FROST & SULLIVAN

INDUSTRY REPORT ON INDIAN STP, MSW MANAGEMENT, AND BIOGAS MARKET

SUBMITTED TO

SFC ENVIRONMENTAL TECHNOLOGIES LTD.

30th November 2024 Final Report

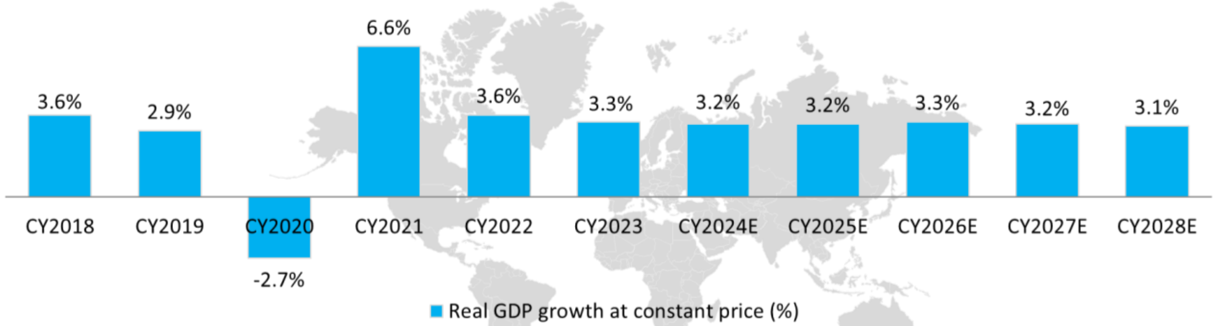
Table of Contents

1. MACROECONOMIC OVERVIEW OF GLOBAL ECONOMY

1.1 Real GDP review and outlook

The global economy, which is now on the path to recovery, has faced significant challenges in recent years due to extended trade conflicts, a slowdown in global investments, and the COVID-19 pandemic. Economic activity slowed from CY2018 and entered a recession in CY2020 due to the pandemic, which brought many economies to a near standstill through CY2020 and part of CY2021 as countries imposed strict restrictions. The global economy rebounded in CY2021, showing strong growth, but encountered new challenges in CY2022, including the Russia-Ukraine war, inflation, slowdowns in the US and Europe, and supply chain disruptions. By CY2023, global real GDP growth stabilised at 3.3%, and it is expected to maintain similar pace over the next three years before slowing to 3.1% in CY2028E. However, this outlook is subject to risks from higher interest rates implemented by central banks to control inflation and reduced government spending due to accumulated debt.

Exhibit 1.1: Real GDP Growth – Historic and Forecast, World, CY2018 – CY2028E



Source: IMF October 2024 forecast, Frost & Sullivan analysis

Exhibit 1.2: Real GDP Growth by Select Regions & Countries – Historic and Forecast, World, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
World	**3.6%**	**2.9%**	**-2.7%**	**6.6%**	**3.6%**	**3.3%**	**3.2%**	**3.2%**	**3.3%**	**3.2%**	**3.1%**
United States	3.0%	2.6%	-2.2%	6.1%	2.5%	2.9%	2.8%	2.2%	2.0%	2.1%	2.1%
China	6.7%	6.0%	2.2%	8.4%	3.0%	5.2%	4.8%	4.5%	4.1%	3.6%	3.4%
India	**6.5%**	**3.9%**	**-5.8%**	**9.7%**	**7.0%**	**8.2%**	**7.0%**	**6.5%**	**6.5%**	**6.5%**	**6.5%**
North America	2.8%	2.2%	-3.0%	6.0%	2.7%	2.8%	2.5%	2.1%	2.0%	2.1%	2.1%
Europe	2.3%	2.0%	-5.4%	6.4%	2.4%	1.2%	1.6%	1.6%	1.7%	1.6%	1.6%
Asia and Pacific	5.3%	4.2%	-0.8%	7.1%	4.1%	4.9%	4.5%	4.4%	4.3%	4.1%	4.0%
Middle East and Central Asia	2.7%	1.9%	-2.2%	4.4%	5.5%	2.1%	2.4%	3.9%	4.2%	3.9%	3.8%
Africa	3.4%	3.1%	-1.4%	4.7%	4.3%	3.3%	3.0%	4.2%	4.4%	4.3%	4.4%
Latin America and Caribbean	1.1%	0.2%	-6.9%	7.4%	4.2%	2.2%	2.1%	2.5%	2.7%	2.8%	2.7%

Source: IMF October 2024 forecast, Frost & Sullivan analysis

1.2 Inflation

Global inflation eased from 8.6% in CY2022 to 6.7% in CY2023 and is expected to decline further to 5.8% in CY2024, driven by tighter monetary policies and lower international commodity prices. However, core inflation is expected to decline more slowly, likely delaying a return to target levels until CY2025. With disinflation and steady growth, the risk of a significant economic slowdown has diminished, and global growth risks are balanced. Faster disinflation could ease financial conditions, while stronger structural reforms could boost productivity. However, potential risks include new commodity price spikes from geopolitical shocks, persistent inflation, property sector issues in China, and disruptive fiscal policies that could hinder growth.

Exhibit 1.3: Inflation Rate – Historic and Forecast, World, CY2018 – CY2028E

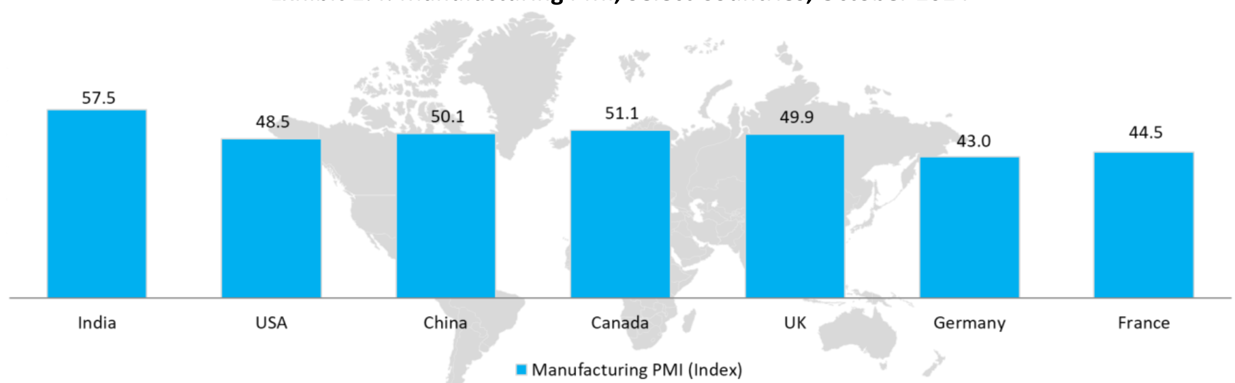
Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
World	**3.6%**	**3.5%**	**3.3%**	**4.7%**	**8.6%**	**6.7%**	**5.8%**	**4.3%**	**3.6%**	**3.4%**	**3.3%**
United States	2.4%	1.8%	1.2%	4.7%	8.0%	4.1%	3.0%	1.9%	2.1%	2.1%	2.1%
China	2.1%	2.9%	2.5%	0.9%	2.0%	0.2%	0.4%	1.7%	2.0%	2.0%	2.0%
India	**3.4%**	**4.8%**	**6.2%**	**5.5%**	**6.7%**	**5.4%**	**4.4%**	**4.1%**	**4.1%**	**4.0%**	**4.0%**
North America	2.7%	2.0%	1.4%	4.7%	7.9%	4.2%	3.1%	2.0%	2.1%	2.2%	2.2%
Europe	2.2%	2.0%	1.2%	3.6%	10.0%	6.3%	3.5%	3.0%	2.5%	2.4%	2.4%
Asia and Pacific	3.1%	3.4%	3.2%	3.0%	6.3%	4.9%	4.4%	3.8%	3.4%	3.2%	3.2%
Middle East & Central Asia	9.6%	7.4%	10.3%	11.9%	13.4%	15.6%	14.6%	10.7%	8.5%	7.3%	6.6%
Africa	11.4%	9.4%	11.1%	12.3%	14.2%	18.2%	20.3%	13.9%	9.2%	8.0%	6.9%
Latin America and Caribbean	6.7%	7.6%	6.5%	9.9%	14.2%	14.8%	16.8%	8.5%	5.7%	4.4%	3.7%

Source: IMF October 2024 forecast, Frost & Sullivan analysis

1.3 Manufacturing Purchasing Managers Index (PMI)

India led with its PMI of 57.5, while the U.S. PMI fell from 51.9 to 48.5. However, Europe struggled with supply chain issues due to the Red Sea conflict. Despite challenges like rapid monetary tightening, banking stress, and ongoing conflicts, the global economy demonstrated resilience in CY2024, bolstered by strong labor markets, healthier balance sheets, and declining inflation. These positive trends are expected to support a 3.1% CAGR in global economic growth over the next five years.

Exhibit 1.4: Manufacturing PMI, Select Countries, October 2024



Source: Trading Economics October 2024, Frost & Sullivan analysis

1.4 Growth drivers impacting the growth of the global economy

Circular Economy: Shifting from the "take-make-dispose" model, the circular economy extends product lifespans, reuses materials, and closes resource loops, driving innovation and reducing reliance on virgin resources.

Democratization of Financial Services: Fintech is transforming access to financial services, promoting inclusion through mobile money and online lending platforms, which empower startups and small businesses.

Silver Economy Boom: The aging global population is fueling demand for products and services tailored to older adults, offering significant growth opportunities in healthcare, senior living, and leisure.

Bio Revolution: Advances in biotechnology are spurring innovation in precision medicine, biofuels, and biomaterials, with significant economic potential dependent on R&D and ethical considerations.

2. MACROECONOMIC OVERVIEW OF INDIAN ECONOMY

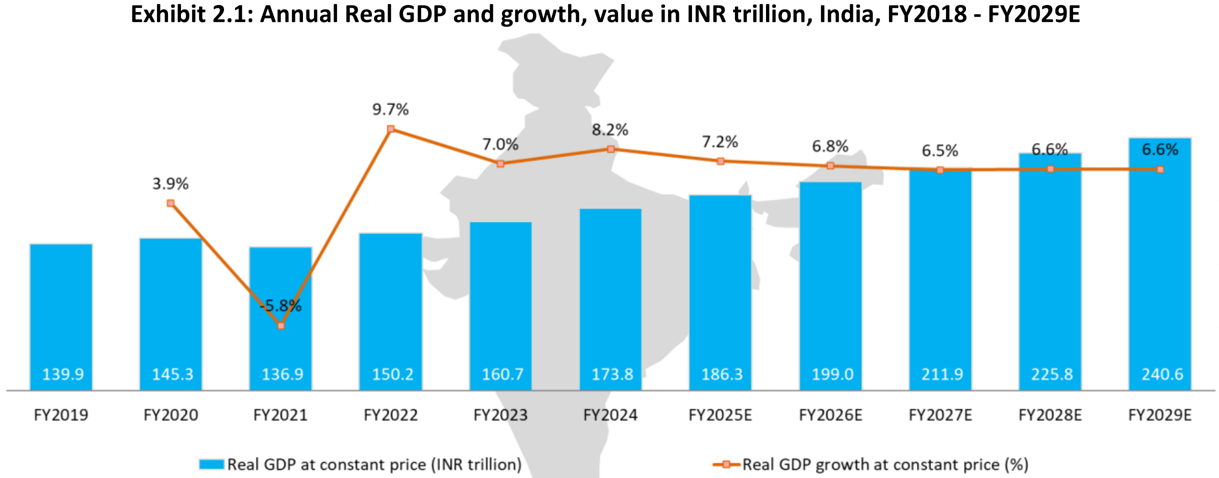
2.1 Indian Macro-economic overview

The Indian economy has demonstrated strong performance, achieving 7.0% growth in FY2023, outperforming many major economies. The government is driving structural reforms to position India as a global manufacturing hub, with a proposed capex outlay of INR 11.11 trillion for FY2025, a 17% year-on-year increase. Key development priorities, termed "Saptarishi," focus on inclusive growth, infrastructure, economic potential, sustainable development, youth empowerment, and financial sector strength. Initially aiming to become a USD 5 trillion economy by FY2025, India's timeline was extended due to COVID-19. The Nominal GDP is expected to surpass USD 4 trillion by FY2025 and reach USD 5 trillion by 2027-2028, making India the third-largest economy globally.

2.2 Review and outlook of Real GDP growth in India

The Indian government launched a comprehensive strategy to revive the economy post-COVID-19, combining immediate relief with long-term growth initiatives. Stimulus packages provided crucial financial support to vulnerable groups and businesses. Infrastructure projects like the PM Gati Shakti National Master Plan aimed to create jobs and enhance logistics. Reforms in agriculture, labor, and other sectors were introduced to boost efficiency and unlock economic potential. The government's focus on green growth and youth empowerment reflects its commitment to a sustainable, future-proof economy. These efforts, alongside stable domestic demand and private investments are expected to drive a 7.0% CAGR between FY2025E and FY2028E.

Exhibit 2.1: Annual Real GDP and growth, value in INR trillion, India, FY2018 - FY2029E

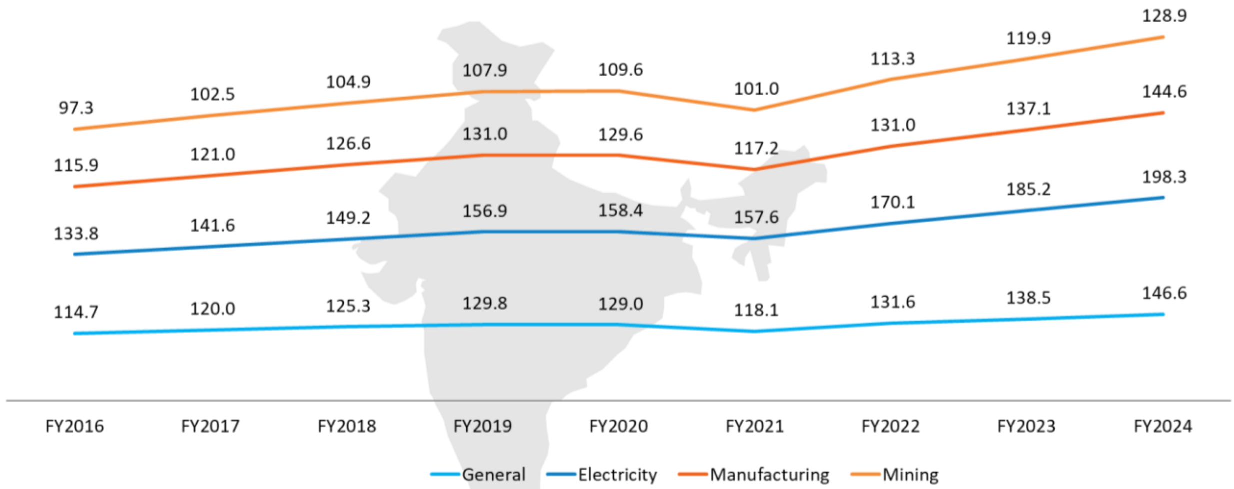


Source: MoSPI (Annual Estimates of GDP at constant price, 2011-12 series), IMF, ADB, S&P, Frost & Sullivan Analysis

2.3 Index of Industrial Production (IIP)

Post-pandemic, since June 2021, industrial activity in the country started picking up and continued its momentum through FY2022 – FY2024 with industrial output recording a sharp growth across all the four constituent sectors in the last three consecutive years. FY2024 IIP provisional data indicates 5.8% cumulative growth in FY2024 and 5.5% growth for the manufacturing sector. The other three segments i.e., Mining, Electricity, and General have grown by 7.5%, 7.1%, and 5.8% respectively in FY2024.

Exhibit 2.3: India - Index of Industrial Production (IIP) by sectors, FY2016 - FY2024

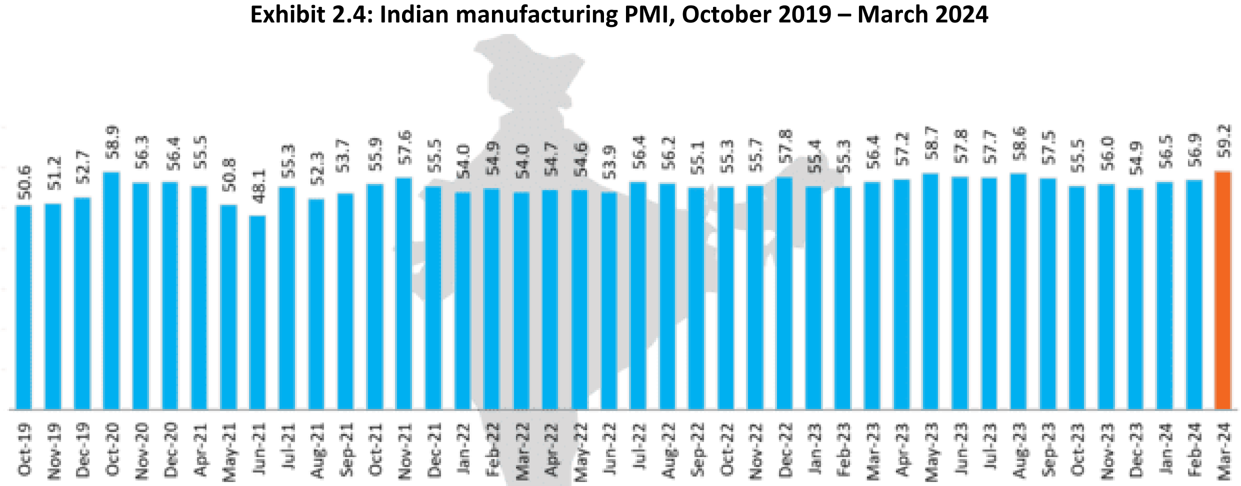


Source: MoSPI (Annual Estimates of GDP at constant price, 2011-12 series); RBI (Reserve Bank of India); Frost & Sullivan Analysis

2.4 India manufacturing PMI (Purchase Managers Index)

The S&P Global India Manufacturing Purchasing Managers' Index (PMI) assesses the manufacturing sector's performance, based on a survey of 500 companies. It uses five weighted indexes: New Orders (30%), Output (25%), Employment (20%), Suppliers' Delivery Times (15%), and Stock of Items Purchased (10%), with Delivery Times inverted for comparability. A PMI reading above 50 signals expansion, below 50 indicates contraction, and 50 shows no change.

Exhibit 2.4: Indian manufacturing PMI, October 2019 – March 2024



Depicts an all-time high

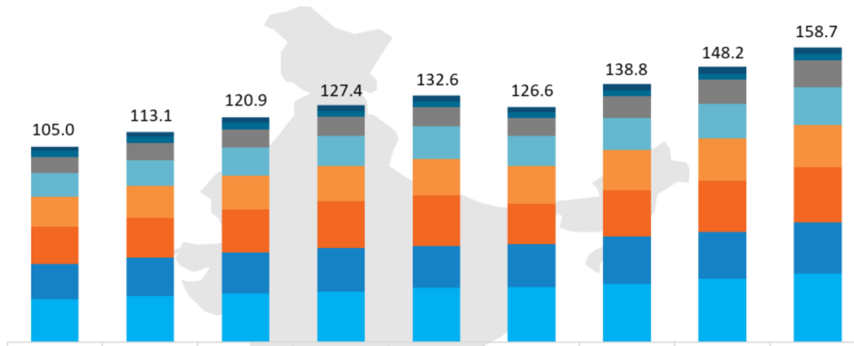
Source: S&P, Frost & Sullivan Analysis

After a volatile period, due to COVID-19, the PMI began to recover in April 2021 (55.5), though it briefly dropped to 50.8 in May 2021. The PMI reached a peak of 58.7 in May 2023, reflecting strong demand, with output and new orders surging. However, it fell to an 18-month low of 54.9 in December 2023 due to weaker demand and lower output, before rebounding to 59.2 in March 2024.

2.5 Sectoral share of Gross Value Added (GVA)

The Gross Value Added of India has grown steadily since suffering a decline of 4.5% in FY2021. The country's GVA has grown by 9.0% and 7.0% respectively in FY2022 and FY2023 and as per the second advance estimate, it is poised to grow at 7.3% in FY2024. Among the sectors, Construction GVA has achieved the highest growth of 8.8% CAGR since FY2020 (Pre covid level) while Financial, real estate and professional Services GVA have grown at approximately 6.0% CAGR during this period

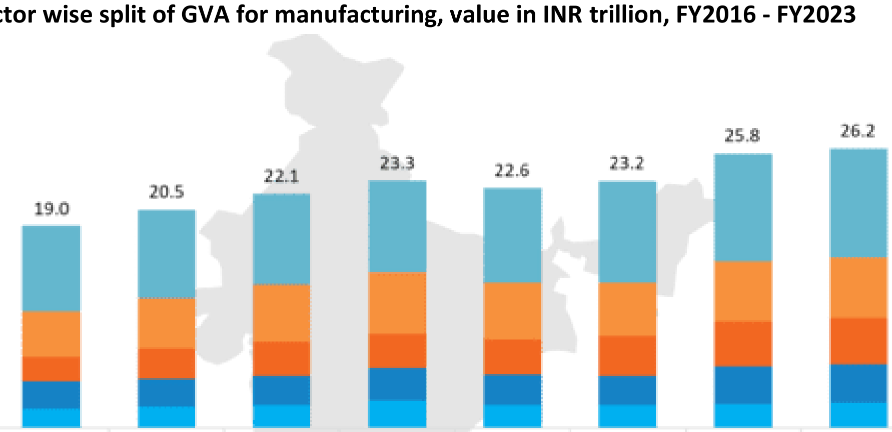
Exhibit 2.5: India - Gross value added (GVA) at basic price by economic activity, INR trillion, FY2016 - FY2024*



	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024*
Electricity, Gas, Water supply & Other utility	2.2	2.5	2.7	2.9	3.0	2.9	3.2	3.5	3.7
Mining & Quarying	3.3	3.5	3.7	3.3	3.2	2.9	3.1	3.2	3.4
Construction	8.7	9.2	9.6	10.3	10.4	9.6	11.9	13.0	14.4
Public administration, Defence & Other services	12.8	13.9	15.3	16.2	17.6	16.3	17.2	18.8	20.2
Agriculture, Forestry & Fishing	16.2	17.2	18.3	18.9	19.7	20.5	21.7	22.7	23.0
Trade, Hotels, Transport & Communication services	19.9	21.5	23.1	25.4	27.0	21.5	24.8	27.8	29.6
Manufacturing	19.0	20.5	22.1	23.3	22.6	23.2	25.7	25.0	27.5
Financial, Real estate & Professional services	23.0	24.9	26.1	27.2	29.2	29.6	31.2	34.1	36.9

** Second Advance Estimates* *Source: National Statistical Office; Frost & Sullivan Analysis*

Exhibit 2.6: India - Sector wise split of GVA for manufacturing, value in INR trillion, FY2016 - FY2023



	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
Other manufacturing goods	8.1	8.3	8.6	8.6	8.9	9.5	10.1	10.2
Machinery and Equipments	4.3	4.7	5.3	5.8	5.4	5.1	5.7	5.7
Metal Products	2.3	2.9	3.2	3.3	3.3	3.8	4.2	4.4
Textiles, apparel and leather products	2.6	2.6	2.8	3.0	2.9	2.7	3.5	3.6
Food products, beverages and tobacco	1.8	2.0	2.1	2.6	2.2	2.2	2.3	2.4

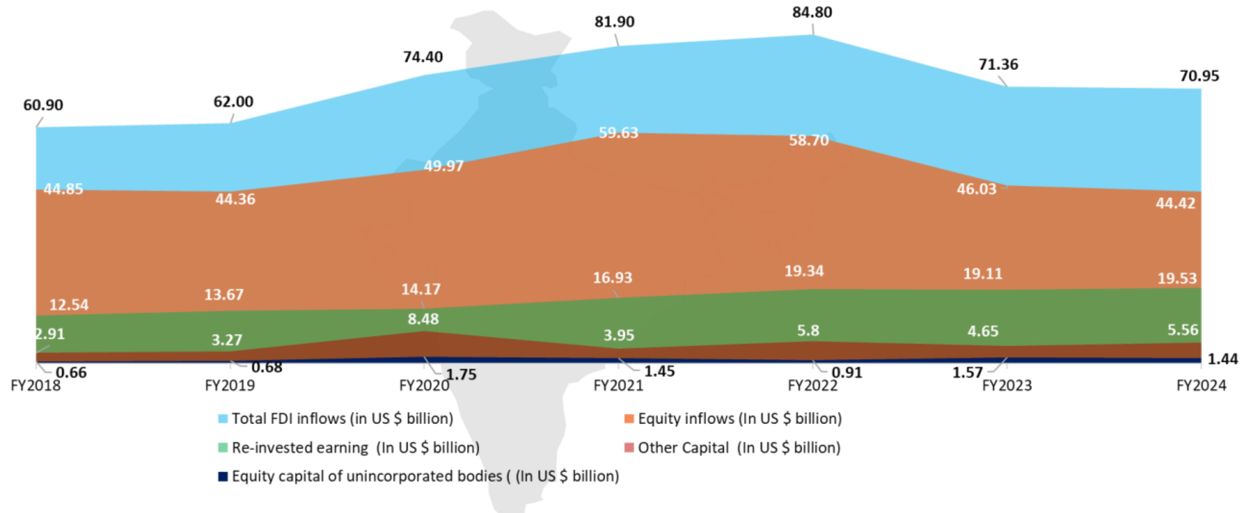
Source: National Statistical Office; Frost & Sullivan Analysis

The manufacturing GVA of the country has been growing at a steady pace and even registered growth in the covid year. The growth was highest in FY2022 at 11.1% but moderated to 2.0% in FY2023 to reach INR 26.2 trillion. As per first advance estimates, the manufacturing GVA is expected to reach INR 27.9 trillion by FY2024 at an annual growth of 6.5%. One of the key reasons for this healthy growth is the government's vision of making India a global manufacturing hub. Indian manufacturing sector's contribution has increased from 16% to 17% buoyed by initiatives like Make in India, Production Linked Incentive (PLI) schemes and sector-specific initiatives that aim to make India a global manufacturing destination.

