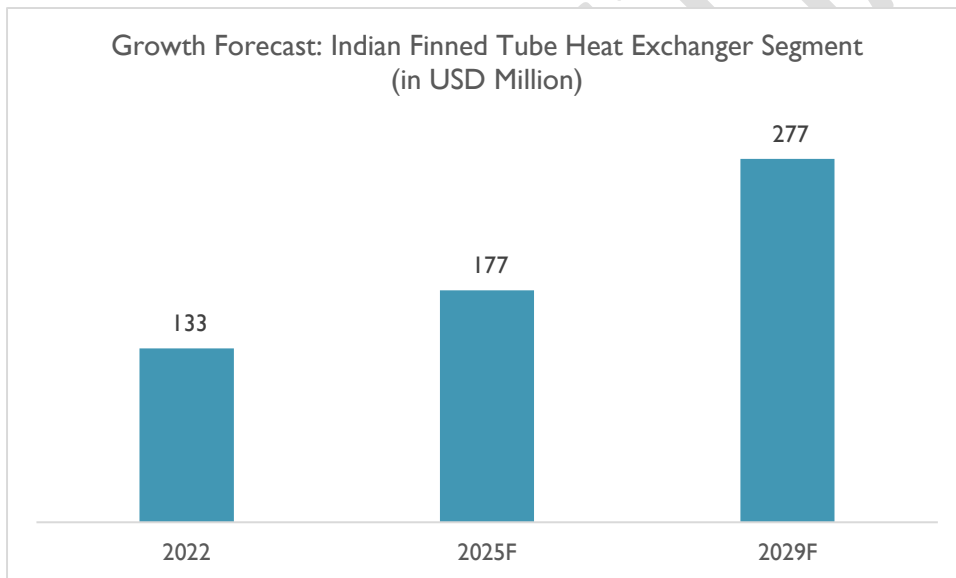
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Growth Forecast in Indian Finned Tube Heat Exchanger Market

HVAC applications is expected to play a key role in expanding the demand for finned tube heat exchangers in India. The emerging landscape in real estate construction, manufacturing, warehousing, and transportation all points to a continuation of HVAC demand. It is the strong demand from these sectors that is expected to drive the annual turnover in Indian HVAC market from USD 7.8 billion in 2021 to nearly USD 27.4 billion in 2030.

This demand growth would translate into an increase in the production of HVAC equipment, creating demand for all the components & accessories used. Since heat exchanger is an integral part of HVAC equipment, the growth in production of HVAC systems would be most favourable for heat exchanger industry.

On the back of this supportive demand landscape, the annual turnover in finned tube heat exchanger, the annual turnover is set to increase from USD 133 million in 2022 to nearly USD 277 million in 2029, nearly doubling in size.



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