2.6 Foreign Direct Investment (FDI)

Foreign Direct Investment (FDI) in India has significantly increased in the last few years on the backdrop of improved 'Ease of Doing Business' ranking and proactive manufacturing policies from the Indian Government. The country received a record USD 434.9 billion FDI between FY2018 and FY2023.

Exhibit 2.7: FDI inflow in India, in USD billion, FY2018 – FY2024



Source: RBI, Frost & Sullivan Analysis

FDI reached a record USD 84.8 billion in FY2022 – the highest FDI in any fiscal year to date. Even though the FDI declined to USD 71.4 billion in FY2023, it is still at par with the last 6 year's average FDI in the country – India has achieved this feat despite the Indian government's restrictions on FDI from China. In FY2024, India has registered a gross FDI inflow of USD 71.0 billion. Despite high interest rates across the globe, India's FDI inflows remained steady as compared to its peer developing economies, because of the 'demand strength' of the economy.

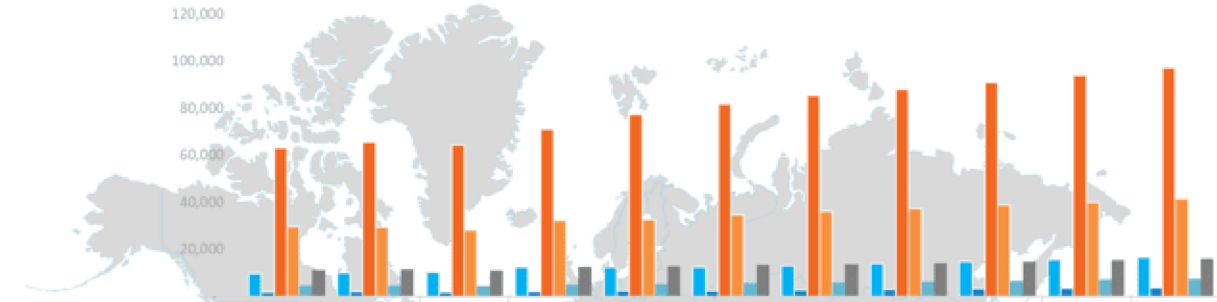
2.7 Per capita income – India vs. leading global economies

Per capita income is a broad indicator of the prosperity of an economy. Consumer confidence and discretionary consumption both improve with the rising per capita income. India's per capita income in CY2023 was USD 2,500 (at current price) and is considered a lower middle-income country.

For India to become a middle-income country, its per capita income needs to grow by almost 2.3 times to USD 6,100. Even though India's per capita income grew by almost 100% since FY2015, wealth distribution among India's 1.4 billion people remains highly skewed. Equitable access to healthcare, quality education, and jobs would be critical for India to deliver sustained growth in per capita income. Global average per capita income in CY2023 was 5.1 times higher than India at USD 13,359. CY2023 per capita income of USA, Europe, and China was USD 81,632, USD 32,415, and USD 12,514 respectively.

India in the last few years has seen a significant expansion of middle-class households. Robust economic development, growing population, relatively slower aging, and rising income levels coupled with urbanization would result in nearly 400 million additional middle-class and high-income population being added to the country's economy by FY2031 effectively pushing the share of upper middle class and high-income earners to nearly 58% of the population by FY2031 – this in turn would drive the growth in per capita income of the country.

Exhibit 2.8: India vs. Global – Per capita income of India vs leading economies (USA, China, Europe and Southeast Asia), value in USD, CY2018 - CY2028E



	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
China, People's Republic of	9,849	10,170	10,525	12,572	12,643	12,514	13,136	14,037	14,929	15,834	16,782
India	1,974	2,050	1,916	2,250	2,366	2,500	2,731	2,984	3,265	3,573	3,911
United States	63,165	65,505	64,367	70,996	77,192	81,632	85,373	87,978	90,903	94,012	97,231
Europe	29,691	29,278	28,313	32,461	32,515	34,663	36,063	37,357	38,738	40,099	41,566
Southeast Asia	4,728	4,957	4,675	5,096	5,441	5,603	5,948	6,343	6,747	7,172	7,623
World	11,472	11,518	11,111	12,527	12,894	13,359	13,836	14,368	14,946	15,533	16,148

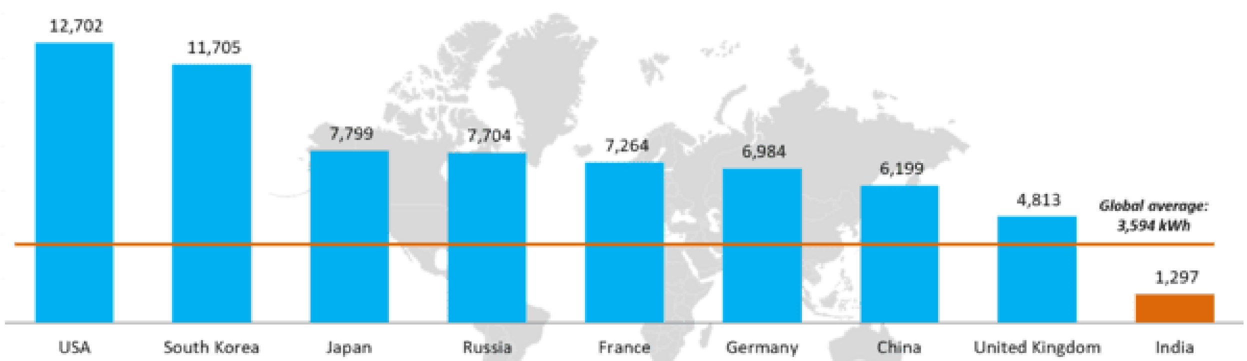
World	India	China	USA	Europe	Southeast Asia (SEA)
CAGR (CY18-23): 3.9%	CAGR (CY18-23): 4.8%	CAGR (CY18-23): 4.9%	CAGR (CY18-23): 5.3%	CAGR (CY18-23): 3.1%	CAGR (CY18-23): 3.5%
CAGR (CY23-28): 3.1%	CAGR (CY23-28): 9.4%	CAGR (CY23-28): 6.0%	CAGR (CY23-28): 3.6%	CAGR (CY23-28): 3.7%	CAGR (CY23-28): 6.3%

Source: IMF, World Economic Outlook; Frost & Sullivan Analysis

2.8 Per capita electricity consumption

Power-intensive industries, the purchasing power of the average citizen, household size, and general power efficiency standards all contribute to the amount of electricity that is consumed per person every year. However, a country's size and population can also play an important role.

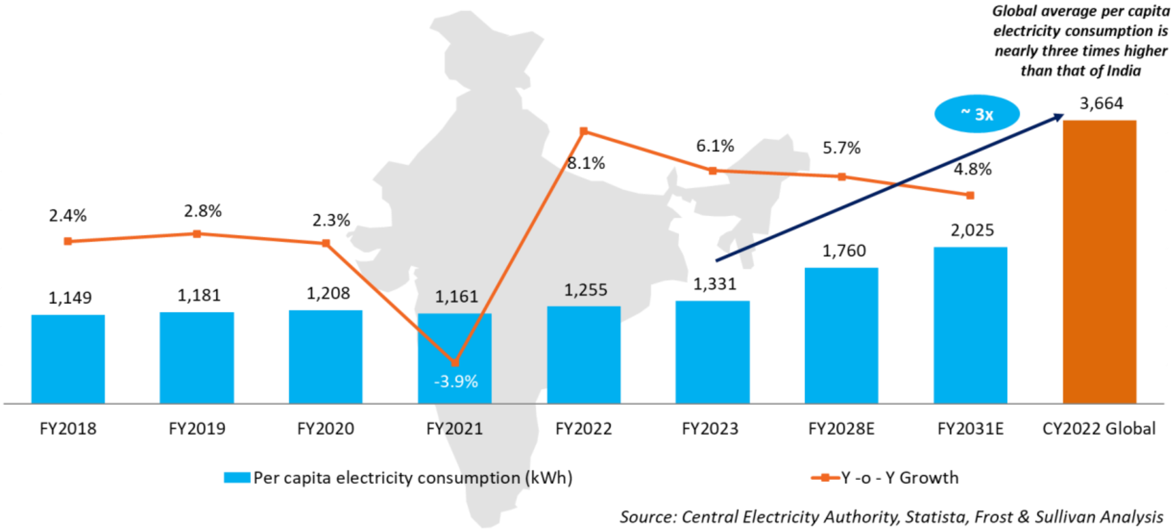
Exhibit 2.9: Per capita electricity consumption of global leading economies vs India, in kWh, CY2022



Source: Statista, Frost & Sullivan Analysis

Among the top 10 global economies, per capita electricity consumption is the highest for the USA whereas, it is the lowest for India – 1,297 kWh, approximately one-third of the global average of 3,664 kWh at the end of CY2022. India's per capita electricity consumption has steadily increased from 1,149 kWh in FY2018 to 1,331 kWh in FY2023. Per capita electricity consumption has grown at a healthy pace of 8.1% and 6.1% in FY2022 and FY2023. The reasons for such an increase include electrification of the villages, heightened economic and manufacturing activities, and increasing penetration of various consumer durables products. Considering a historical average multiplier of 0.8 with the GDP growth, per capital electricity consumption may cross 1,700 kWh by FY2028 and may touch 2,000 kWh by FY2031.

Exhibit 2.10: Per capita electricity consumption of India and growth, in kWh and %, FY2018 – FY2031E



Source: Central Electricity Authority, Statista, Frost & Sullivan Analysis

The government of India launched Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) in December 2014 for the rural areas with the objective of electrification of all un-electrified villages as per Census 2011. Similarly, Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) was launched in October 2017 with the objective to achieve universal household electrification by providing electricity connections to all un-electrified households in rural areas and all poor households in urban areas of the country. For DDUGJY, the total allocation was ₹44,033 crore, with significant progress made in the electrification of villages and households. These programmes have successfully electrified nearly all households across the length and breadth of the country. 100% of urban households and 99.3% of Indian rural households have access to electricity at the end of FY2022 as per a report from the World Bank.

3. INDIA EMERGING AS A GLOBAL MANUFACTURING HUB

3.1 India emerging as a global manufacturing hub

In FY2024, India's merchandise exports reached USD 437 billion, with a goal of USD 1 trillion by 2030. The manufacturing sector, contributing 17% to GDP and employing over 62 million, is targeted to grow to 25% of GDP by CY2025. This includes a substantial allocation for Production-Linked Incentive (PLI) schemes. Government reforms, like GST and corporate tax reductions, have boosted Foreign Direct Investment (FDI), which grew from USD 45.2 billion in FY2015 to USD 70.95 billion in FY2024. Initiatives such as the Phased Manufacturing Programme (PMP) and Project Development Cells (PDCs) are designed to attract global investments and support economic growth.

3.2 India's competitiveness among the leading manufacturing economies

India's economic growth is driven by strong domestic consumption and private investment, supported by initiatives like "Make in India" and "Atmanirbhar Bharat." These programmes aim to boost manufacturing in key sectors, reduce import dependence, and drive innovation. With a young, cost-effective workforce and the "Skill India" programme focusing on modern skills, India remains competitive despite rising wages. As global manufacturing shifts, India is poised to capture a larger market share due to its favourable demographics and policies. Southeast and South Asia are emerging as key manufacturing hubs, with India being a strong contender.

A. Comparison on key economic parameters:

The below exhibit clearly indicates that demographic dividend is a clear advantage that India has over the other leading manufacturing economies. India has one of the largest young workforces with an average Indian being 10 years younger than a Chinese.

Exhibit 3.1: Comparison on key economic parameters – India vs. China, Thailand, Vietnam, and Mexico, CY2023

PARAMETERS		INDIA	CHINA	THAILAND	VIETNAM	MEXICO
Total Population (Million)		1,425.7	1,409.3	71.8	98.9	128.5
Population in age 15-64 years (Million)		924.9	980.4	49.4	68.5	86.6
Median age (Years)		28.2	39.0	40.2	32.8	29.8
Annual GDP (USD Trillion)		3.73	17.70	0.51	0.43	1.81
GDP Growth (%)	CY2023	6.7	5.2	2.7	4.7	3.2
	CY2028E	6.3	3.4	3.0	6.8	2.1
Inflation (%)		5.5	0.7	1.2	3.3	4.7

Source: World Bank (Data Bank), IMF, UN (Population Data), Frost & Sullivan analysis

B. Labour market comparison:

India, with one of the world's largest workforces, ranks second only to China. Each year, millions of young people enter the job market, providing a significant workforce advantage. The Ministry of Skill Development & Entrepreneurship (MSDE), National Skill Development Corporation (NSDC), and Sector Skill Councils (SSCs) are enhancing vocational training to build a skilled, job-ready workforce. India offers competitive labour costs compared to other major manufacturing economies. As manufacturers shift to Vietnam to avoid tariffs, India's lower labour costs and skilled workforce provide a notable advantage.

Exhibit 3.2: Labour market comparison - India vs. China, Thailand, Vietnam, and Mexico, CY2023

PARAMETERS	INDIA	CHINA	THAILAND	VIETNAM	MEXICO
Total Labour Force (Million)	594.0	781.8	40.1	52.4	59.2
Total Labour Force, Female (% of Total population)	26.0	45.2*	46.0	48.5	40.6
Labour force participation rate (% of total population)	49.3	66.9	68.8	68.9	59.9
Employment in Industry (% of Total Employment)	26.0	32.0	22.0	21.4*	25.0
Wage and salaried workers (% of Total Employment)*	24.2	55.3	49.7	45.7	68.1
Real Average Daily Wage	~ 6.03	~36.0	~14.3	~9.7	~16.6

** Data available only until CY2022*

Source: IMF, ILO, Statista, Frost & Sullivan analysis

C. Comparison of manufacturing ecosystem:

As per the 'Global Manufacturing Risk Index 2022' by Cushman & Wakefield, China remains the most advantageous location for manufacturing among 45 countries across the continents. The rankings in the index are based on parameters such as operating conditions, cost competitiveness, labour cost, and economic and political risks. The government's continual focus on improving manufacturing infrastructure and ease of doing business in the country (India ranked 63rd in CY2022 compared to 142 in CY2014), a growing young and vibrant workforce, and cost competitiveness have helped India to become 2nd most advantageous manufacturing location globally.

Exhibit 3.3: Comparison of manufacturing ecosystem - India vs. China, Thailand, Vietnam, and Mexico, CY2023

PARAMETERS	INDIA	CHINA	THAILAND	VIETNAM	MEXICO
Manufacturing Value Added (% of GDP)	17.0	28.0	27.0	24.8	21.5
Total Export (USD Trillion)	0.32	3.38	0.28*	0.37*	0.58*
Total Imports (USD Trillion)	0.67	2.56	0.28	0.36*	0.60
Manufacturing Risk Index (Rank)	2	1	5	11	12
Global manufacturing output (% share)	3.3%	28.4%	2.5%	2.1%	1.5%
FDI Investments (USD Billion)	70.9	33.0	18.9	36.6	32.9#
Favourable government policies	High	High	High	Medium	Medium
Developed component ecosystem	Medium	High	High	Medium	Medium

** Data available only until CY2022; # Data until Q3 2023*
Import and Export values mentioned are only for commodities and do not include services
Rank 1 indicates the most beneficial locations for global manufacturing

Source: IMF, Statista, Frost & Sullivan analysis

3.3 Government policies and schemes driving manufacturing in India

The manufacturing sector of India is going through a major transformation in the last 6-7 years. The Government of India has launched several schemes and initiatives to promote India as a global manufacturing hub. Some of the notable initiatives are:

Exhibit 3.4: Approved financial outlay under Production Linked Incentive (PLI) scheme

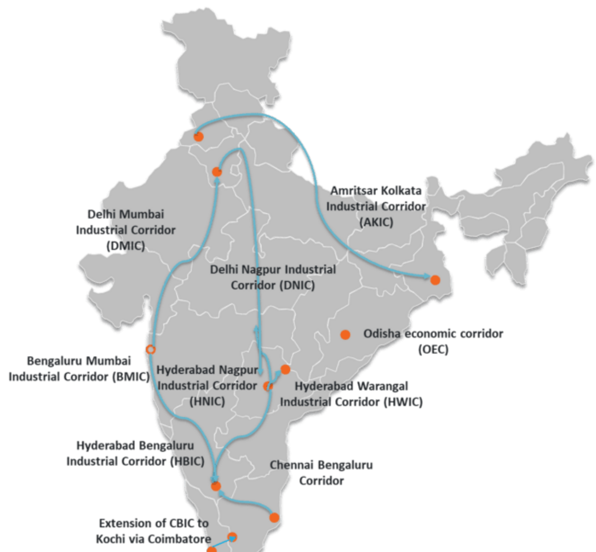
Sectors	Implementing Ministry/Department	Approved financial outlay over a five-year period (INR billion)
Large Scale Electronics and IT Hardware	Ministry of Electronics and Information Technology	556.5
Automobiles & Auto Components	Department of Heavy Industries	259.4
High-Efficiency Solar PV Modules	Ministry of New and Renewable Energy	240.0
Pharmaceuticals – KSMs, Dis, and APIs and Bulk Drugs	Department of Pharmaceuticals	219.4
Advance Chemistry Cell Batteries	NITI Aayog and Department of Heavy Industries	181.0
Telecom & Networking Products	Department of Telecom	122.0
Food Processing	Ministry of Food Processing Industries	109.0
Textiles and Apparels	Ministry of Textiles	106.8
Specialty Steel	Ministry of Steel	63.2
White Goods (ACs and LEDs)	Department for Promotion of Industry and Internal Trade	62.4
Medical Devices	Department of Pharmaceuticals	34.2
Drone and Drone Components	Department of Civil Aviation	1.2
	Total	**1,955.1**

Source: Invest India, Frost & Sullivan Analysis

3.4 India emerging as the world's technology hub

India is emerging as a major player in global manufacturing technology due to shifting demographics, technological advancements, and a young, skilled workforce. Key strengths include government initiatives like "Make in India," a focus on innovation through startups, and competitive production costs. Indian companies are leading innovations in water and wastewater treatment, solid waste management, and biogas production. Policies such as relaxed FDI norms, Special Economic Zones, and support for startups and R&D are driving growth and attracting foreign investment. India's robust IT infrastructure further supports the integration of advanced manufacturing technologies.

Exhibit 3.5: Development of 11 industrial corridors



Source: Make in India, Frost & Sullivan Analysis

4. OVERVIEW OF GLOBAL WASTEWATER TREATMENT MARKET

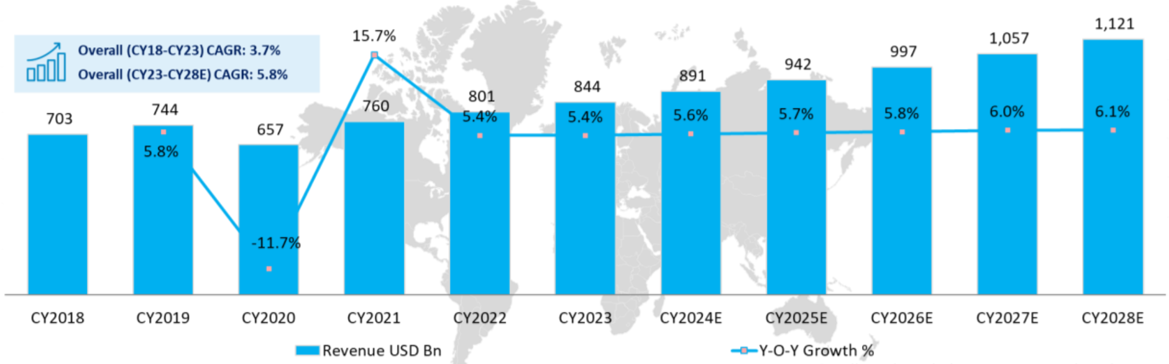
4.1 Overview of the Global Wastewater treatment market

The global wastewater treatment market is essential for public health and environmental protection. As populations grow and cities expand, effective wastewater management is increasingly crucial. The COVID-19 pandemic underscored the need for resilient and adaptable water infrastructure. Municipalities and industries are now prioritizing sustainability, with goals for net-zero emissions, decarbonization, and circularity in water usage. Energy optimization is important, but there's also a strong focus on circularity, especially in Southeast Asia (SEA), where nutrient and energy recovery from sludge is gaining traction. Europe and North America are focusing on treating emerging pollutants, while treated wastewater reuse is a major priority across SEA, North America, Latin America, and the Middle East

4.2 Size of the global wastewater treatment market

The global water and wastewater treatment market is set to grow from USD 703 billion in CY2018 to USD 1,121 billion by CY2028, with a CAGR of 5.8% from CY2023 to CY2028.

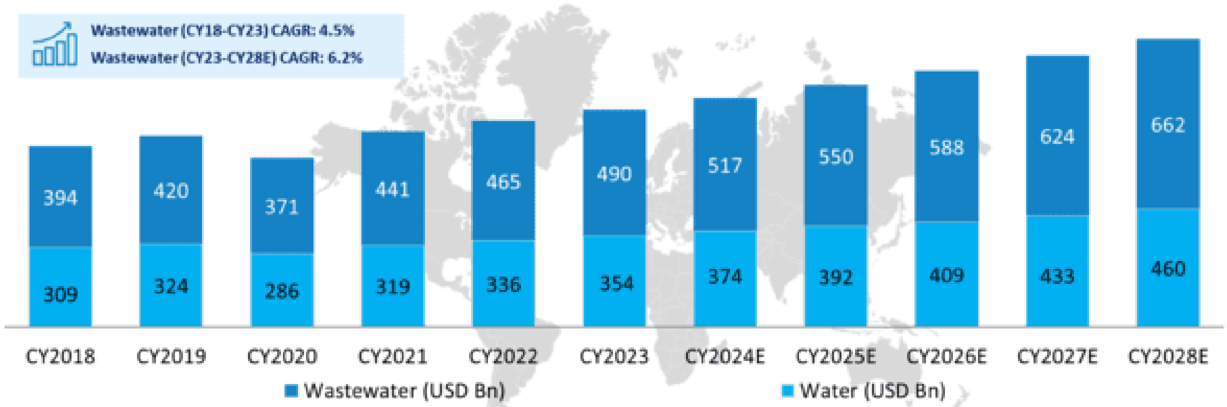
Exhibit 4.1: Global water and wastewater treatment market size, Global, in USD billion, CY2018 – CY2023



Source: Frost & Sullivan knowledge repository and analysis

Wastewater treatment alone is projected to reach nearly USD 662 billion by CY2028, driven by stricter regulations, increased industrial activity, and the potential for water reuse.

Exhibit 4.2: Global water and wastewater treatment market, Global, in USD billion, CY2018–CY2028E

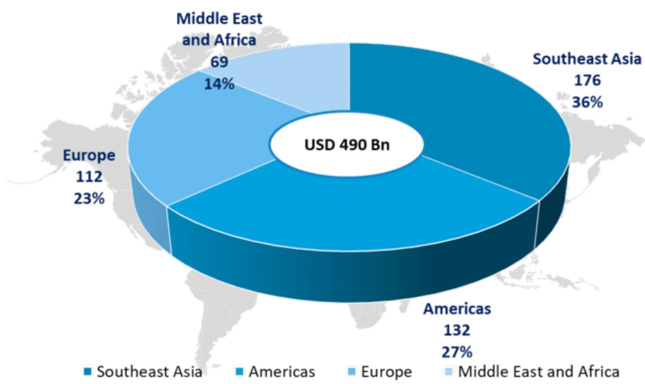


Source: Frost & Sullivan knowledge repository and analysis

4.3 Global Wastewater treatment market split by region

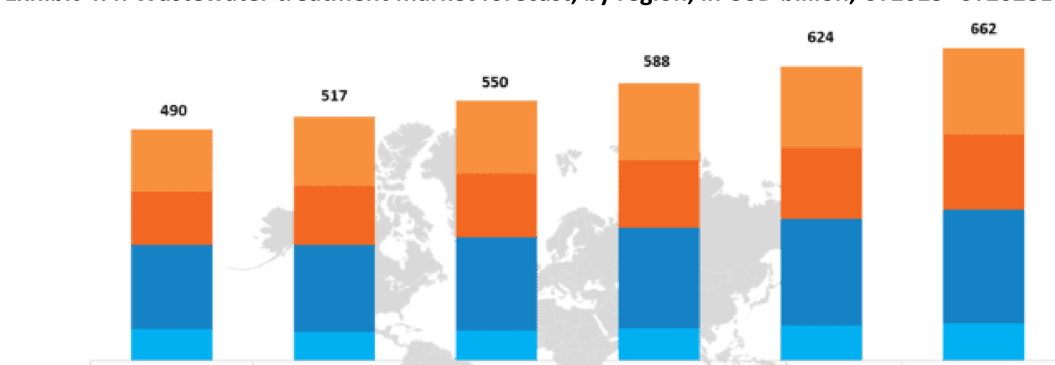
Southeast Asia, leading the wastewater treatment market with 36% of the USD 490 billion market in CY2023, is expected to grow from USD 176 billion in CY2023 to USD 241 billion by 2028, at a CAGR of 6.4%.

Exhibit 4.3: Wastewater treatment market size by region, split by percentage, value in USD Bn, CY2023



Source: Frost & Sullivan knowledge repository and analysis

Exhibit 4.4: Wastewater treatment market forecast, by region, in USD billion, CY2023–CY2028E



	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Americas	132	145	154	164	173	182
Europe	113	126	134	143	150	159
SEA	176	185	197	212	226	241
MEA	69	61	65	70	74	79

Source: Frost & Sullivan knowledge repository and analysis

This growth is driven by rapid urbanization, increased water quality awareness, water scarcity, and stringent regulations, with key investments in recycling and reuse systems across developing economies like China, India, Vietnam, and Indonesia.

4.4 Factors driving the growth of the wastewater treatment market by different regions

Middle East and Africa (MEA): Demand for wastewater treatment in the MEA region is driven by population growth, economic diversification, and a shift from oil reliance. GCC countries focus on sustainability and water reuse, with Saudi Vision 2030 setting ambitious targets. Israel leads in water reuse, while Jordan supports treated wastewater for irrigation.

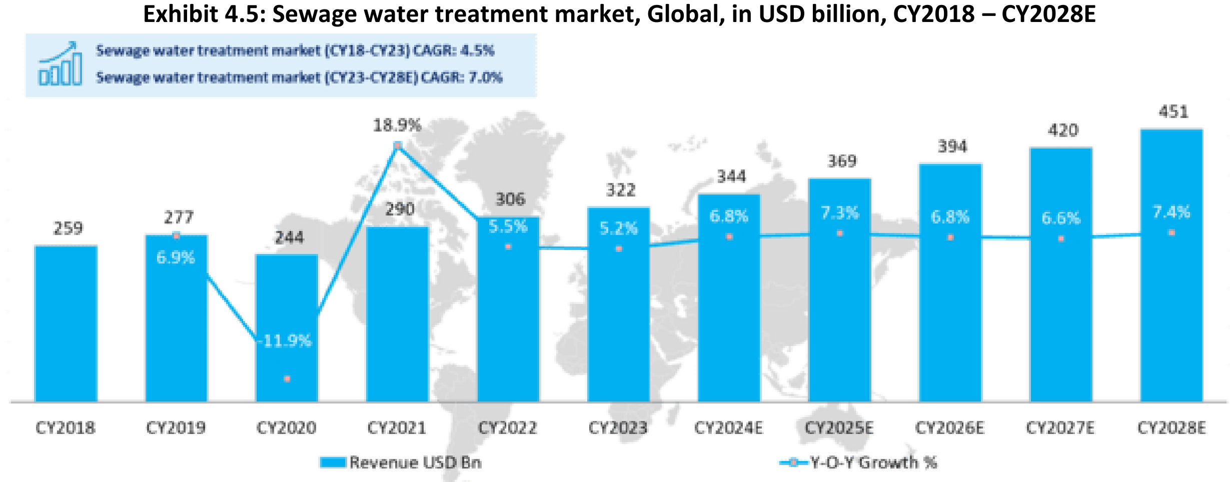
Southeast Asia: Rapid urbanisation, technological advancements, and circular economy principles are expanding the wastewater treatment market. Urban growth and smart sensors, such as those in Singapore's Tuas South Water Reclamation Plant, drive investment. Initiatives like Vietnam's Da Nang Green City project reflect a focus on resource recovery and sustainability.

Europe: European wastewater treatment is shaped by strict regulations and ageing infrastructure. The EU mandates infrastructure upgrades and advanced technologies, with the UK facing a significant investment gap. Countries like the Netherlands invest in technologies for water reuse and nutrient recovery to enhance sustainability.

4.5 Overview of the global Sewage treatment market

Sewage treatment is a critical subset of the broader wastewater treatment segment, focusing specifically on the processing and management of wastewater originating from residential, industrial, and commercial sources. The global sewage water treatment market has grown significantly, increasing from USD 259 billion in CY2018 to USD 322 billion in CY2023. This growth is fueled by a shift in perspective, viewing sewage water not just as waste but as a resource. Advanced technologies like nutrient recovery and biosolids conversion are enabling wastewater to be transformed into valuable byproducts, driving investments in innovative treatment solutions.

Exhibit 4.5: Sewage water treatment market, Global, in USD billion, CY2018 – CY2028E

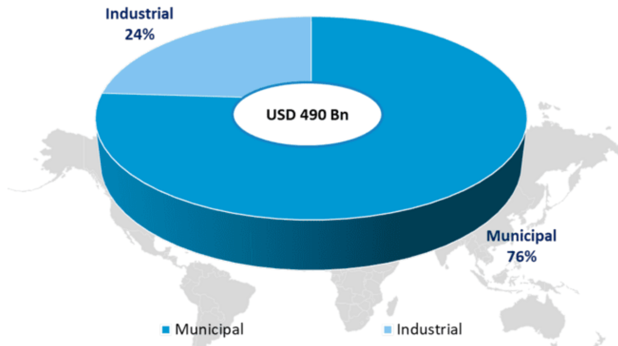


Source: Frost & Sullivan knowledge repository and analysis

Municipal Segment: Sewage treatment is crucial for municipal systems, managing over 76% of municipal wastewater from households, businesses, and institutions. This segment uses comprehensive treatment stages to ensure public health and hygiene.

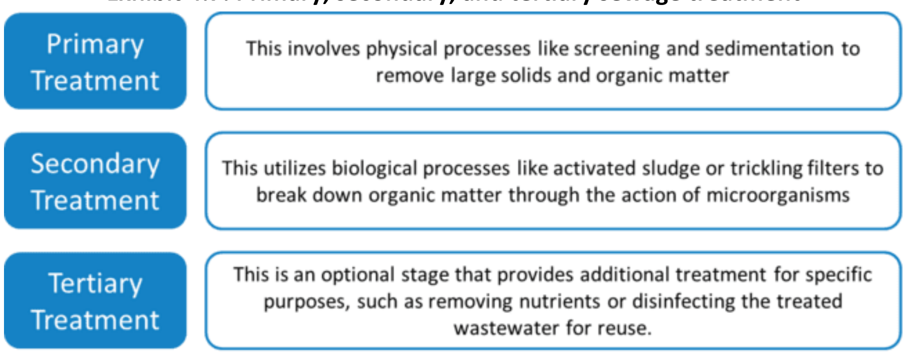
Industrial Segment: Industrial sewage treatment accounts for about 24% of the total Industrial wastewater, with high contaminants, often requires extensive pre-treatment before discharge. Many industries use on-site treatment solutions to manage specific wastewater characteristics and reduce environmental impact

Exhibit 4.6: Wastewater treatment market split by end-user segment, Global, CY2023



Source: Frost & Sullivan knowledge repository and analysis

Exhibit 4.7: Primary, secondary, and tertiary sewage treatment



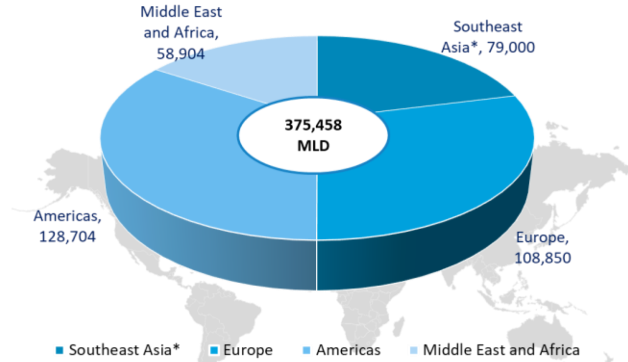
Source: Frost & Sullivan analysis

4.6 Global Sewage water treatment market split by regions

Southeast Asia dominates the global sewage treatment market, driven by rapid urbanization and economic expansion. Countries like Indonesia and Vietnam are heavily investing in infrastructure upgrades to address sanitation and flood risks. In CY2023, the region (excluding India) generated approximately 79,000 Million Litres per Day (MLD) of sewage. Europe produced around 108,850 (Million Litres per Day) MLD of sewage.

In 2023, the Americas produced around 128,704 Million Litres per Day (MLD) of sewage. The Middle East and Africa generated about 58,904 MLD of sewage. Southeast Asia generated approximately 79,000 Million Litres per Day (MLD) of sewage. Europe generated about 108,850 MLD of sewage. In the U.S. and Canada, tightening regulations like the Clean Water Act are driving investments in advanced technologies for wastewater treatment. Europe follows stringent EU regulations, prompting infrastructure investments to meet standards. Water scarcity drives growth in the Middle East, where Saudi Arabia's National Program for Wastewater Treatment aims to treat 70% of wastewater by 2030 for reuse.

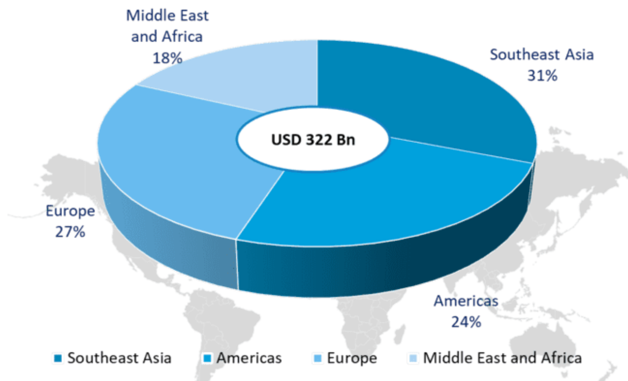
Exhibit 4.8: Sewage generation, in MLD, in countries of interest, CY2023



**Note: Southeast Asia numbers are excluding India*

Source: Frost & Sullivan knowledge repository and analysis

Exhibit 4.9: Sewage water treatment market size by region, split by percentage, CY2023



Source: Frost & Sullivan knowledge repository and analysis

4.7 Factors driving the growth of the sewage water treatment market in the region

The global sewage water treatment market is experiencing notable growth driven by regional factors:

Middle East: Water scarcity drives the use of treated sewage for non-potable purposes, such as irrigation, and supports sustainable tourism. For example, Doha uses treated sewage for public parks, and Sharm El Sheikh's plant was upgraded in 2022 to support tourism.

Southeast Asia: Rapid urbanisation strains sewer systems, prompting investments in advanced treatment technologies and infrastructure to meet environmental standards and address public health concerns. Vietnam's Ministry of Health is investing in sewage treatment, and Singapore explores advanced biological treatments.

Africa: Limited sanitation facilities drive investments in sewage treatment to improve public health. International funding supports decentralized systems for rural areas, and capacity building through international guidelines is crucial for effective management.

4.8 Prominent technologies deployed for sewage treatment in these regions

Exhibit 4.9: Comparison of sewage water treatment technologies, Southeast Asia (SEA) vs Middle East & Africa (MEA)

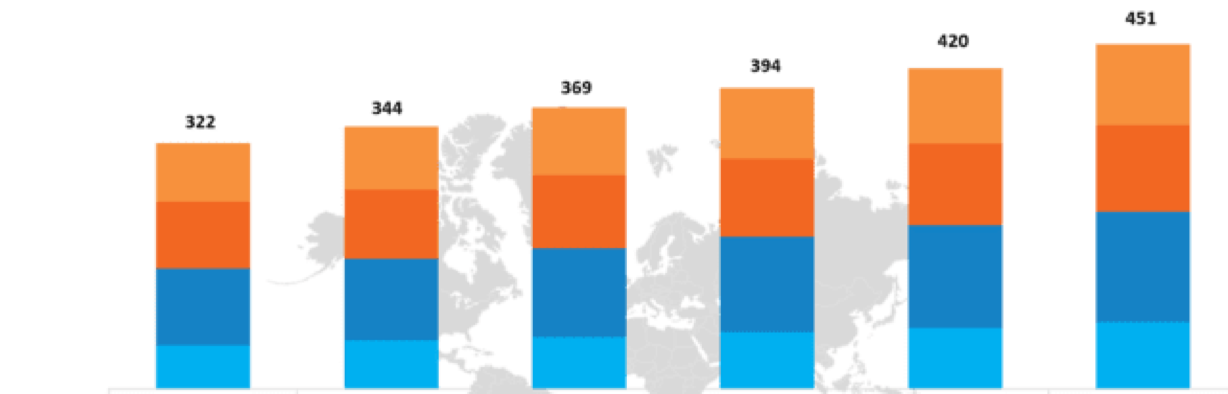
TECHNOLOGY	ADVANTAGES	DISADVANTAGES	SEA (POTENTIAL PREFERENCE)	MEA (POTENTIAL PREFERENCE)

Membrane Bioreactors (MBR)	High-quality water; suitable for reuse and irrigation	High investment and operational cost	**Moderate**	**Low (due to cost)**
Advanced Oxidation Process (AOP)	Removes emerging contaminants	High energy consumption	**Low**	**Moderate (for specific applications)**
Activated Sludge Process	Widely used, established technology	Requires significant space and energy	**High**	**Moderate (due to established infrastructure)**
Constructed Wetlands	Low energy consumption, natural treatment process	Requires large land area	**High**	**Moderate (limited land availability in some areas)**
Sequencing Batch Reactors (SBR)	Operational flexibility, highly efficient	Requires longer treatment time	**Moderate**	**Low (may not be as cost-effective in all areas)**
Upflow Anaerobic Sludge Blanket Reactors (UASB)	High efficiency, compact design	-	**Moderate**	**High (suitable for areas with space limitations)**

4.9 Growth forecast for the sewage treatment market: Middle East, Southeast Asia, and Africa

The global sewage treatment market is projected to reach USD 451 billion by CY2028E, growing at a CAGR of 7.0%.

Exhibit 4.10: Sewage water treatment market forecast by region, in USD billion, CY2023 –2028E



	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Americas	77.3	82.6	88.5	92.6	98.8	106.0
Europe	87.0	91.2	95.8	102.5	107.2	112.8
SEA	99.9	106.7	116.1	124.1	134.5	144.4
MEA	58.0	63.7	68.2	74.9	79.9	88.0

Source: Primary interactions, Frost & Sullivan knowledge repository and analysis

Southeast Asia, holding a 31% market share in CY2023, will see strong growth at a CAGR of 7.7% due to rapid urbanisation and infrastructure needs. Europe and the Americas, with established infrastructure and strict regulations, will experience slower but steady growth driven by technological advancements and infrastructure upgrades.

4.10 Notable list of upcoming sewage treatment projects

Exhibit 4.11 provides a snapshot of various water infrastructure projects currently underway around the world. It encompasses a range of facilities including sewage treatment plants that are geographically spread across the Middle East, Southeast Asia, Africa, and Europe.

Exhibit 4.11: List of upcoming sewage water treatment projects

REGION	PROJECT NAME	LOCATION	INVESTMENT	CAPACITY (MLD)	TECHNOLOGY
Middle East	Jebel Ali Sewage Treatment Plant Phase 2	Dubai, UAE	**NA**	1,050/day	Activated sludge reactors
Middle East	SWPC – Tabuk Independent Sewage Treatment Plant Phase II	Tabuk, Saudi Arabia	145.8 Million USD	90/day	SBR (Sequencing Batch Reactor)
Middle East	RAK Wastewater Treatment Plant	Moulay Bousselham, Morocco	**NA**	NA	Closed low pressure ultraviolet disinfection.
Africa	MHHUD Wastewater Treatment Plant	Maghagha, Egypt	19.4 million USD	30 - 60/day	Sedimentation, biological and filtration
Southeast Asia	Nhieu Loc Thi Nghe Wastewater Treatment Plant	Vietnam	**NA**	816/day	Moving Bed Biofilm Reactor (MBBR)
Europe	Vappa Sewage Treatment Plant	Enkoping, Uppsala, Sweden	**NA**	NA	NA

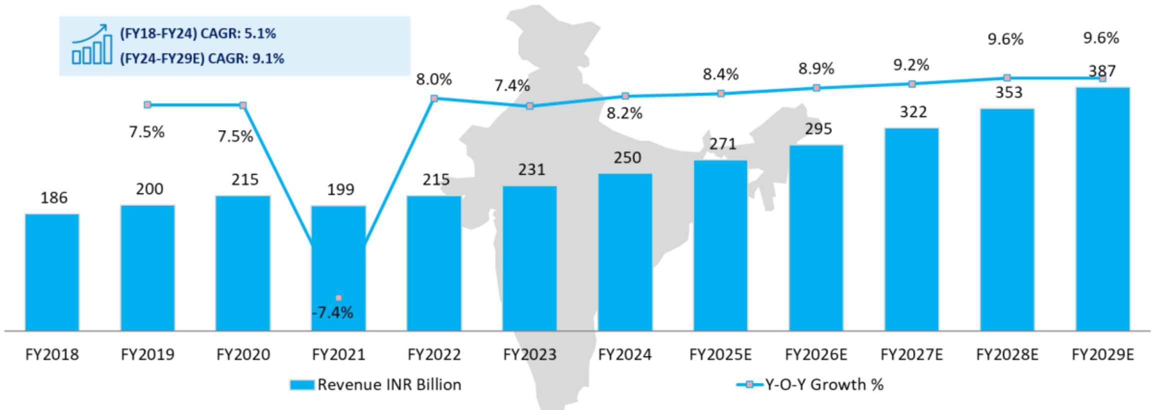
5. OPPORTUNITY LANDSCAPE OF INDIA'S SEWAGE TREATMENT MARKET

5.1 Overview of Indian Wastewater Treatment Market

India's wastewater treatment market is growing due to opportunities in the industrial and municipal sectors. Market growth is driven by high industrial activity, economic expansion, and groundwater depletion, creating demand for effective wastewater management solutions. Urban expansion and industrial growth, coupled with the government's commitment to sustainability and financial incentives, indicate a favourable environment for innovative technologies. The focus is shifting from price to value, with increased private participation leading to more Build, Own, Operate, and Transfer (BOOT) projects, typically lasting 15 to 30 years. These projects emphasise value and performance over cost. Public-private partnerships (PPPs) in the municipal sector benefit private companies with business opportunities and municipalities with improved efficiency and shared responsibility. Existing infrastructure across many Indian cities requires modernization to meet current environmental and operational standards.

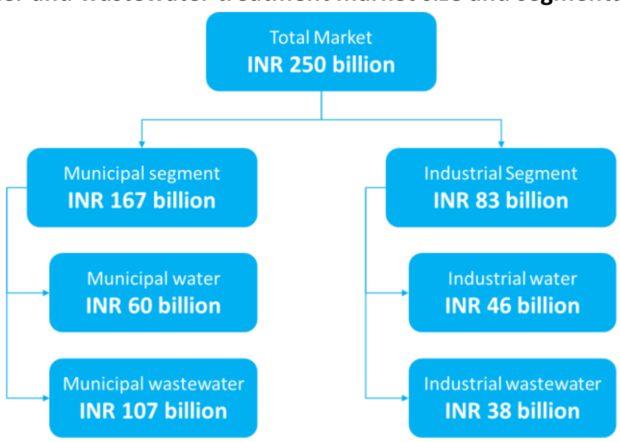
The wastewater treatment industry has maintained a 5.5% CAGR over the past five years and is projected to accelerate to 9.6% growth in the next five years. In general, for an STP with a capacity between 20 MLD and 100 MLD, the total estimated STP capital cost can range from INR 300 million to INR 1000 million based on various factors. In terms of cost breakdown, the C-Tech[1] package accounts for 10% to 15% of total STP Capital cost. Disc filters and blowers are estimated to contribute approximately 5% to 8% each to the total STP capital cost. The remaining portion of the STP capital cost goes towards civil works, other electromechanical and instrumentation work, piping and other miscellaneous works as per the project requirement.

Exhibit 5.1(a): Water and wastewater treatment market size, in INR billion, India, FY2018 – FY2029E



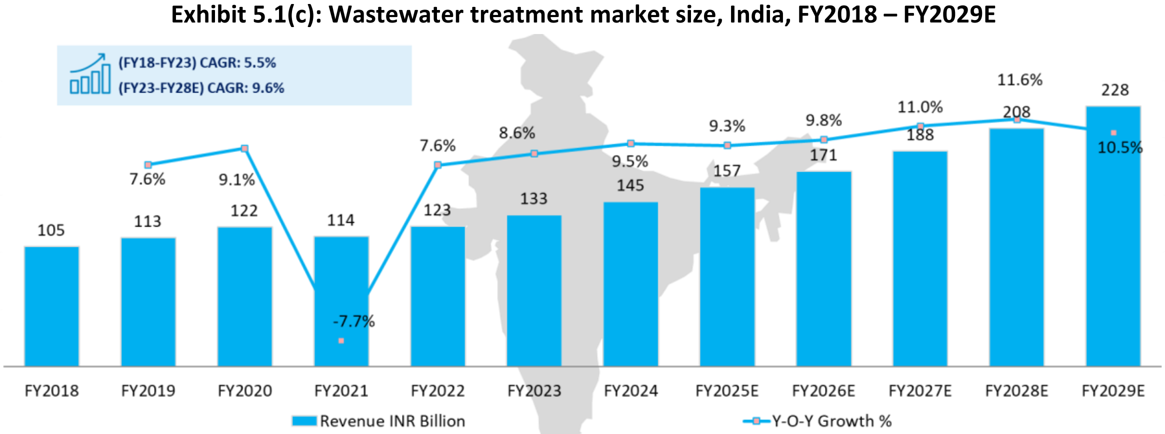
Source: Primary interactions, Frost & Sullivan analysis

Exhibit 5.1(b): Water and wastewater treatment market size and segmentation, India, FY2024



Source: Primary interactions, Frost & Sullivan analysis

Exhibit 5.1(c): Wastewater treatment market size, India, FY2018 – FY2029E



Source: Primary interactions, Frost & Sullivan analysis

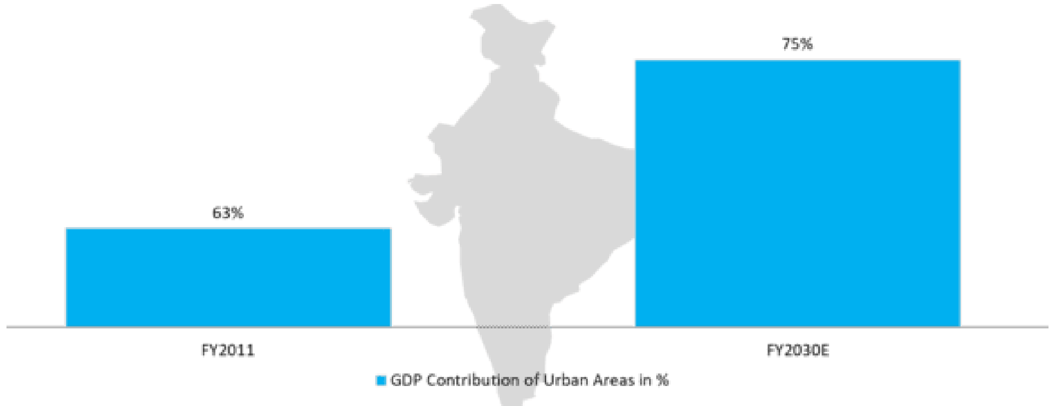
[1] Refer section 5.18 on C Tech Technology

5.2 Factors and rules driving the Indian wastewater treatment market

A. Rising population and per capita consumption:

Urban India faces challenges in providing water and sanitation due to population growth and changing consumption patterns. Rising disposable incomes and urbanisation lead to more water-intensive lifestyles, increasing water use for activities like gardening and using appliances.

Exhibit 5.2: GDP contributions of urban areas, India, FY2011 and FY2030E



Source: Census 2011, Ministry of Urban Development's Smart Cities Mission Statement & Guidelines

Groundwater levels have declined in many urban areas due to uneven rainfall and overexploitation. The Central Ground Water Board (CGWB) reports a 0 to 2-metre decline in 33% of groundwater tables since 2010, with cities such as Delhi and Chennai experiencing declines exceeding 4 metres. Coastal cities like Chennai have adopted seawater RO desalination to address shortages. These factors result in increased wastewater volumes needing treatment

B. Leachate Treatment for municipal solid waste landfill management:

India's reliance on overflowing landfills and inadequate leachate management highlights a significant opportunity for advancements in wastewater treatment. Over 3,000 landfills lack proper leachate management systems, causing environmental damage. Although stringent regulations are in place, lax enforcement results in minimal compliance. However, anticipated stricter regulation enforcement, driven by a focus on sustainability and UN SDGs, is expected to boost the demand for effective leachate treatment technologies. Major urban centres in India will see increased demand for such solutions, presenting opportunities for companies with innovative leachate treatment technologies.

Exhibit 5.3: Disposal of treated leachate in India

	STANDARDS (MODE OF DISPOSAL)		
PARAMETER	INLAND SURFACE WATER	PUBLIC SEWERS	LAND DISPOSAL
Suspended solids, mg/l, max	100	600	200
Dissolved solids (inorganic) mg/l, max	2,100	2,100	2,100
pH value	5.5 – 9.0	5.5 – 9.0	5.5 – 9.0
Ammonical nitrogen (as N), mg/l, max.	50	50	-

Total Kjeldahl nitrogen (as N), mg/l, max	100	-	-
Biochemical oxygen demand (3 days at 270 C) max.(mg/l)	30	350	100
Chemical oxygen demand, mg/l, max.	250	-	-
Arsenic (as As), mg/l, max	0.2	0.2	0.2
Mercury (as Hg), mg/l, max	0.01	0.01	-
Lead (as Pb), mg/l, max	0.1	1.0	-
Cadmium (as Cd), mg/l, max	2.0	1.0	-
Total Chromium (as Cr), mg/l, max.	2.0	2.0	-
Copper (as Cu), mg/l, max.	3.0	3.0	-
Zinc (as Zn), mg/l, max.	5.0	15	-
Nickel (as Ni), mg/l, max	3.0	3.0	-
Cyanide (as CN), mg/l, max.	0.2	2.0	0.2
Chloride (as Cl), mg/l, max.	1000	1000	600
Fluoride (as F), mg/l, max	2.0	1.5	-
Phenolic compounds (as C6H5OH) mg/l, max.	1.0	5.0	-

C. Decentralized solutions

India faces a hidden water crisis due to ageing or inadequate sewage systems in many urban areas, particularly smaller towns and peri-urban fringes. This leads to untreated wastewater contaminating groundwater and posing health risks. The demand for decentralized wastewater treatment solutions is rising as these compact, on-site systems can treat wastewater at the source, easing the burden on centralised infrastructure and enabling local reuse for irrigation or sanitation.

D. Growing water scarcity and need for reuse

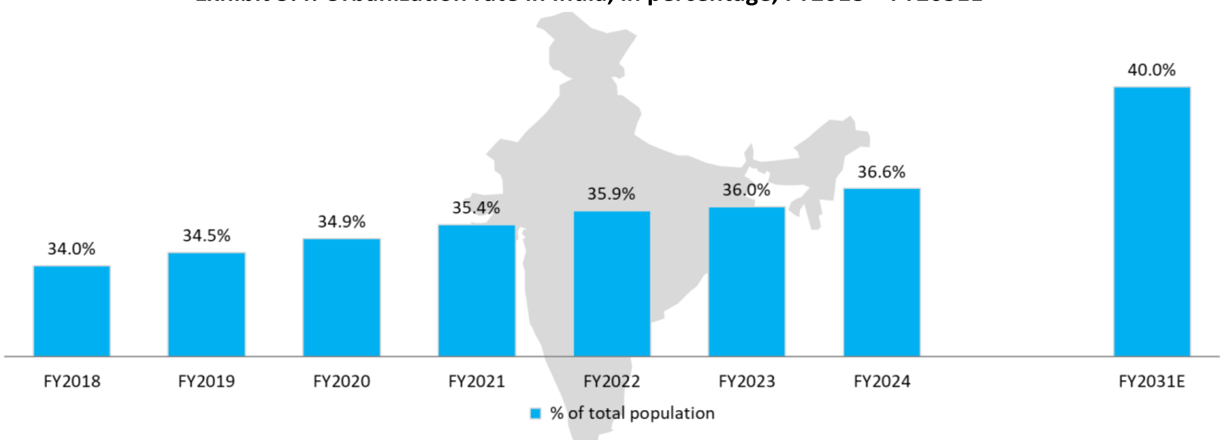
The pressing issue of water scarcity amplifies the urgency for effective water management practices, driving investment in innovative treatment technologies. Water scarcity is a growing threat across the globe, with burgeoning populations and climate change putting immense strain on freshwater resources. India's water future is poised for positive change, driven by a growing emphasis on wastewater treatment and reuse. By treating wastewater to appropriate standards, it can be used for non-potable purposes like irrigation or industrial processes, essentially creating a new and reliable water source. The National Water Policy (2012) reinforces this approach by mandating effective wastewater treatment and promoting its reuse. Policy support, financial incentives, and a commitment to sustainability are advancing the role of treated wastewater in addressing India's water needs.

E. Urbanization and Industrial growth

Rapid urbanization leads to increased wastewater generation due to denser populations and greater infrastructure development. Industries are another major source of wastewater, particularly water-intensive sectors like textiles and pharmaceuticals. Regulatory Framework is as follows:

- **Town and Country Planning Acts of various states:** Often mandate provisions for wastewater treatment infrastructure in urban development plans.
- **Industry-specific regulations:** Certain industries, like textiles and pharmaceuticals, have specific regulations governing wastewater treatment and disposal within their respective environmental acts.

Exhibit 5.4: Urbanization rate in India, in percentage, FY2018 – FY2031E



Source: Trade Economics, World Bank, Primary interactions, Frost & Sullivan analysis

F. Government initiatives and funding

The Indian government recognizes the importance of wastewater treatment and has launched several initiatives to accelerate infrastructure development. Key Programs are:

- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** Provides funds for urban infrastructure, including wastewater treatment plants. This funding has improved wastewater management in Indian cities, enhancing treatment capacity, reducing untreated wastewater discharge, and improving public health by decreasing waterborne diseases.
- **National Mission for Clean Ganga (NMCG):** Invests in wastewater treatment projects along the Ganges River to clean the river. NMCG has constructed numerous sewage treatment plants (STPs) and improved sanitation infrastructure, leading to improved water quality in the Ganges.
- **Jal Jeevan Mission (JJM):** Aims to provide piped drinking water to rural households and requires investments in wastewater treatment to prevent contamination. JJM's focus on piped water reduces open defecation, decreasing raw sewage contamination. It also promotes decentralized wastewater treatment through greywater management plans in villages with piped water.

The growing emphasis on wastewater treatment and reuse could also create opportunities for vertically integrated players like SFC Environmental Technologies, which can provide a comprehensive range of services from treatment to reuse management.

G. Technological advancements and efficiency:

The Indian wastewater treatment market is witnessing a wave of tech-driven innovation. Start-ups and established companies are developing cost-effective and efficient treatment solutions tailored to India's specific needs. These innovations include:

- **Modular Treatment Plants**: These prefabricated units offer a faster and more cost-effective solution for setting up wastewater treatment facilities, particularly in smaller communities.
- **Internet of Things (IoT) Integration:** Integrating sensors and real-time monitoring systems allows for remote monitoring and optimization of wastewater treatment processes, leading to improved efficiency and reduced operational costs.
- **Low-Energy Treatment Technologies:** With rising energy costs, developing treatment technologies that require less energy consumption is crucial for the long-term sustainability of wastewater treatment solutions in India.

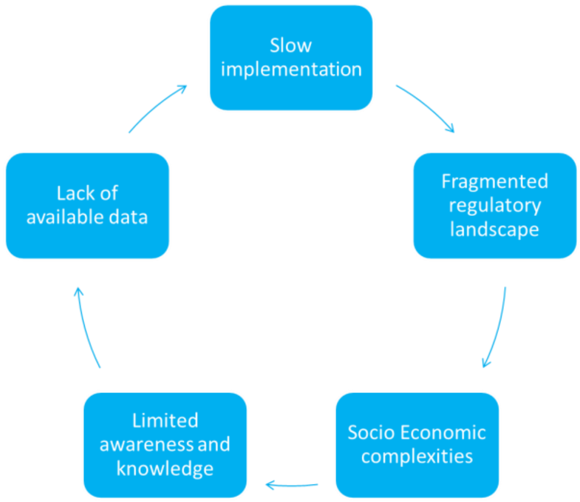
H. A shift of mindset:

Traditionally, wastewater in India has been seen as a waste product. However, there is a growing shift in perspective, with government initiatives and public awareness campaigns promoting wastewater as a resource. Treated wastewater can provide an alternative source for irrigation, addressing agricultural water scarcity and reducing reliance on freshwater. Advances in treatment technologies also enable the reuse of treated wastewater for non-potable urban applications, such as toilet flushing and park irrigation. This approach decreases freshwater demand and supports a more circular water economy in cities.

5.3 Market restraints for the Indian wastewater treatment market

With rapid urbanization, many Indian cities are facing significant waste management challenges. Consequently, wastewater treatment has emerged as a critical sector, promising not only environmental benefits but also the potential for water reuse and resource recovery. While the market presents a significant opportunity, its growth is not without its challenges. Beyond the frequently cited hurdles of infrastructure investment and technological adoption, several unconventional restraints hinder the sector's full potential. These restraints include:

Exhibit 5.5: Market restraints for the Indian wastewater treatment market



Source: Frost & Sullivan analysis

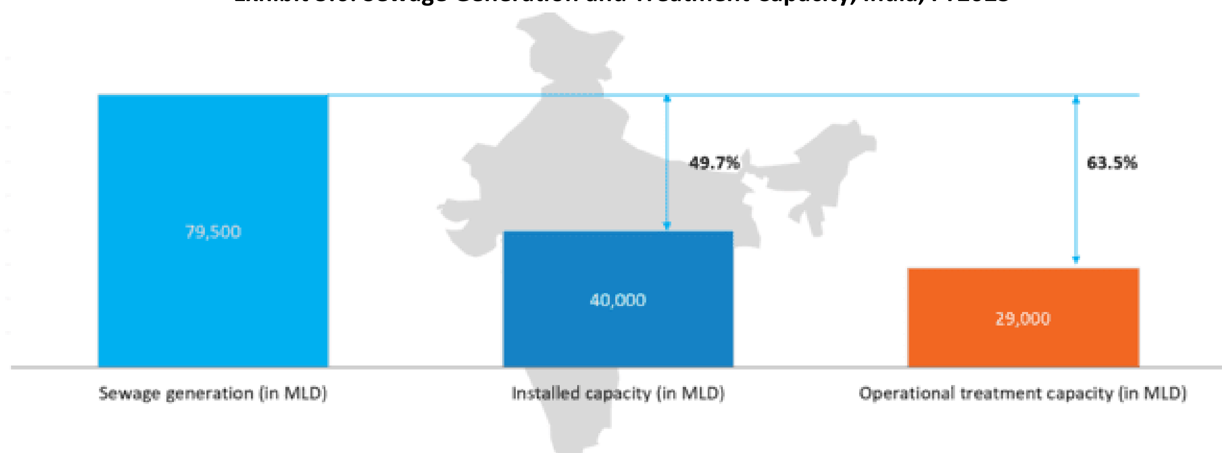
5.4 Indian sewage treatment market

India's sewage water treatment market is experiencing a surge driven by the urgent need for effective wastewater management. Expanding industries, and the alarming state of river pollution are all converging to create a critical situation. Fortunately, the Indian government recognizes this challenge and is taking steps to remedy this.

A. Sewage generation and treatment capacity in India

Stringent environmental regulations, a focus on sustainability, and infrastructure development are fostering innovation in wastewater treatment. India's urban population generates 79,500 million litres per day (MLD) of sewage, but the operational treatment capacity is only 29,000 MLD, leaving a shortfall of 50,500 MLD.

Exhibit 5.6: Sewage Generation and Treatment Capacity, India, FY2023



Source: Primary interactions, Frost & Sullivan analysis

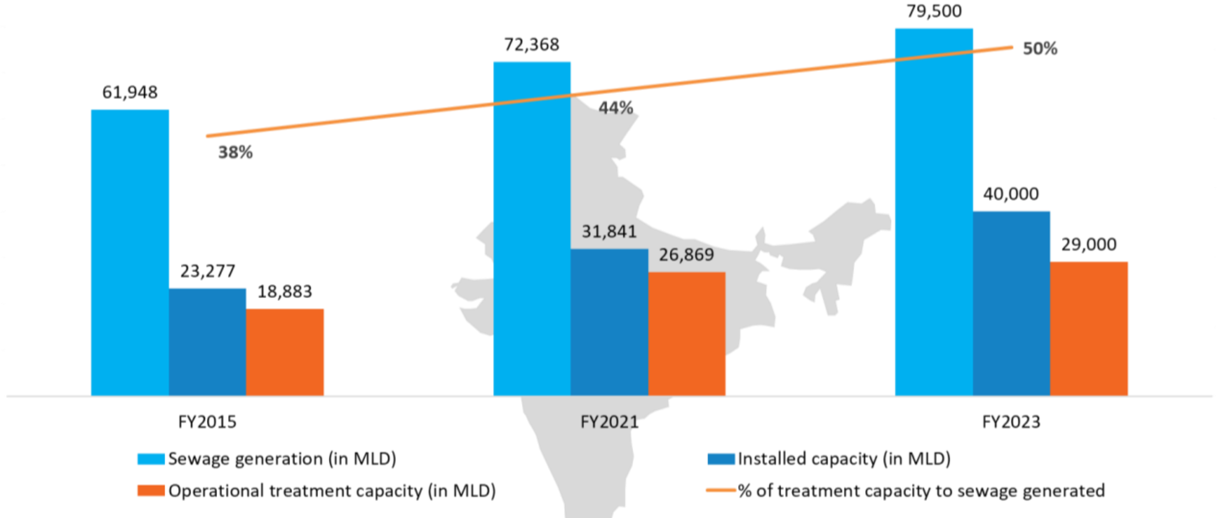
This results in 63.5% of sewage being untreated, leading to river and groundwater pollution, harming ecosystems, contaminating drinking water, and spreading waterborne diseases. Addressing these challenges requires new technologies to modernize outdated treatment plants and enhance the water cycle's sustainability.

B. Current inventory of Sewage Treatment plants in the country

Effective wastewater management is a cornerstone of environmental health and sustainable development. In India, significant efforts are underway to address the challenge of untreated sewage. A crucial aspect of this endeavor is maintaining a comprehensive inventory of existing Sewage Treatment Plants (STPs). According to the Central Pollution Control Board's (CPCB) latest report published in March 2021, India possesses a network of 1,093 Operational Sewage Treatment Plants (STPs) (no. of installed STPs being 1,469) spread across its 35 states and union territories as on June 30, 2020.

India's sewage generation for urban areas has steadily increased from 61,948 million liters per day (MLD) in FY2017 to 79,500 MLD in FY2023, reflecting urbanization and population growth. Over the same period, sewage processing capacity has risen from 23,277 MLD in FY2015 to 40,000 MLD in FY2023, indicating efforts to expand infrastructure but still lagging behind the growing sewage output. Projections show that by FY2029, sewage generation will reach 102,025 MLD, while processing capacity is expected to improve to 68,737 MLD, highlighting the need for continued investment to bridge the gap and meet environmental sustainability goals.

Exhibit 5.7(a): Sewage generation and treatment capacity in India, FY2015, FY2021 and FY2023

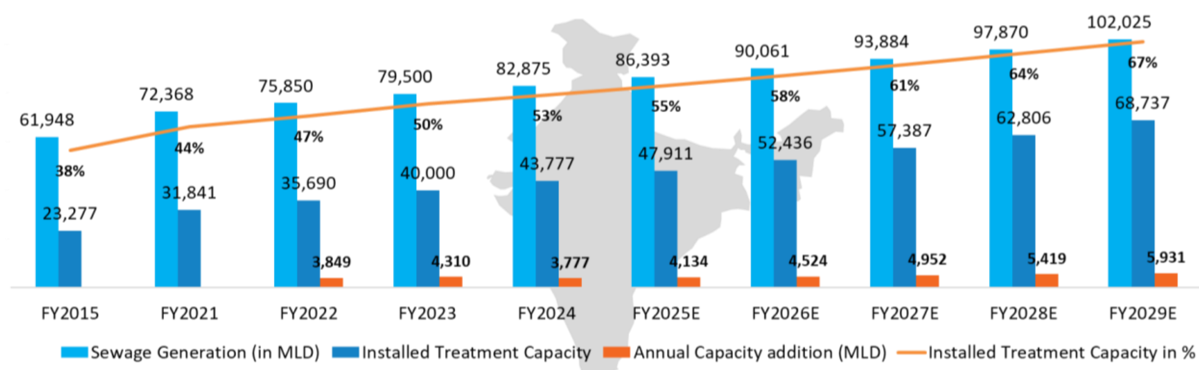


Source: National inventory of sewage treatment plants, Primary interview, Frost & Sullivan analysis

The data indicates a significant and consistent issue with the gap between sewage generation and processing capacity in India, yet it shows a promising trend of gradual improvement. From FY2015 to FY2029, sewage generation is projected to increase from 61,948 MLD to 102,025 MLD. Although installed treatment capacity is also projected to increase from 23,277 MLD in FY2015 to an estimated 68,737 MLD in FY2029, the gap between generated sewage and its processing remains substantial.

However, it is noteworthy that the gap is slowly narrowing over the years. In FY2015, the gap was 38,671 MLD, and it is projected to decrease to 33,288 MLD by FY2029. Additionally, the percentage of sewage processed has improved from 38% in FY2015 to an expected 67% by FY2029, indicating progressive strides towards enhancing sewage treatment infrastructure.

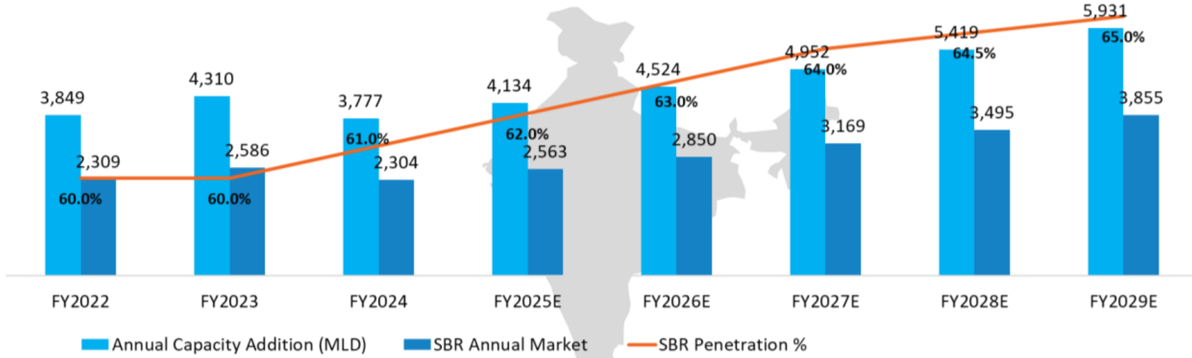
Exhibit 5.7 (b): Estimated sewage generation versus installed treatment capacity in India, FY2015 – FY2029E



Source: Primary interactions, Frost & Sullivan analysis

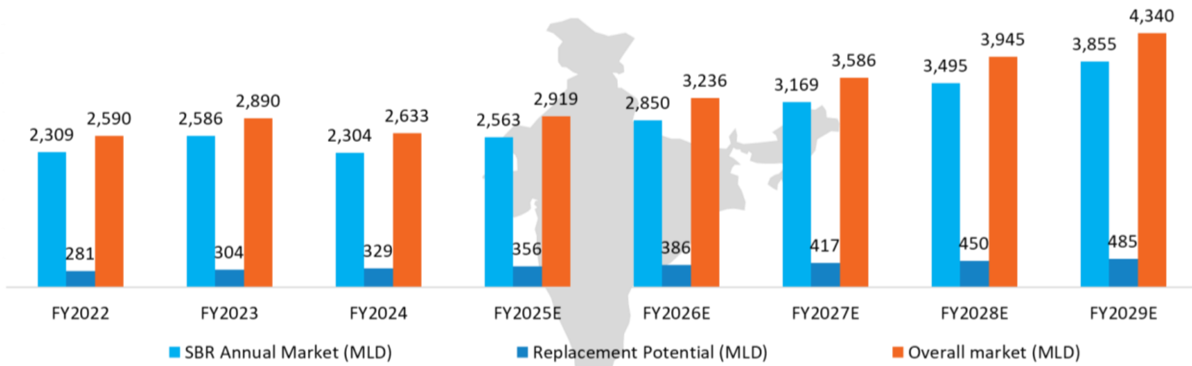
Despite these improvements, the persistent gap highlights the need for accelerated efforts in expanding sewage treatment facilities to keep pace with increasing urbanization and population growth. This challenge underscores the importance of investing in more efficient and scalable sewage treatment technologies and policies to bridge this gap more rapidly.

Exhibit 5.7 (c): Estimated annual capacity addition and penetration of SBR in India, FY2022 – FY2029E



Source: Primary interactions, Frost & Sullivan analysis

Exhibit 5.7 (d): SBR annual market, Replacement potential and overall market, India, in MLD, FY2022 – FY2029E



Source: Primary interactions, Frost & Sullivan analysis

The Sequential Batch Reactor (SBR) market is experiencing steady growth, driven by both new installations and replacement needs. The annual market for SBR systems is expected to increase from 2,309 MLD to 3,855 MLD between FY2022 and FY2029E. Replacement potential has also expanded, from 281 MLD in FY2022 and is anticipated to grow to 485 MLD by FY2029E. As a result, the overall annual market for SBR, which combines new demand and replacements, is projected to increase from 2,590 MLD in FY2022 to 4,340 MLD in FY2029E, reflecting rising investment in wastewater treatment infrastructure.

5.5 Guidelines and Governance in the Sewage Treatment Sector: Incentives and Penalties

The Indian government enforces regulations and incentives to ensure environmentally sound wastewater management in the sewage treatment industry. The Central Pollution Control Board (CPCB) mandates that certain infrastructures, including apartments, commercial projects, educational institutions, townships, and area development projects, must have sewage treatment plants (STPs) if they meet specific conditions. The regulations cover STP site selection, technology, operation, and maintenance to ensure effective and safe operation. These rules aim to promote compliance while also providing financial incentives and penalties to regulate the industry.

A. The Technology of STP

The approved STP technologies are:

- Sequential Batch Reactor (SBR) (Cyclic activated sludge technology (C-Tech) is the recent version of sequential batch reactor)
- Activated Sludge Process (ASP) (only when above 500 KLD sewage is generated).
- Membrane Bio Reactor (MBR)

- Moving Bed Bio Reactor (MBBR)

B. Regulations:

In India, housing projects over 20,000 square metres in metro cities must install private sewage treatment plants (STPs) with builders responsible for installation and five years of maintenance. Regulations have evolved since 2015, with the Central Pollution Control Board (CPCB) initially enforcing strict discharge rules, which were relaxed in 2017, leading to a decline in water quality. The National Green Tribunal (NGT) tightened these regulations in 2019, setting stricter standards for STPs on Biochemical Oxygen Demand (BOD), pH, Total Suspended Solids, Nitrogen, Chemical Oxygen Demand (COD), and Fecal Coliform levels.

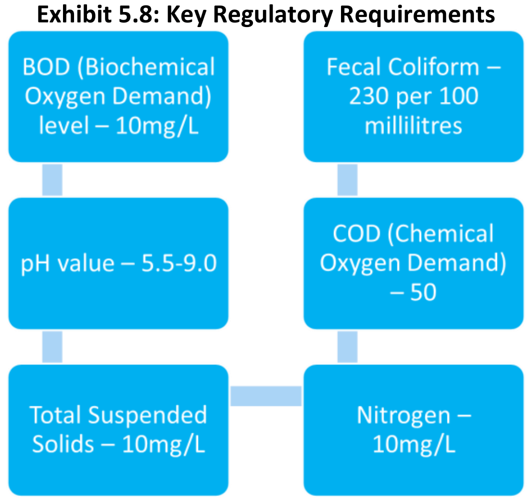
C. Incentive Structures for Investment and Participation:

The Indian government promotes sewage treatment investment through financial mechanisms like the Hybrid Annuity Model (HAM) under the National Mission for Clean Ganga (NMCG). The government covers 40% of the capital cost, while developers cover 60% and all operational costs, with repayment over 15 years. The "one city, one operator" concept is also used for efficient STP management.

D. Penalty for non-compliance:

State governments impose penalties under the Water (Prevention and Control of Pollution) Act, capped at INR 5 lakhs, which may not deter violations. The NGT has fined states a total of approximately INR 301.8 billion for mismanagement of sewage and solid waste, including INR 80,000 crore for non-compliance. Major deficiencies include unmanaged liquid waste and legacy waste, with Tamil Nadu, Maharashtra, Madhya Pradesh, and Uttar Pradesh receiving the highest penalties.

Exhibit 5.8: Key Regulatory Requirements



Source: Frost & Sullivan analysis

Exhibit 5.9: Total fine levied for non-compliance, by State

STATE	FINE (INR BILLION)
Maharashtra	120
Karnataka	29
Rajasthan	25
West Bengal	25
Telangana	25
Punjab	20

5.6 Indian Government's vision and initiatives for sewage treatment infrastructure growth

While there isn't a single, overarching national target for sewage treatment capacity growth in India, the government acknowledges the critical need for improvement. The Governments vision focuses on achieving sustainable wastewater management and minimizing water pollution through strategic initiatives and programs.

A. Vision for sewage treatment infrastructure:

Environmental Sustainability: The goal is to establish a network of efficient Sewage Treatment Plants (STPs) to prevent untreated sewage discharge into water bodies, thereby enhancing environmental sustainability.

Public Health Improvement: Proper sewage treatment aims to reduce waterborne diseases and improve public health outcomes.

Resource Recovery: The government supports the reuse of treated wastewater for non-potable purposes such as irrigation and industrial processes to promote water conservation.

B. Key Government initiatives and potential targets:

National Mission for Clean Ganga (NMCG): Launched in 2011, this initiative aims to achieve complete sewage treatment for the Ganga by 2030, significantly boosting treatment capacity along the river.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT): Initiated in 2015, AMRUT aims for universal sanitation access in cities by 2024, necessitating increased urban sewage treatment infrastructure.

Swachh Bharat Mission (SBM) Urban 2.0: In 2020, an updated program emphasized faecal sludge management and wastewater treatment, highlighting the urgent need for improved sewage treatment infrastructure. These initiatives also integrated sanitation, urban transformation, and river rejuvenation, all of which are critical components of India's broader infrastructural development plans.

5.7 Unique challenges in India's sewage treatment industry

The Indian government recognizes the critical need to improve sewage treatment infrastructure. However, the industry faces a multitude of challenges beyond the usual suspects of funding and infrastructure limitations. Here's a comprehensive analysis of 10 unique issues hindering growth:

Exhibit 5.10: Challenges in India's sewage treatment industry

Source: Frost & Sullivan analysis

5.8 Select upcoming sewage treatment plants in the country

Exhibit 5.11: Upcoming STP Plant * in India

CITY	PROJECT NAME	CAPACITY (MLD)	PROJECT COST IN INR Cr #
Ahmedabad, Gujarat	424 MLD STP Pirana AMC	424	599
Ahmedabad, Gujarat	375 MLD STP Vasna	375	778
Meerut, Uttar Pradesh	220 MLD STP Meerut	220	370
Hyderabad	965 MLD (38 STPs) (HMWSSB)	965	1,565

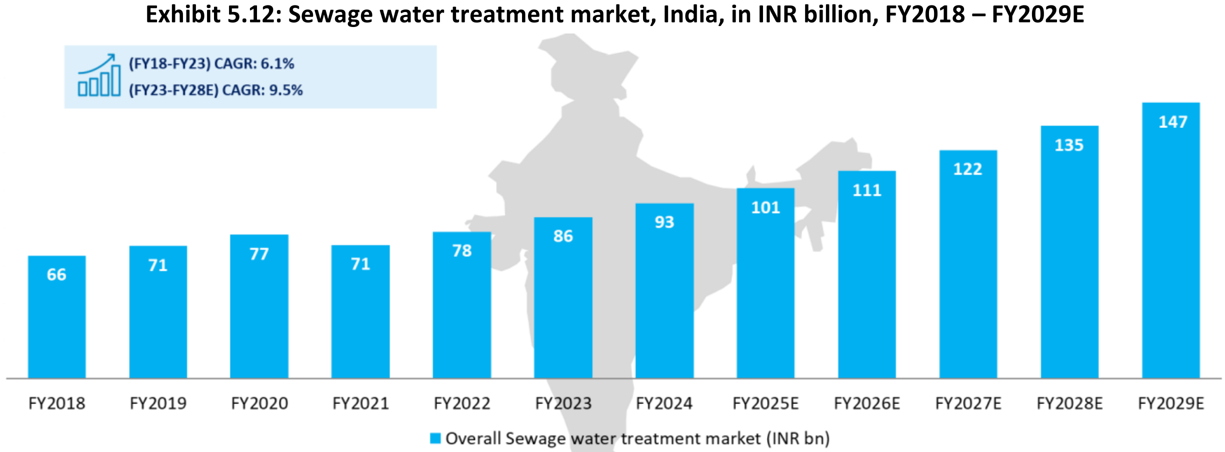
**includes projects under construction and upcoming projects at tender stage*
 # sourced from data in the public domain and this may include the cost of construction of ancillary infrastructure facilities in addition to STP

5.9 Growth forecast of the Indian Sewage Treatment market

India's urbanisation and economic growth have led to increased wastewater generation, driving government and private sector efforts to improve sewage treatment infrastructure. This collaboration is advancing the sewage treatment market through new technologies that enhance treatment efficiency and support resource recovery, such as converting wastewater into reusable water or biogas.

The Indian sewage water treatment market has grown at a CAGR of 6.1% between FY2019 and FY2024 and is projected to grow at a CAGR of 9.5% between FY2025 and FY2029. A key factor driving this growth is India's population, which, while growing at a slower rate (approximately 0.8% annually as of FY2023), still results in a significant increase in sewage generation, particularly in urban and industrial areas. The pace of sewage generation, driven by both population growth and urbanization, is expected to outpace the growth in operational sewage treatment capacity.

Exhibit 5.12: Sewage water treatment market, India, in INR billion, FY2018 – FY2029E



Source: Primary interactions, Frost & Sullivan analysis

This imbalance emphasizes the critical need for expansion and modernization of wastewater treatment infrastructure. As more people migrate to cities and industrial activity intensifies, the existing systems struggle to handle the volume of waste produced. Addressing this gap will be essential to meeting both environmental standards and public health needs.

5.10 Overview of global Treated Wastewater (TWW) reuse practices

A. Global insights into treated wastewater reuse: Key factors driving success

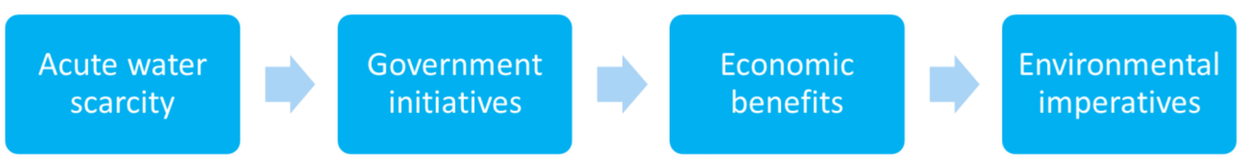
Exhibit 5.13: Global best practices adopted in three Nations

	SPAIN	ISRAEL	SINGAPORE
Challenge	Uneven water distribution with drier regions facing scarcity.	Chronic water shortage and increasing water demands.	Limited land and water sources, reliant on imports.
Solution	Legal framework established through the Spanish Royal Decree (2007) for TWW reuse.	Defined wastewater as a resource in its first Water Law (1959).	Developed a comprehensive water security strategy focusing on diversification.
	National Investment Plan (2020) promotes reuse and treatment efficiency.	Established a centralized Israel Water Authority (IWA) for water management.	Implemented the Water Master Plan (1972) creating a strong legal and institutional framework. Established the Public Utilities Board (PUB) to manage water supply, treatment, and reuse
Outcome	This approach led to high reuse rates in regions like Murcia and Catalonia.	This resulted in a reuse rate of nearly 90% of treated wastewater.	Currently reuses about 40% of treated wastewater, projected to reach 55% by 2060.

B. Treated Wastewater Reuse in India: A Unique Opportunity for Water Security

Water scarcity is a growing threat across the globe, with burgeoning populations and climate change putting immense strain on freshwater resources. Treated wastewater reuse (TWW) has emerged as a promising solution for sustainable water management.

Exhibit 5.14: Growth drivers for treated wastewater reuse in India



Source: Frost & Sullivan analysis

Exhibit 5.15: Enablers for Successful Treated Wastewater Reuse in India

Source: Frost & Sullivan analysis

While countries like Singapore and Israel have pioneered successful TWW programs, India presents a unique case. With a vast and diverse population, a rapidly growing economy, and specific socio-economic challenges, India's approach to TWW reuse needs to be tailored to its unique context.

5.11 Review of existing centre and state-level policies regarding TWW Reuse in India [2]

In the absence of specific standards and guidelines, wastewater reuse for irrigation is practised informally in India. Local governments and industries in several parts of the country earn income by selling treated or untreated wastewater to local farmers. However, a lack of comprehensive standards and policy framework is hindering the development of a formal market, appropriate technology, and sustainable business/financial models (Mahreen, 2022). Some states have already formulated policies on the reuse of treated wastewater.

Exhibit 5.16: Existing state-level and national policies for reuse of TWW

STATE	POLICY NAME	KEY HIGHLIGHTS
West Bengal	Treated Wastewater Re-use Policy of Urban West Bengal (June 2020)	Focuses on sustainable water resource management through effective re-use of treated wastewater, reducing dependency on fresh ground/surface water, and implementing reforms in planning, institution, finance, technology, and legal regulation.
Gujarat	Policy for Reuse of Treated Wastewater (May 2018)	Aims for 70% reuse of treated wastewater by 2025 and 100% by 2030, reducing dependency on freshwater sources by maximising collection and treatment of sewage.
Karnataka	Policy for Urban Wastewater Reuse (December 2017)	Promotes wastewater reuse to address water scarcity and environmental protection through resource efficiency, environmental stewardship, water security, economic benefits, and a focus on agriculture for sustainable irrigation.
Jharkhand	Wastewater Policy (2017)	Emphasizes the role of urban local bodies in wastewater management, promoting reuse with a phased approach to agricultural applications due to public health concerns. Recognises treated wastewater as a long-term renewable water resource.
Madhya Pradesh	State Level Policy for Wastewater Recycle & Faecal Sludge Management (2017)	Aligns with national sanitation goals, promoting reuse in non-agricultural urban areas like parks and green belts due to limited agricultural land in urban areas.
Andhra Pradesh	Policy on Wastewater Reuse and Recycling for Urban Local Bodies	Encourages the substitution of groundwater with treated wastewater for industrial and agricultural uses, prioritising institutional arrangements, participatory approaches, and legislative measures.
Rajasthan	State Sewerage and Wastewater Policy (2016)	Aims to improve urban health through sustainable sanitation services, targeting treated wastewater reuse for irrigation according to WHO guidelines. Includes financial models and approaches for incentivization.

[2] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.niti.gov.in/sites/default/files/2023-08/Revised_Strategy-Paper-on-Reuse-of-Treated-wastewater-in-peri-urban-agriculture-in-India.pdf

Punjab	Treated Wastewater Policy (2017)	Prioritises agricultural reuse of treated effluent with a focus on irrigation water quality, soil type, and economic feasibility to ensure crop suitability and viability.
Tamil Nadu	Treated Wastewater Reuse Policy	Encourages reuse of treated wastewater for industrial and agricultural uses through MoUs between Urban Local Bodies and user agencies for the reuse of secondary treated effluent water.
Jammu & Kashmir	State Policy for Wastewater Reuse (2017)	Formulated before the formation of UTs of Ladakh and J&K, focusing on wastewater reuse.
Chhattisgarh	Chhattisgarh's Urban Administration and Development Department	Chhattisgarh's Urban Administration and Development Department has introduced a Wastewater Recycle and Reuse Policy aimed at promoting the use of treated wastewater for non-drinking purposes. The policy seeks to balance domestic, agricultural, and industrial needs, fostering sustainable growth and minimizing conflicts over limited water resources
Haryana	Treated wastewater treatment policy, 2019	Haryana's 2019 Treated Wastewater Reuse Policy prioritizes the reuse of treated wastewater to address water scarcity and quality concerns. The reuse hierarchy includes thermal power plants, industries, construction, dual water systems, large commercial use, municipal use, and agriculture/irrigation, with agricultural use permitted only after other demands are met
Maharashtra	Maharashtra's State Water Policy	Maharashtra's State Water Policy promotes the recycling and reuse of treated wastewater and mandates penal actions against polluters. It ensures that at least 80% of water used for domestic purposes will be available for reuse. Local bodies are required to treat and make the entire generated sewage available for reuse, following standards set by the Maharashtra Pollution Control Board (MPCB). There is no separate policy specifically for wastewater reuse.
National Framework	National Framework for the Safe Reuse of Treated Wastewater (November 2022)	Developed by NMCG with NITI Aayog and others, this framework supports a circular economy approach for the safe reuse of treated wastewater to reduce pressure on surface water resources, environmental pollution, and public health risks.

5.12 Potential applications for TWW Reuse in India

Treated wastewater reuse (TWW) in India is poised for a significant transformation. Moving beyond conventional applications, a wave of innovative approaches is emerging, promising to unlock the true potential of this valuable resource. Here, we delve into this diversified landscape, exploring promising sectors and applications for TWW reuse in India:

Exhibit 5.17: Potential applications for TWW reuse in India

CATEGORY	APPLICATION	DETAILS
Rethinking Agriculture: Sustainable Irrigation	**Precision Irrigation**	Utilises drip irrigation and fertigation to deliver treated wastewater directly to roots, maximising water use efficiency and benefiting high-value crops like fruits and vegetables.
	Aquaponics	Integrates aquaculture and hydroponics; treated wastewater nourishes fish, and nutrient-rich water fertilizes plants, creating a sustainable, closed-loop system.
	Bioremediation & Phytoremediation	Utilises treated wastewater to irrigate tree plantations or constructed wetlands, acting as biofilters to remove pollutants and enhance biodiversity.
A Circular Water Economy	**Non-potable Urban Applications**	Applies treated wastewater for toilet flushing, street cleaning, and landscape irrigation, reducing freshwater reliance in cities.
	Industrial Process Water	Substitutes freshwater with treated wastewater for cooling and boiler feed in industries, especially in water-stressed zones.
	Urban Aquifer Recharge	Recharges groundwater by injecting advanced treated wastewater into aquifers, securing water resources for future use.
Embracing Innovation	**Construction Industry**	Uses treated wastewater for dust suppression, concrete curing, and mixing, reducing potable water usage in construction.
	Energy Production	Employs treated wastewater in cooling towers of thermal power plants, conserving freshwater resources.
	Sanitation and Hygiene	Provides treated wastewater for sanitation in urban slums and peri-urban areas, coupled with hygiene education to improve public health.

5.13 Current landscape and future trajectory of TWW availability in India

Exhibit 5.18: Current landscape and future trajectory of TWW availability in India

CATEGORY	ASPECT	DETAILS
Current Scenario	**Limited Treatment Capacity**	Only around 30% of India's wastewater is treated, leaving a vast resource untapped.
	Uneven Distribution	TWW generation and treatment are concentrated in urban areas, creating geographical disparities, particularly in water-stressed rural regions.
	Infrastructure Bottlenecks	Aging treatment plants and lack of distribution networks, especially in rural areas, limit TWW access and efficiency.
Emerging Trends	**Policy Push**	Initiatives like AMRUT and SBM 2.0 are driving investment in wastewater treatment, projected to increase TWW generation significantly over the next two decades.
	Technological Advancements	Innovations in modular and decentralized treatment systems offer cost-effective solutions for smaller communities, expanding TWW reach beyond major cities.
	Public-Private Partnerships (PPPs)	Collaboration between government and private entities can accelerate infrastructure development, enhancing wastewater treatment efficiency and TWW availability.
A Vision for FY2044	**Increased Availability**	A four-fold increase in TWW availability is projected by 2044, driven by policy, infrastructure, and technology improvements.

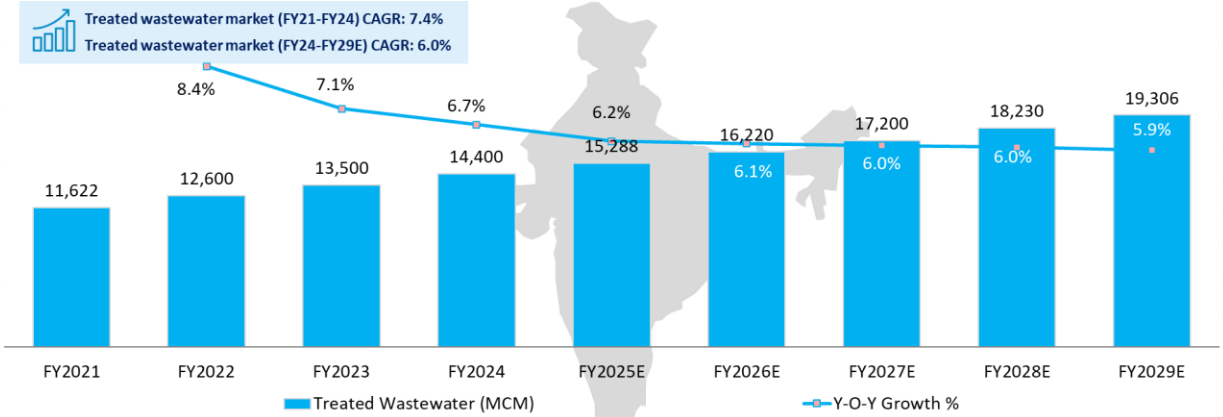
	Geographical Diversification	Investments in rural treatment and distribution networks will help bridge geographical gaps, making TWW viable for irrigation and other uses in water-stressed regions.
	Shifting Market Dynamics	As TWW availability increases, its economic value will rise, encouraging broader adoption of TWW reuse practices in industries and communities.
Challenges and Opportunities	**Challenges**	**Public Perception & Acceptance**: Negative public perception requires educational campaigns and safe reuse demonstrations.
	Regulatory Framework	Inconsistent regulations hinder TWW adoption; clear guidelines are needed.
	Treatment Infrastructure	Upgrading WWTP infrastructure, especially in smaller towns, is essential for sufficient treated water supply.
	Technological Limitations	Investment in advanced treatment technologies (C-Tech) is necessary for improving effluent quality and expanding reuse options.
	Cost Considerations	Initial costs for upgrading WWTPs and infrastructure are high; exploring PPPs and innovative financing models can improve economic feasibility.
	Skilled Workforce	Developing training programs is crucial for managing treatment plants, monitoring water quality, and educating stakeholders.
	Logistical Challenges	Developing efficient distribution methods for treated wastewater, particularly in rural areas, is vital.
	Opportunities	**Water Scarcity**: Growing water scarcity creates demand for alternative water sources, with TWW as a sustainable solution.
	Industrial & Agricultural Demand	TWW offers a reliable, cost-effective alternative for industrial processes and irrigation.
	Cost Savings	TWW reuse reduces freshwater dependency, leading to cost savings for industries, farmers, and municipalities.
	Environmental Benefits	TWW reuse reduces freshwater extraction, wastewater discharge, and promotes a circular water economy.
	Job Creation	Expanding TWW infrastructure can create jobs in construction, operation, maintenance, and related industries.
	Technological Advancements	Innovations like membrane filtration and advanced oxidation processes can improve effluent quality and reuse applications.
	Policy & Regulatory Support	Government initiatives, subsidies, and incentives can significantly accelerate TWW adoption.

5.14 Market potential for TWW reuse in India

The treated wastewater (TWW) market in India is set to grow due to increasing water scarcity and supportive government policies like AMRUT and SBM 2.0. The treated wastewater (TWW), in almost entirety, is either discharged to the watercourses or being used for irrigating parks, lawns or public places. Its reuse for non-potable purposes, such as crop irrigation, industrial processes, and groundwater recharge, is still relatively uncommon.

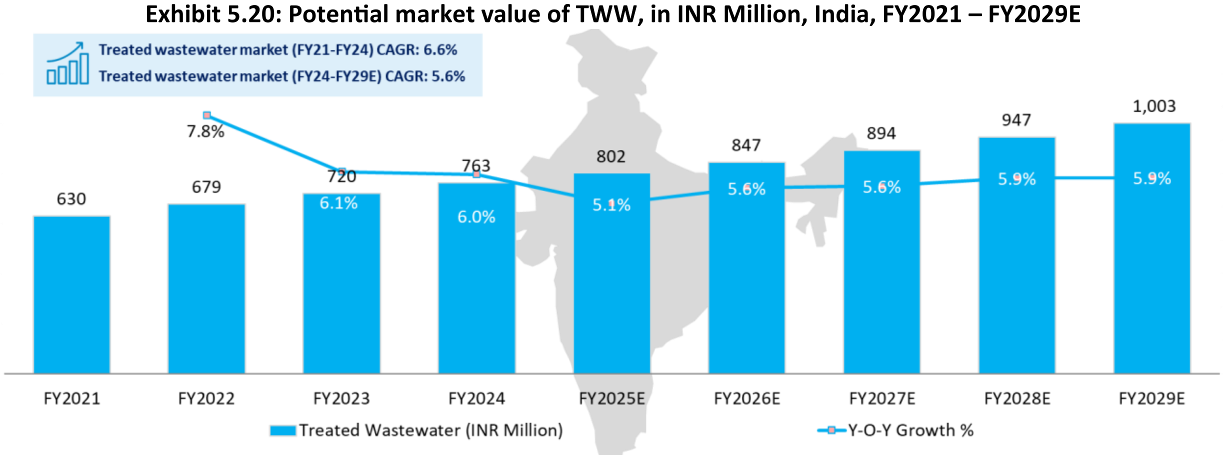
Only a small fraction of treated wastewater finds its way back into productive use, representing an untapped resource that could alleviate water scarcity concerns. As inferred from the inventory of STPs published by CPCB, just less than 1,000 MLD, which is about 3% of treated wastewater and 1% of wastewater generated, is being reused for some valuable purposes.

Exhibit 5.19: Market potential for treated wastewater reuse, in India, in MCM, Per annum, FY2021 – FY2029E



Source: Primary interactions, Frost & Sullivan knowledge repository and analysis

Exhibit 5.20: Potential market value of TWW, in INR Million, India, FY2021 – FY2029E



Source: Primary interactions, Frost & Sullivan knowledge repository and analysis

Non-utilization of TWW is a waste of resources, the capital cost of the treatment facility, and the expense incurred in treating the used water. These factors are driving infrastructure development and stricter wastewater treatment regulations, positioning treated wastewater as a valuable resource. In FY2024, India had approximately 14,400 MCM of treated wastewater available for potential reuse. This is projected to rise to 15,288 MCM by FY2025 and 19,306 MCM by FY2029E. In FY2023, around 8,603 MCM of treated wastewater could have been reused in irrigation, potentially irrigating 1.38 million hectares of land, equivalent to nine times the area of New Delhi. .

5.15 Additional economic benefits from the reuse of treated water

A. Reduction in fertilizer usage

Wastewater contains valuable nutrients (nitrogen, phosphorus, and potassium, or NPK). Thus, reusing treated wastewater for irrigation can aid crop growth and reduce the demand for synthetic fertilizer use. This can lead to both environmental and economic benefits. the nutrients from currently available TWW for irrigation amount to more than 6,000 tonnes. On account of this inherent nutrient value, irrigation using TWW has the potential to reduce fertilizer usage by 9–10 per cent.

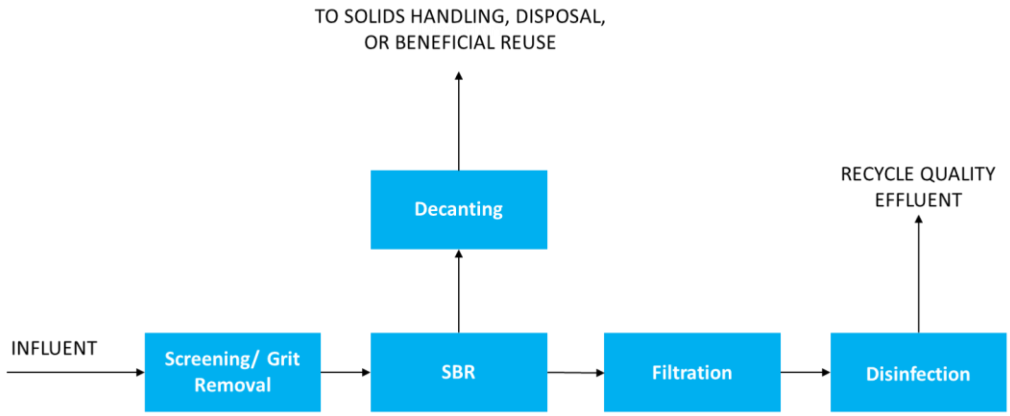
B. Reduction in area irrigated by groundwater and GHG emissions

India has a net irrigated area of 68.2 Mha, of which 60% (about 39 Mha) is irrigated through groundwater. The available treated wastewater would have the potential to irrigate 3 Mha by 2050. This would have reduced pumping in 3.5% of the groundwater-irrigated area in FY2021, which will increase to 8% by FY2050.

5.16 Overview of SBR technology

The Sequencing Batch Reactor (SBR) is a key wastewater treatment technology in India, representing about 28% to 30% of installed capacity for municipal and industrial plants. It treats wastewater in a single batch reactor, combining equalisation, aeration, clarification and nutrient removal (nitrogen and phosphorus). Wastewater is screened and grit is removed before entering a partially filled reactor with acclimated biomass. The reactor operates in batches, performing aeration and mixing, then allowing biomass to settle before removing treated water. Excess biomass is periodically removed to maintain the proper influent-to-biomass ratio. In continuous flow systems, this ratio is maintained by adjusting return activated sludge flowrates. After SBR treatment, the wastewater may flow to an equalisation basin for controlled flow to additional processes. In some cases, it is further filtered and disinfected.

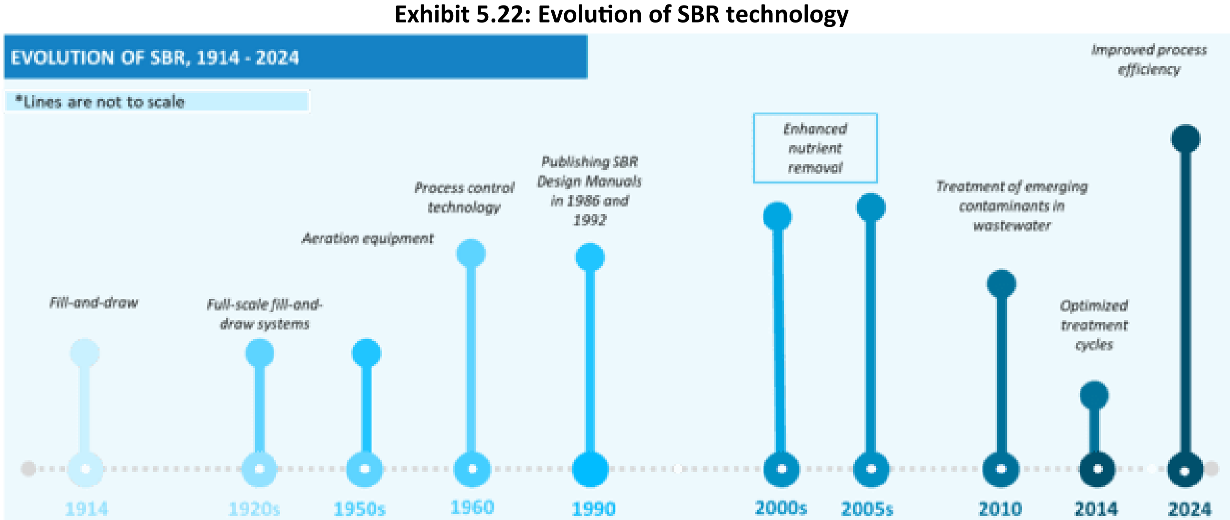
Exhibit 5.21: Process flow diagram for a typical SBR



Source: Frost & Sullivan analysis

The SBR technology, though not entirely new, has seen a resurgence in recent decades due to its flexibility and efficiency.

Exhibit 5.22: Evolution of SBR technology



Source: Frost & Sullivan analysis

5.17 Overview of C-Tech process

C-Tech is the latest generation SBR process, employed extensively for treating both domestic sewage and industrial effluents to achieve recyclable quality water with low life cycle cost, and has installations in many countries, including UK, Germany, Poland, Austria, China, Russia, Australia, Vietnam and Malaysia. Unlike traditional SBR systems, C-TECH uses two or more batch tanks in parallel, with their sequences out of phase, allowing continuous flow without the need for an upstream buffer tank. This design reduces the site footprint by approximately 50%. C-TECH operates as a cyclic-activated sludge process and is fully automated through PLC and SCADA, requiring minimal operator intervention. C-Tech technology offers up to 40% savings in power consumption as compared to other conventional technologies, thereby reducing the overall O&M cost of the STP.

C-Tech is a versatile technology that effectively handles seasonal, diurnal and quality variations compared to conventional technologies by automatically adjusting water level, decanting rate and air supply, and has successfully been implemented to treat wastewater from refineries / pharmaceutical / petrochemical / textile industries.

The C-TECH system features several circular or rectangular batch reactor basins, each with an anoxic-anaerobic selector zone, aeration zone, internal recycle, decant arm, and an oxygen uptake rate (OUR) based aeration control system. It operates with one equalization tank and one tank or with two or more batch tanks in parallel, with their cycles out of phase, enabling continuous flow and eliminating the need for an upstream buffer tank, thus reducing space requirements compared to traditional SBR systems. C-Tech is SFC's proprietary technology for wastewater treatment which is an advanced technology for treating sewage and effluents. The Company was the first technology provider in the SBR space, with the introduction of C-Tech in India in the WWT segment. A primary advantage of the C-Tech system, as compared to other conventional technologies, is that it offers an efficient method of a cyclic activated sludge treatment, that produces a recyclable quality effluent in a single step. This proprietary technology is not only superior to conventional systems but also drives significant cost, space, and environmental benefits. This technology stands out for its ability to handle large volumes of sewage, achieving superior treatment efficiency with a smaller footprint compared to traditional systems.

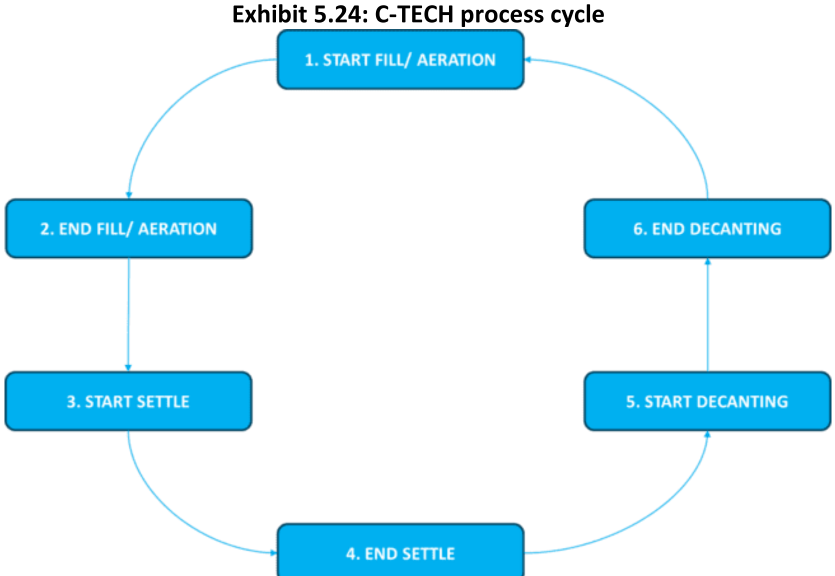
Exhibit 5.23: Summary of C-TECH Wastewater Treatment System

ASPECT	DETAILS
Process Flow	**Fill and Anoxic Mix:** Influent fills reactor; mixed with previous cycle effluent for microorganisms. Anoxic conditions favour PAOs for nutrient removal.
	Aeration: Dissolved oxygen increases, promoting aerobic bacteria growth.
	Settle: After aeration, solids settle; clarified supernatant is treated effluent.
	Decant: Clarified effluent removed from the top; sludge may be withdrawn.
Performance Parameters	**Effluent Quality:**
	BOD: ≤ 10 mg/l (typical 5-10 mg/l).
	SS: ≤ 10 mg/l (typical 5-10 mg/l).
	TN: ≤ 10 mg/l (typical 5-10 mg/l).

	TP: ≤ 1 mg/l (typical 0.5-1 mg/l).
	Process Efficiency:
	SVI: Target 40 mL/g – 60 mL/g
	Cycle Time: 3-6 hours.
	OUR: Oxygen Uptake Rate control for energy optimisation.
	Footprint: 30-50% reduction compared to conventional SBRs.
	Costs: 10-20% capital cost savings; 75-85% energy savings compared to ASPs.
Benefits	High efficiency, compact footprint, flexibility, low energy consumption.
Applications	Municipal and industrial wastewater treatment, small communities, remote locations.

C-Tech uses the latest automation technology, using the PLC / SCADA systems. The process automation is designed for operation without manual intervention and the performance of the STP is independent of the operators' skill. C-Tech technology introduced three path-breaking innovations, namely bacterial selection by using selectors prior to main treatment, concurrent nitrification and denitrification, and biological phosphorus removal by unique process designed based on simply switching air on and off, thereby facilitating the efficient removal of both carbon and nutrients (nitrogen and phosphorus) in a single treatment step, while also generating sludge with very low SVI, which results in excellent settling of suspended solids giving a crystal clear outlet with low suspended solids (<10 ppm) and BOD (< 5-10 ppm).

Exhibit 5.24: C-TECH process cycle



Source: Frost & Sullivan analysis

With 621 C-Tech installations commissioned in the wastewater treatment segment, particularly in STPs, SFC holds over 80% market share in SBR technology in India, as of September 2024. This demonstrates their experience and leadership in this technology. SFC's C-Tech technology has been implemented in the large-scale SBR-based STPs in India, including one of the largest STP under development, which has a treatment capacity of 375 MLD wastewater, as of November 2024. Over the years, the Company has successfully executed diverse portfolio of projects spanning various capacities and geographical locations.

This underscores the Company's reliability, trustworthiness, and ability to consistently deliver value, solidifying its position as a preferred partner in the industry. The company's C-Tech technology generates sludge having one of the best sludge volume index ("SVI"), offering up to 98% biochemical oxygen demand ("BOD") removal efficiency in a single step.

These projects span diverse locations, including Germany, the UK, Austria, China, Iran, Saudi Arabia, Hungary, Mexico, and importantly, India. SFC's C-Tech technology has been implemented in the large-scale SBR-based STPs in India which has an impressive treatment capacity of 375 MLD (under construction) wastewater and even smaller plants handling 0.35 MLD. This demonstrates the company's ability to cater to diverse wastewater treatment needs across the country. This positions C-Tech as a promising technology for efficient and sustainable wastewater management in India.

5.18 The evolving landscape of sewage treatment: A comparative analysis of prominent technologies

Effective sewage treatment is crucial for public health and environmental protection. With rising urbanisation and industrial activity, efficient wastewater treatment solutions are increasingly needed. This report examines key technologies in the global sewage treatment market, including C-Tech, and benchmarks their performance on parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and capital investment costs. The following section will provide a structured comparison of these technologies, assessing their effectiveness and cost-efficiency.

Exhibit 5.25: Performance Comparison of Sewage Treatment Technologies, India, for 1,000 MLD plant

TECHNOLOGY	BOD/COD REMOVAL EFFICIENCY (%)	TSS REMOVAL EFFICIENCY (%)	NUTRIENT REMOVAL	LAND FOOTPRINT (HECTARES)	ESTIMATED CAPITAL (₹ CRORE)	OPERATION-AL COST (₹ PER M3)
Activated Sludge Process (ASP)	BOD: 80-90 COD: 90-95	85-90	Moderate (Additional processes needed)	10-15	200-250	3-5
Membrane Bioreactors (MBRs)	BOD: 90-95 COD: 95-98	98-99	High (Nitrogen and Phosphorus removal possible)	5-8	300-400	4-6
Trickling Filters	BOD: 80-85 COD: 85-90	80-85	Low (Additional processes needed)	20-25	100-150	2-4
Lagoons	BOD: 60-70 COD: 70-80	60-70	Low (Natural processes)	40-50	50-80	1-2
C-Tech (SBR Variant)	BOD: 90-98 COD: 90-95	90-95	High (Nitrogen and Phosphorus removal possible)	8-12	250-300	3-5

Key considerations:

CRITERIA	HIGH	MEDIUM	LOW
BOD/COD Removal Efficiency	Excellent: Removes most organic pollutants effectively	Moderate: May require additional treatment steps for stricter regulations	-
TSS Removal Efficiency	Excellent: Removes most pollutants effectively	Moderate: May require additional treatment steps	-
Nutrient Removal	Efficiently removes nitrogen and phosphorus	May require additional processes for advanced nutrient removal	Limited nutrient removal capabilities
Land Footprint	Requires significant space	Moderate land needs	Minimal land area required
Capital Investment	Highest upfront costs	Moderate initial investment	Very low initial costs
Operational Cost	Requires significant ongoing maintenance and energy consumption	Moderate operational expenses	Low maintenance and energy requirements

5.19 Benchmarking SBR (Sequential Batch Reactor) technologies

SBR technology offers a flexible and efficient wastewater treatment approach. However, various configurations and operational modifications exist within the SBR umbrella. Here's a breakdown comparing some prominent versions:

Factors for Comparison:

- Treatment Efficiency: Measured by BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) removal rates.
- Nutrient Removal: The capability to remove nitrogen and phosphorus, increasingly crucial for stricter regulations.
- Footprint: Land area required for the treatment system.
- Operational Complexity: Level of automation and operator skill required.
- Sludge Management: Methods for handling and disposing of excess sludge produced.

Exhibit 5.26: Advanced Sequencing Batch Reactor (SBR) Technologies Comparison (1000 MLD Plant)

TECHNOLOGY	TREATMENT EFFICIENCY (BOD/COD) %	NUTRIENT REMOVAL	FOOTPRINT (Hectares)	OPERATIONAL COMPLEXITY	SLUDGE MANAGEMENT

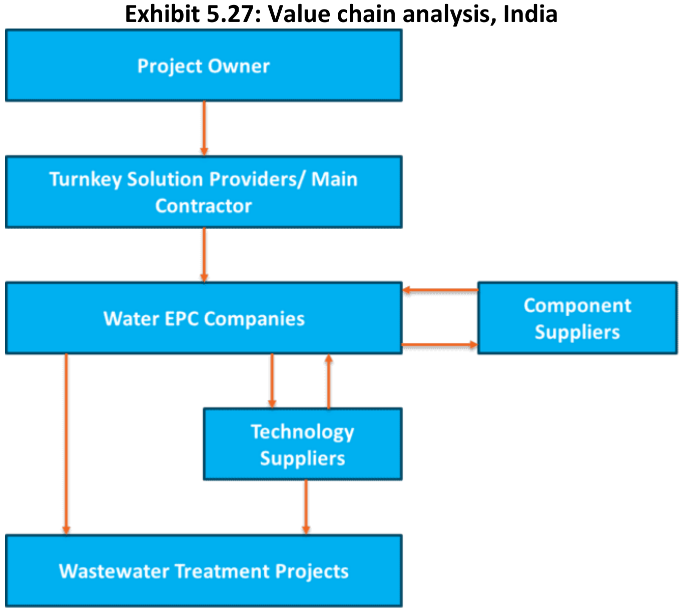
Conventional SBR	BOD: 85-90 COD: 90-95	Moderate (Additional processes for N & P removal might be needed)	8-12	Moderate	Requires periodic wasting (around 5-10% of treated effluent)
Modified Ludzack-Ettinger (MLE)	BOD: 85-90 COD: 90-95	Moderate (Additional processes for N & P removal might be needed)	8-12	Moderate	Similar to conventional SBR (periodic wasting)
Intermittent Cycle Extended Aeration System (ICEAS)	BOD: 85-90 COD: 90-95	Moderate (Additional processes for N & P removal might be needed)	8-12	Moderate	Similar to conventional SBR (periodic wasting)
C-Tech (Cyclic Activated Sludge with biological selector)	BOD: 90-95 COD: 95-98	High (Nitrogen & Phosphorus removal)	5-8	High (Automated operation)	Requires periodic wasting (around 2-5% of treated effluent)

5.20 Value chain analysis of the Indian wastewater treatment sector: Key stakeholders

India's wastewater treatment sector is expanding due to rising water scarcity, stricter effluent discharge regulations, and government sanitation and infrastructure initiatives. The sector's value chain involves several key stakeholders:

- **Project Owners**: Government agencies, industries, or private developers who identify the need for treatment plants, define project requirements, secure financing, and obtain permits.

Exhibit 5.27: Value chain analysis, India



Source: Frost & Sullivan analysis

- **Turnkey Solution Providers/Water EPC Companies**: They handle project design, procurement, construction, and commissioning. Some also offer operation and maintenance services. They may focus on specific aspects of a project or technology.
- **Component Suppliers**: Manufacturers and distributors of essential equipment such as pumps, valves, and clarifiers, providing critical components for treatment plants.
- **Technology Suppliers**: Companies that develop and license wastewater treatment technologies (e.g., activated sludge, MBRs, SBRs), offering expertise in design and operation.
- **Wastewater Treatment Plants**: The facilities where wastewater is treated to meet discharge standards and enable resource recovery.

Project owners work with turnkey providers or EPC companies to define project scope and select appropriate technology. These companies collaborate with technology and component suppliers to procure equipment and ensure regulatory compliance.

5.21 Competitive landscape

The Indian sewage water treatment sector is witnessing significant growth, driven by stricter environmental regulations, and increasing urbanization. This growth has fostered a diverse market with a range of companies offering various services.

Exhibit 5.28: Leading Sewage Technology and Equipment Suppliers, Revenue, FY2024

NAME OF COMPANY	FY2024 REVENUE IN INR MILLION
SFC Environmental Technologies	6,583.9
Thermax	93,234.6
Xylem Inc.	5,924.3
Praj Industries	34,662.8
Alfa Laval	NA
Ion Exchange	23,478.5

Note: Va Tech Wabag is not a close peer to SFC Environmental Technologies as major portion of their revenue comes from EPC

5.22 Leading industrial wastewater treatment solution

Technology landscape:

- **Sequencing Batch Reactor (SBR):** This technology is widely used for the treatment of sewage due to its ability to achieve efficient treatment with lower sludge volume and potentially lower energy consumption compared to the other technologies. The table given below offers ballpark estimates for the Indian sewage water treatment sector.

Exhibit 5.29: Market share of leading solutions with technology market share estimates

SEWAGE WATER TREATMENT TECHNOLOGY	ESTIMATED MARKET SHARE (%)	ESTIMATED MARKET SHARE IN INCREMENTAL TREATMENT CAPACITY FY2015 – FY2021 (%)
Sequencing Batch Reactor (SBR)	30-35%	60%
Others	65- 70%	40%

- Other Technologies include Activated Sludge Process (ASP), Membrane Bioreactor (MBR), Moving Bed Biofilm Reactor (MBBR), Upflow Anaerobic Sludge Blanket (UASB), Extended Aeration (EA), Fluidized Aerobic Bed Reactor (FAB), Oxidation Pond (OP), Waste Stabilization Pond (WSP), Aerated Lagoon (AL), Trickling Filter (TF), Bio-Tower, Electro Coagulation (EC), FMBR and Root Zone etc.

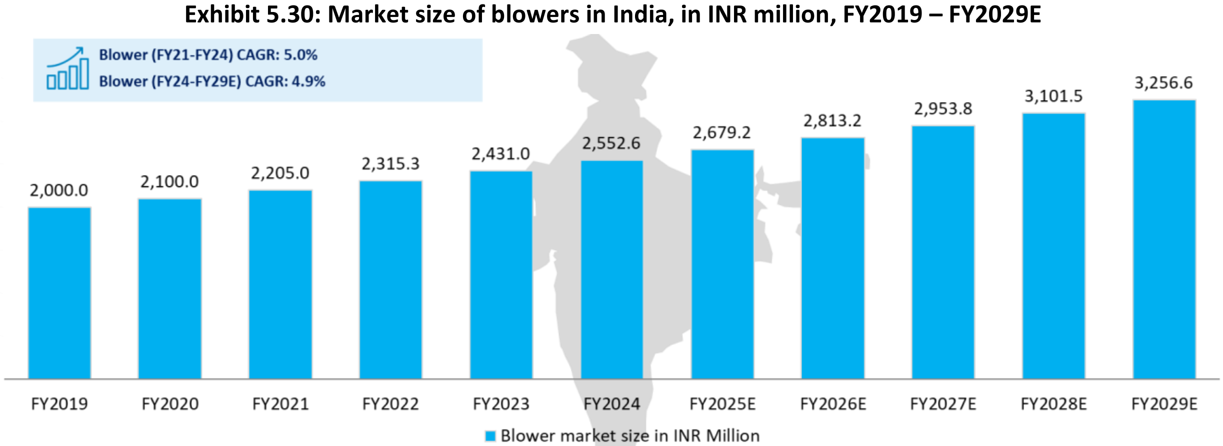
5.23 Overview of Blowers and Fibre Disc Filters

Efficient wastewater treatment is crucial for environmental protection and public health. Municipal STPs play a vital role in treating sewage before discharging it into water bodies. Blowers and disc filters are two key components of modern STPs, each contributing significantly to the treatment process.

Blowers:

- **Function:** Blowers provide the essential air supply for the biological treatment process in STPs. This aeration process allows bacteria to break down organic matter present in the sewage.
- **Types:** There are various types of blowers used in STPs, including positive displacement blowers and centrifugal blowers. The choice depends on factors like required airflow, pressure, and energy efficiency.
- **Benefits in STPs:** Efficient aeration is critical for maintaining healthy bacterial populations and optimizing treatment. Blowers ensure adequate oxygen supply, leading to improved effluent quality and reduced odour problems.

Exhibit 5.30: Market size of blowers in India, in INR million, FY2019 – FY2029E



Source: Primary interactions, Frost & Sullivan knowledge repository and analysis

Note: In terms of cost breakdown, blowers are estimated to contribute approximately 5% to 8% of the total STP capital cost.

Disc Filters:

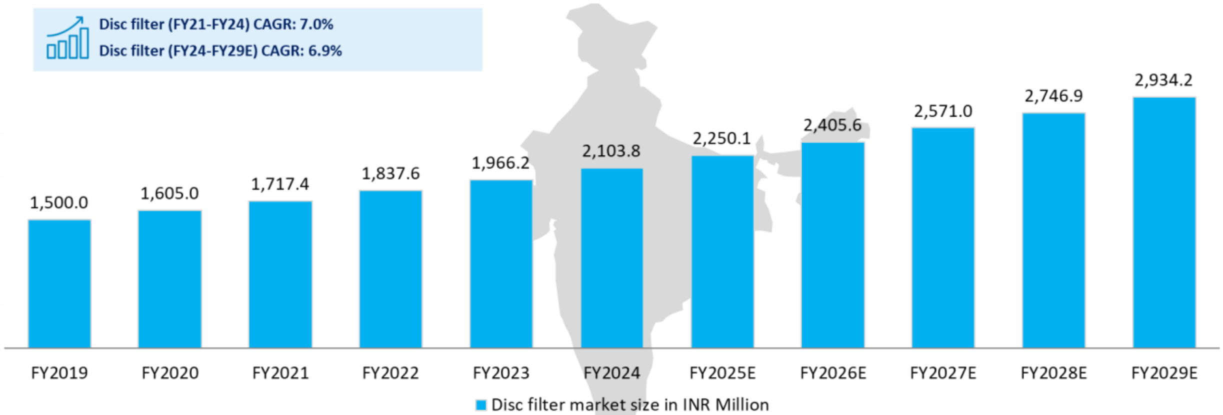
- **Function:** Disc filters are advanced filtration systems used in STPs for separating solids from the treated wastewater.
- **Components:** It consists of a series of discs that rotate partially submerged in the wastewater. Solids get captured between the discs, and the rotation helps remove them for further processing.
- **Benefits in STPs:** Disc filters offer several advantages over conventional filtration systems like sand filters. They have a smaller footprint, require less maintenance, and provide superior effluent quality with lower solids content.

Combined Application in Municipal STPs:

Blowers and disc filters work together in STPs to achieve efficient wastewater treatment:

- **Blowers provide aeration:** This creates an oxygen-rich environment for bacteria to break down organic pollutants in the sewage.

Exhibit 5.31: Market size of disc filters in India, in INR million, FY2019 – FY2029E



Source: Primary interactions, Frost & Sullivan knowledge repository and analysis

- **Disc filters remove solids:** After biological treatment, disc filters effectively remove any remaining solids from the treated wastewater, ensuring it meets the required discharge standards.

Note: In terms of cost breakdown, disc filters are estimated to contribute approximately 5% to 8% of the total STP capital cost.

A. Expanding the Reach: Applications of Blowers and Disc Filters Beyond Municipal STPs

While blowers and disc filters play a critical role in municipal Sewage Treatment Plants (STPs), their capabilities extend far beyond treating wastewater from households. These technologies offer efficient solutions for various other segments with similar treatment requirements.

- **Industrial Wastewater Treatment:** Industries like textiles, chemicals, and food processing use blowers for aeration and disc filters to remove pollutants and solids for compliant discharge.
- **Aquaculture:** Blowers maintain oxygen levels, and disc filters remove waste, ensuring a clean environment for aquatic life.
- **Food & Beverage Processing:** Blowers break down organic matter, while disc filters manage residual solids for wastewater treatment.
- **Other Applications:** These technologies support water reuse, environmental remediation, and wastewater treatment in pulp & paper processing.

5.24 Market presence and strategic focus of SFC Environmental Technologies

SFC has catered to a customer base across diverse end markets with footprints across various geographies, including Europe, the Middle East, Africa, and Southeast Asia. Contributing to this global growth, SFC has implemented many large-scale wastewater treatment plants utilizing SBR/C-TECH technology around the world, making it one of the leading integrated environmental companies.

The municipal wastewater treatment market features prominent players like SFC Environmental Technologies, which provides efficient technologies and comprehensive engineering solutions in the field of wastewater treatment. The Company mainly provides technology for wastewater treatment (predominantly STPs) plant projects. SFC's focus and expertise in SBR position it as a leading player, with over 80% market share in the SBR segment as of September 30, 2024. With 621 installations in the wastewater treatment segment, particularly in sewage treatment plants (STPs), SFC's technologies facilitate the treatment of 14,812.86 million litres per day (MLD) of wastewater.

SFC's relevant industry experience, technical expertise, product portfolio driven by manufacturing capabilities and exclusive tie-ups, and market presence position the company well to capitalize on the upsurge in the tertiary wastewater treatment (TWW) market. The entire value chain is addressed, from upgrading existing wastewater treatment plants to meet stricter regulations and enhancing effluent quality, to building new treatment facilities, especially in areas experiencing rapid growth. The Company provides advanced treatment of sewage and effluents using C-Tech solutions.

SFC currently produces its ultrafiltration membrane, C-MEM™, at its Czech facility, which is used for tertiary wastewater treatment. The Company recently entered into an exclusive collaboration agreement with a leading ultrafiltration technology company for the distribution of its UF membranes in tertiary wastewater treatment projects in India. This forward integration enables the Company to offer a complete suite of water treatment solutions, from initial sewage treatment to advanced tertiary processes, thereby enhancing its value proposition and market reach.

Additionally, the Company markets and sells Fibre Disc Filters (FDF) in India, procured from a South Korean company through an exclusive agreement. FDF is an industrial filtration technology that enables the treatment of water for reuse purposes. SFC also provides equipment and solutions for sewage sludge management – a potential source of additional value through resource recovery.

This comprehensive approach, encompassing design, manufacturing, installation, and potential operation and maintenance, makes SFC a vital partner in unlocking the immense economic potential of treated wastewater reuse in India.

6. OPPORTUNITY LANDSCAPE OF INDIA'S MUNICIPAL SOLID WASTE MANAGEMENT MARKET

6.1 Overview of Indian Municipal Solid Waste management market

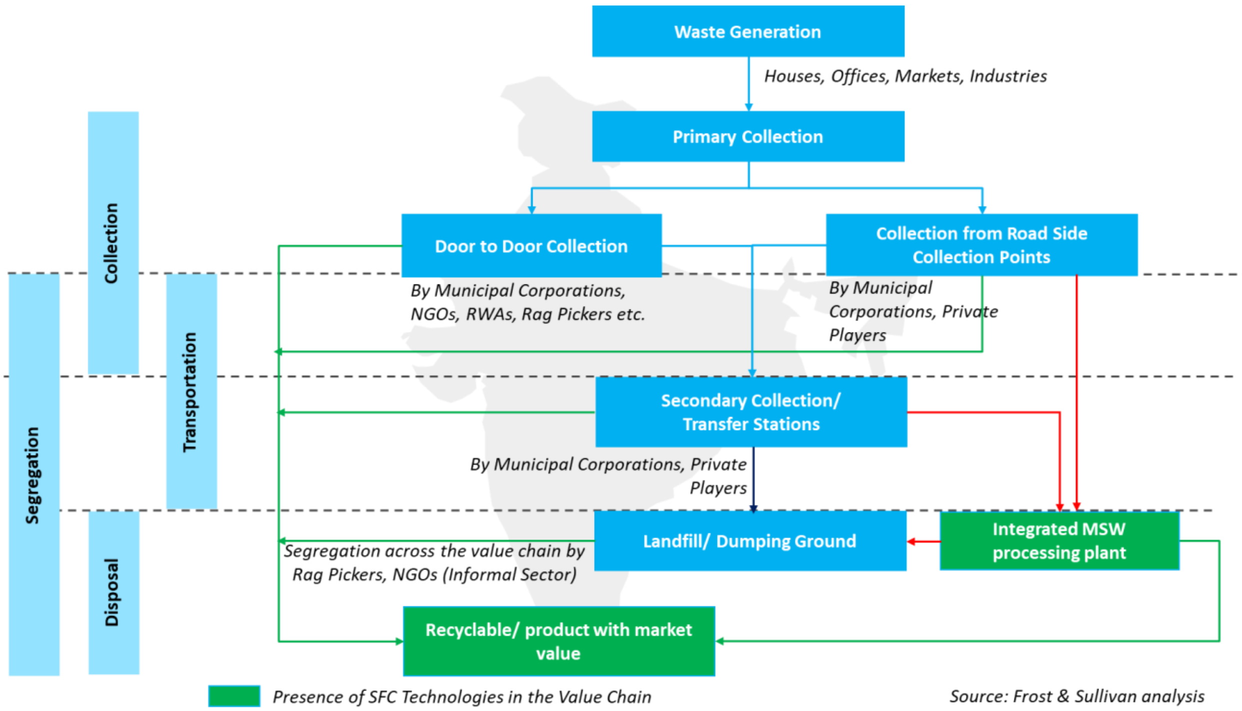
The solid waste management sector in India has experienced notable growth in recent years, primarily propelled by the government's emphasis on cleanliness and sanitation. The surge in population and rapid urbanization has led to a substantial rise in waste generation, necessitating efficient and sustainable waste management practices. The Swachh Bharat Abhiyan launched by the Government has significantly contributed to the sector's momentum, resulting in heightened demand for waste management solutions.

6.2 Municipal Solid Waste management value chain in India

The Municipal Solid Waste (MSW) management value chain begins with waste generation by households, industries, and institutions. This waste is collected by municipalities or private entities and transported to treatment facilities or landfills. At treatment facilities, organic waste is converted into compost or biogas, recyclables are processed, and non-recyclable waste is treated through incineration or landfilling.

Government bodies, waste collectors, technology providers, and recycling companies are the key stakeholders in this value chain.

Exhibit 6.1: Municipal Solid Waste Management Value Chain in India

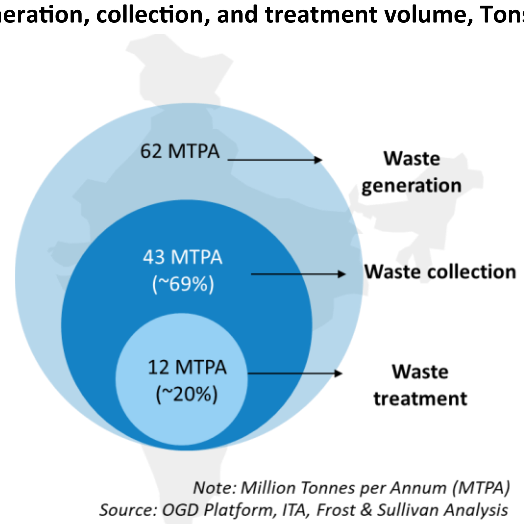


Source: Frost & Sullivan analysis

6.3 Solid waste generation and processing across various states in India

India generates over 62 million tons (MT) of waste annually with an average annual growth rate of 4%, of which 43 MT gets collected, with 12 MT (~20%) being treated before disposal and the remaining 31 MT (~50%) discarded in waste yards. The 62 MT of waste generated annually includes 7.9 MT of hazardous waste, 5.6 MT of plastic waste, 1.5 MT of e-waste, and 0.17 MT of biomedical waste.

Exhibit 6.2: Waste generation, collection, and treatment volume, Tons per Annum (TPA), India

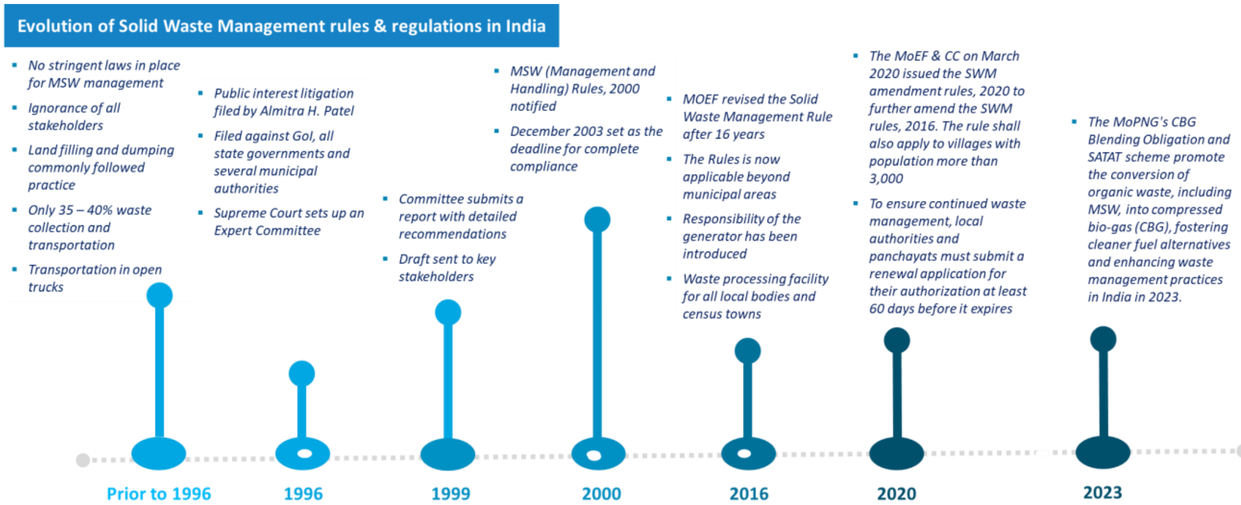


Note: Million Tonnes per Annum (MTPA)
Source: OGD Platform, ITA, Frost & Sullivan Analysis

The Swachh Bharat Mission-Urban (SBM-U), launched in October 2014, aims for a garbage-free India through 100% source segregation, door-to-door collection, and scientific waste management, including controlled landfill disposal and dumpsite remediation. The Central Pollution Control Board (CPCB) projects annual waste generation will reach 165 million tons by 2030.

6.4 Evolution of solid waste management rules and regulations in India

Exhibit 6.3: Evolution of solid waste management rules in India



Source: Frost and Sullivan Analysis

6.5 Salient features of Solid Waste Management Rules, 2016

FEATURES	DESCRIPTION	REASONS AND LIKELY IMPLICATION
SEGREGATION OF MUNICIPAL SOLID WASTE	• The SWM 2016 emphasizes source segregation, making it mandatory to separate municipal solid waste into wet and dry categories. This applies throughout the entire waste management value chain, including collection, transportation, storage, and ultimately, the treatment method used.	• SWM companies need to collect segregated waste, add compartmented or separate vehicles for dry and wet waste as well as deploy bio- methanation/ composting for wet waste and **WTE only for dry waste, post recovery of recyclables**.
PROMOTION OF MARKETING AND UTILIZATION OF COMPOST	• The Department of Fertilizers shall ensure promotion of compost with chemical fertilizers in the ratio of 3 to 4 bags: 6 to 7 bags by the fertilizer companies to the extent compost is made available. • The Ministry of Agriculture shall also facilitate manufacturing and sale of compost for usage in farmlands and issue suitable usage guidelines.	• This will make the compost plants economically viable and improve the gainful utilization of waste.
PROMOTION OF WASTE TO ENERGY PLANT	• The Ministry of Power shall fix tariff or charges for the power generated from the WtE plants and ensure compulsory purchase of power by DISCOMs from these plants. • MNRE shall facilitate infrastructure creation for WtE plants and provide appropriate subsidy or incentives for such Plants. • All industrial units using fuel and located within 100 km from a RDF plant to replace at	• This will make the waste to energy plants economically viable. • Usage of RDF by nearby industries will support the WtE and reduce the consumption of fossil fuels. • WTE plants are however commercially viable for more than 600 TPD - most of the tier 2 cities would probably need to go for bio-methanation for the wet fraction and RDF disposal to Cement

	least 5% of their fuel requirement by RDF so produced. • Non-recyclable waste having calorific value of 1,500 Kcal / Kg or more shall not be disposed and to be utilized for energy generation. • High calorific wastes shall be used for co-processing in cement or thermal power plants.	plants as RDF generation is 30% (500 TPD MSW plant will produce 150 TPD of RDF, which is not enough for a WTE plant).
CRITERIA AND STANDARDS FOR WASTE TREATMENT FACILITY AND POLLUTION CONTROL	• The SWM Rules 2016 provide for detailed criteria for setting up of solid waste processing and treatment facilities. • Emission standards are completely amended and include parameters for dioxins, furans, reduced limits for particulate matters from 150 to 100 and now 50. • Compost standards have been amended to align with Fertilizer Control Order.	• The criteria and buffer zone for waste treatment and landfill facility and stringent standards will facilitate smooth functioning of the facility without any pollution issues.
TIMEFRAME FOR IMPLEMENTATI ON	• The local bodies and other concerned authorities would be responsible for implementation of these rules. • Setting up solid waste processing facilities by all local bodies having 0.1 Mn or more population - within two years; local bodies and census towns below 0.1 Mn population – within 3 years. • Setting up of common or stand-alone sanitary landfills by or for all local bodies (0.5 million or more population) and census towns (under 0.5 million population) – within three years. • Bioremediation or capping of old and abandoned dump sites - within five years.	• This will ensure proper landfills and waste processing facilities across the country even in smaller towns.

6.6 Prominent technologies for energy generation from Municipal solid wastes

FEATURES	DESCRIPTION	EQUIPMENT USED FOR POWER GENERATION
Anaerobic Digestion/ Bio-methanation	• Organic fraction of the waste is processed through Biogas Digester. • Biogas Digester produces methane rich biogas and effluent. • Biogas can be used either for cooking / heating application, for power generation or for CBG/ Bio-CNG.	• Dual fuel / Gas Engine • LP Gas Turbine • Steam Turbine
Combustion / Incineration	• Waste is directly burned in presence of excess air (oxygen) at high temperatures (about 1,200° C), liberating heat energy, inert gases, and ash. Combustion results in transfer of 65% - 80% of heat content of organic matter. • The hot air thus produced is used to generate steam and power. Combustion / Incineration, however, is not suitable for all types of organic waste, especially when considering environmental and regulatory factors.	• Steam Turbine

Densification / Pelletization / Refused Derived Fuel (RDF)	• Segregating, crushing, and drying of inorganic material from MSW into fuel pellets is known as Refused Derived Fuel (RDF). The fuel is then used in Boilers for energy generation. • Balance waste in the dry fraction (after recovery of recyclables), often referred to as refused derived fuel ("RDF"), has a calorific value approximately between 3,000 to 3,500 Kcal/kg, making it a viable alternate fuel source for energy production or as a fuel (as replacement to coal) in cement plants.	• Steam Turbine

Based on discussions with the industry stakeholders, majority of the WtE plants in the country are based on incineration technology. There would be a handful of plants that are using Bio-methanation to generate energy from MSW. Pertinent to note that, the SWM Rules 2016, considering environmental impacts, provides for

- Bio-methanation, microbial composting, vermi-composting, anaerobic digestion or any other appropriate processing for bio-stabilisation of biodegradable wastes
- Waste to energy processes including refused derived fuel for a combustible fraction of waste or supply as feedstock to solid waste-based power plants or cement kilns.

The SWM Rules 2016 highlights the need for and resultantly provides huge future potential for energy generation based on bio-methanation/anaerobic digestion of biodegradable wastes.

6.7 Overall potential of energy generation from Municipal Solid Waste in India

With its expanding population and rapid urbanization, India has experienced a significant rise in municipal solid waste (MSW), posing notable environmental challenges.

Exhibit 6.4: Energy generation potential from Urban and Industrial organic waste in India

Sl No.	Sectors	Energy potential – MW
1	Urban Solid Waste	**1247**
2	Cattle farm (solid waste)	**862**
3	Distillery (liquid waste)	**781**
4	Vegetable Raw(solid waste)	**579**
5	Poultry (solid waste)	**462**
6	Urban Liquid waste	**375**
7	Slaughterhouse (liquid waste)	**263**
8	Paper (liquid waste)	**254**
9	Fruit Raw (solid waste)	**203**
10	Sugar press mud (solid waste)	**200**
11.a	Others (Solid Waste)*	**100**
11.b	Others (Liquid Waste)*	**364**
		5,690

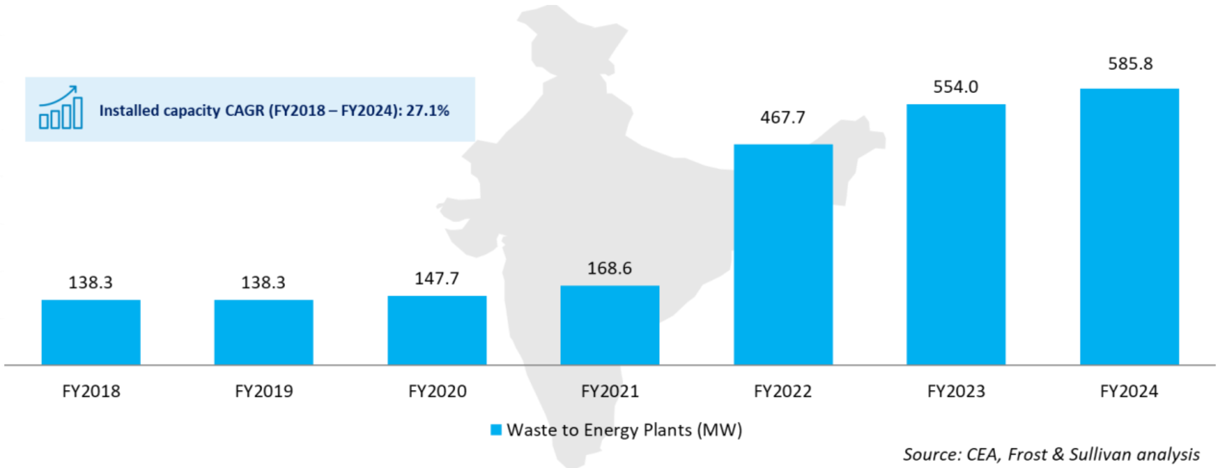
Note: Million Tonnes per Annum (MTPA)
Source: MNRE and Frost and Sullivan Analysis

As per the Ministry of New and Renewable Energy, the total estimated energy generation potential from urban and industrial organic waste in India is approximately 5690 MW.

6.8 Installed capacity of Waste to Energy plants in India and historical growth

The WTE sector in India is in focus since last 7 – 8 years due to growing challenges related to waste management and need for energy through sustainable sources thereby ensuring the country's energy security. Installed capacity of WTE plants in the country has increased by 4.2 times between FY2018 and FY2024 – from 138.3 MW in FY2018 to 585.8 MW in FY2024. These WTE plants are both grid-connected and off-grid plants and they generate power from MSW and Industrial wastes. Based on discussions with the stakeholders, approximately 25 – 27 MSW based WTE plants are operational in the country at the end of FY2024 and installed capacity of these plants are approximately 250 MW.

Exhibit 6.5: Installed capacity of Waste to Energy plants in India, in MW, FY2018 – FY2024



Source: CEA, Frost & Sullivan analysis

Reviving India's Waste-to-Energy (WTE) sector presents numerous advantages, including diminished dependence on fossil fuels, a broader energy portfolio, and bolstered energy resilience. Additionally, WTE facilities skilfully handle solid waste by easing pressure on scarce landfill capacity and tackling the escalating waste production issue. These facilities also foster employment prospects, bolstering the regional economy and livelihoods. By harnessing latent waste resources, curbing greenhouse gas (GHG) emissions, mitigating health hazards, and combating climate change, WTE initiatives resonate with Sustainable Development Goals and promote a circular economy.

6.9 Leading developers of Waste to Energy plants in India and their portfolio

The Indian Waste-to-Energy (WtE) market is fragmented, with key players including SFC Environmental Technologies, RE Sustainability, JITF Urban Infrastructure, Abellon Clean Energy, and Antony Lara Renewable Energy. These companies does processing, and recycling of waste and few of them also does collection and transportation. Out of them, RE Sustainability, JITF, and Abellon focus solely on incineration. While majority of the companies use incineration to produce electricity from wastes, SFC Environmental Technologies is the only company to use bio-methanation technology to produce Biogas/ electricity, avoiding harmful emissions and ash. SFC Environmental Technologies is among the select few players who have leveraged global technology in the MSW space and transformed it to be suitable for Indian needs. The key features of its MSW plant at North Goa are as under:

- Ability to achieve biogas yield more than the industry average. The Company has achieved an average biogas yield of more than 150 Nm^3/ton of organic waste in the North Goa Plant in the last financial year, higher than the industry average of 80-100 Nm^3/ton.
- By converting the digestate formed after the fermentation of organic fraction into high-quality compost, the process improves the marketability and price realization of the compost produced.
- The Company has capability to recover higher proportion of recyclables than the industry average through their proprietary municipal solid waste processes
- Balance waste in the dry fraction (after recovery of recyclables), often referred to as refused derived fuel ("RDF"), has a calorific value approximately between 3,000 to 3,500 Kcal/kg, making it a viable alternate fuel source for energy production or as a fuel (as replacement to coal) in cement plants.

SFC is among the market leaders in the MSW space basis their operational results and comprehensive solutions. The company currently runs a 250 TPD Municipal Waste to Biogas plant in North Goa and a 125 TPD plant in South Goa. With around 8 years of operation, the plant in North Goa holds the distinction of being one of the longest-operating integrated SWT-based biogas plants in India.

The plant deploys the Company's proprietary OREX technology. OREX is SFC's proprietary innovation, designed to efficiently separate biodegradable organics from inorganic materials and lignocellulosic fibres from mixed municipal waste. OREX automatically segregates mixed municipal waste into organic (wet) and inorganic (dry) fractions in a single step reducing the need for manual oversight, translating into lower ongoing operational costs and promotion of reuse.

OREX is a multi-stage system designed to extract maximum organics from the mixed waste and preparation of de-gritted organic slurry for downstream digesters resulting into homogenous pulped slurry having >98% biodegradable material, largely free of contaminants and non-biodegradable fractions which enhance the bio-methanization process inside digesters. This technology is particularly adept at processing the typical municipal solid waste found in India, which characteristically includes a diverse mix of bio-waste, inerts, textiles, glass, wood, metal, rubber, plastic, paper, and miscellaneous items.

Exhibit 6.6: Profile of leading Waste to Energy project developers in India, FY2024

			Waste Processing Technology					
Company Name	**Year of incorporation**	**Waste C&T**	**CBG/Bio-methanation**	**Incineration**	**Inorganic waste recycling**	**Waste Handling Capacity (TPD)**	**WTE Capacity (MW)**	**States where operational**
SFC Environmental Technologies	2005	✗	✓	✗	✓	350	2.17	South and North Goa
RE Sustainability	1994	✓	✗	✓	✓	13,500	68.5	13 states across India
Ecogreen Energy	2011	✓	✗	✓	✓	3,750	55 (proposed)	MP, UP, Haryana
JITF Urban Infrastructure	2007	✓	✗	✓	✓	~2,000	23	Delhi, Punjab
Abellon CleanEnergy	2008	✓	✗	✓	✓	3,100	Current - 45 Upcoming - 65	Gujarat
Antony Lara Renewable Energy	2018	✓	✗	✓	✓	1,000	14	Maharashtra, UP

Note: (SFC Data - Waste Handling capacity - 350 TPD, with an additional handling capacity of 75 TPD resulting in our aggregate treatment capacity of up to 425 TPD)

Source: Annual Report, Frost & Sullivan Research and analysis

The organic fraction, high in biodegradable matter and moisture, enhances the bio-methanation process. The inorganic fraction, or refuse-derived fuel (RDF), includes materials like plastics and paper. After removing metals and heavy materials, RDF is refined into high-quality fuel with a calorific value of 3,000 to 3,500 Kcal/kg. This underscores the company's reliability, trustworthiness, and ability to consistently deliver value, solidifying the company's position as a preferred partner in the industry. The company benefits from a strong brand reputation that has been cultivated over more than 19 years of industry presence.

6.10 Key growth drivers of WTE sector in India

A. Increasing waste generation and waste management expected to drive the market

India's rapid urbanization is increasing waste generation, with organic waste making up over 50% of the total. Urban growth and high population densities are creating large landfills nearing capacity. Recycling occurs through formal and informal channels, causing environmental issues such as pollution from e-waste and improper dumping.

B. Government initiatives and policies to strengthen Waste to Energy Programme

The National Bioenergy Programme promotes waste-to-energy plants through the Waste to Energy (WTE) Programme, with a budget of INR 6,000 million from FY2022 to FY2026. The programme provides financial support for Biogas, Bio CNG, and power plants using urban, industrial, and agricultural waste.

The programme allows Viability Gap Funding (VGF) up to INR 2,000 million and include two sub-schemes:

- **Infrastructure Projects**: Supports water supply, solid waste management, and wastewater treatment, offering up to 30% of the total project cost as capital grant. Additional funding can cover up to 30% of the project cost, with projects required to recover 100% of operational costs.
- **Demonstration/Pilot Projects**: Provides up to 40% of the total project cost as capital grant and 25% of the net present value of O&M costs for the first five years. Additional funding can cover up to 40% of the project cost and 25% of O&M costs.

C. Only alternative to landfilling

Landfills are considered the least desirable option for waste management due to various issues, including the emission of greenhouse gases, the requirement for large areas of land, and the potential for pollutants to contaminate soil and groundwater.

6.11 List of notable, successful, and currently operating WTE plants in India

Waste-to-energy technologies transform waste materials into various forms of energy, such as electricity, heat, or fuel, through processes like combustion, gasification, or anaerobic digestion. These technologies provide a dual benefit: they process waste that would otherwise go unused, converting it into usable energy, and they significantly reduce the volume of waste sent to landfills, thereby mitigating environmental impact.

Furthermore, waste-to-energy plants offer the added advantage of recovering valuable resources, such as metals and plastics, during the treatment process. These materials can be extracted, recycled, and reintroduced into the economy, supporting circular economy initiatives and reducing the need for virgin resource extraction. By integrating energy production with resource recovery, waste-to-energy technologies present a sustainable solution for waste management and energy generation.

Exhibit 6.7: List of notable, successful, and currently operating WTE plants in India

City	Commencement Year	Location	Capacity (MW)	Developer
North + South Goa	2014	Saligoan and Cacora	1.37 MW + 0.8 MW	SFC Environmental Technologies
Delhi	2016	Narela-Bawana	24.0	Ramky Enviro Engineers
Hyderabad	2012	Jawaharnagar	20.0	Ramky Enviro Engineers
Delhi	2012	Okhla	16.0	Jindal ITF
Delhi	2016	Gazipur	12.0	IL&FS - EverSource Capital will take over the Plant
Jabalpur	2018	Kathonda	11.5	Essel Infra; The plant will be taken over by Averda India
Hyderabad	2018	Bibinagar	11.0	RDF Power Projects Limited (IL&FS is yet to finalize the successor)
Solapur	2013	Not Known	4.0	Organic Recycling Systems
Shimla	2017	Bhariyal	1.7	Elephant Energy

Source: Frost & Sullivan research and analysis

6.12 Environmental issues and operational challenges

A. Low calorific value of solid waste in India due to improper segregation

In India, mixed waste has a calorific value of around 1,500 kcal/kg, insufficient for power generation compared to coal's 8,000 kcal/kg. Biodegradable waste, high in moisture, is more suited for composting. Segregated and dried non-recyclable waste has a higher calorific value of 2,800 to 3,500 kcal/kg, suitable for power generation. Proper segregation, ideally at the source, is crucial for meeting this calorific requirement.

B. High costs of energy production

Power generation from waste costs about INR 7-8 per unit, while traditional sources like coal and solar provide power at INR 3-4 per unit. To be competitive, waste-to-energy power prices need to be halved. Despite this, the primary goal of waste-to-energy plants is improving health, hygiene, and environmental conditions. Developers should receive adequate compensation through justified tariffs, and subsidies for capital expenditure could boost the sector. Operational costs can be offset by selling CBG and recyclables.

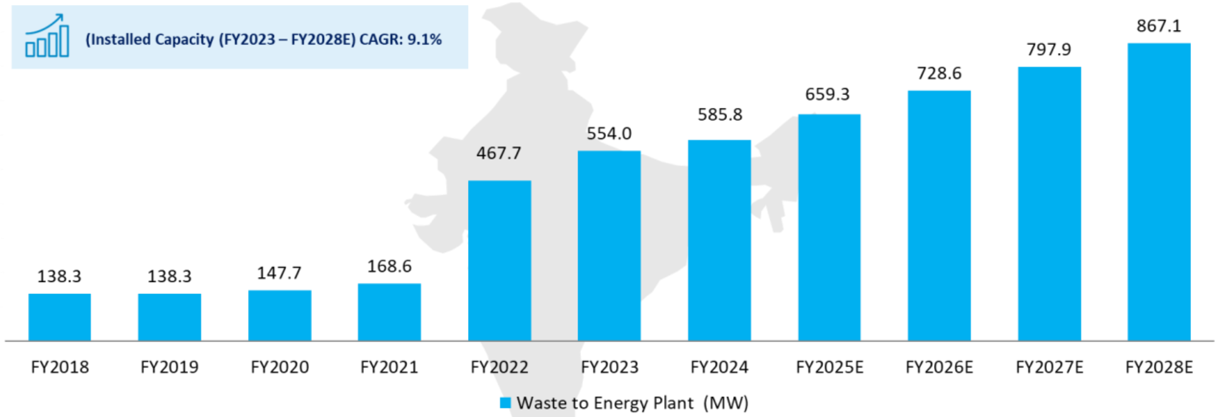
C. Improper assessments and unfavorable on-ground conditions

Many waste-to-energy projects face challenges due to poor assessments, unrealistic projections, and on-site issues. Waste volumes fluctuate due to seasonal changes, rainfall, and transient populations. These projects should use only non-recyclable dry waste, about 25% of total waste, which must be segregated to ensure effective energy generation. Successful operation depends on efficient waste collection, segregation, and processing. Issues at processing plants can increase moisture and reduce calorific value, affecting power generation efficiency.

6.13 Expected in installed capacity of WTE plants in the country

Based on discussions with the stakeholders and as per ongoing projects in the country, installed capacity of WTE projects in the country is expected to grow at approx. 9.1% CAGR to reach nearly 870 MW by FY2028. MNRE projected that India's Waste-to-Energy capacity to reach 1,075 MW by 2031 and 2,780 MW by 2050.

Exhibit 6.8: Growth forecast of WTE plants in India, MW, FY2018 – FY2028E



Source: Stakeholder Consultations, CEA, and Frost and Sullivan Analysis

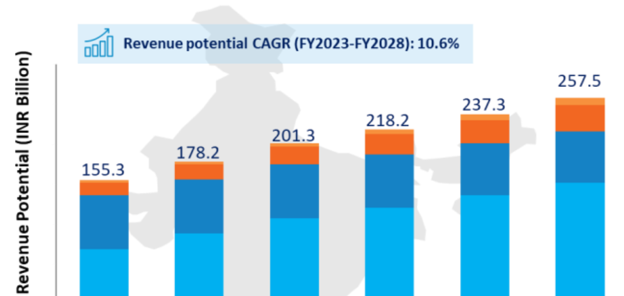
6.14 Revenue potential from MSW (CBG, Electricity, Compost, and Recyclables)

Municipal Solid Waste (MSW) has multiple revenue potentials from sales of Compressed Biogas, Electricity, Recyclables, and Compost. Based on solid waste generated in the country in FY2023 and subsequent collection and processing, revenue potential from the above-mentioned businesses were INR 155.3 billion. The potential is likely to increase to INR 257.5 billion by FY2028, growing at a CAGR of 10.6%.

Exhibit 6.9: Revenue potential from MSW related businesses, India, INR billion, FY2023-FY2028

Key assumptions for calculation of potential revenue:

Parameters	FY23	FY28E
MSW Generation (TPD)	153,818	187,143
MSW collection %	96%	100%
MSW treatment %	77%	95%
Wet waste as % waste collected	50%	50%
CBG volume (Nm^3 per TPD)	100	120
CBG price including GST (Rs./Kg)	57	75
Compost as % of wet waste	6%	7%
Compost price (Rs./Kg)	2.0	3.0
Recyclables as % of dry waste	10%	15%
Recyclables price (Rs./kg)	6.0	8.0
MW / '100 TPD RDF	2	2
Electricity price (Rs./Kg)	7.5	7.5



	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028
Compost	3.2	3.6	4.7	5.5	7.2	8.6
Recyclables	16.2	18.7	21.8	25.3	29.0	32.8
Electricity	66.8	67.3	67.7	66.6	65.3	64.0
CBG	69.1	88.6	107.1	120.8	135.8	152.2

Source: Stakeholder Consultations, Frost and Sullivan Analysis

6.15 List of announced, planning, and under-construction projects

SL. NO.	MUNICIPAL CORPORATION	LOCATION	CAPACITY (MW)	CURRENT STATUS	DEVELOPER
1	Ahmedabad Municipal Corporation	Ahmedabad Gujarat	15.0	Under Construction	JITF Power Infra
2	Kozhikodde Corporation	Kozhikode Kerala	6.0	Under Construction	Zonta Infratech Private Ltd
3	Municipal Corporation of Greater Mumbai	Mumbai Maharashtra	4.0	Under Construction	Municipal Corporation of Greater Mumbai
4	Gurgaon Municipal Corporation	Gurgaon Haryana	25.0	Under Construction	Ecogreen Energy

5	Bathinda Municipal Corporation	Bhatinda Punjab	8.0	Under Construction	Jindal ITF
6	Municipal Corporation Mohali	Mohali Punjab	7.0	Under Construction	NTPC
7	Muzaffarnagar Municipal Corporation	Muzaffarnagar Uttar Pradesh	30.0	Under Construction	NA
8	Kolkata Municipal Corporation	Kolkata West Bengal	22.5	Under Construction	NA
9	Pune Municipal Corporation	Pune Maharashtra	7.5	Under Construction	NA
10	Patna Municipal Corporation	Patna Bihar	15.0	Planning	NA
11	Roorkee Municipal Corporation	Roorkee Uttarakhand	25.0	Planning	BSR Green Power
12	Bhopal Municipal Corporation	Bhopal Madhya Pradesh	23.0	Planning	Essel Infra
13	North Delhi Municipal Corporation	Delhi	15.0	Planning	Developer yet to be decided (Re-Tendering)
14	Surat Municipal Corporation	Surat Gujarat	14.0	Planning	NTPC
15	Vadodara Municipal Corporation	Vadodara Gujarat	14.9	Planning	Abellon Clean Energy
16	Ranchi Municipal Corporation	Ranchi Jharkhand	11.0	Planning	Essel Infra
17	Munnar & Devikulam Panchayat	Munnnar Kerala	10.0	Planning	A G Dauters Waste Management
18	Jaipur Municipal Corporation	Jaipur Rajasthan	8.0	Planning	Jindal Urban Infrastructure
19	Meerut Municipal Corporation	Meerut Uttar Pradesh	12.0	Planning	Organic Recycling Systems
20	Rampur Municipal Corporation	Rampur Uttar Pradesh	8.0	Planning	NA
21	Bruhat Bangalore Mahanagara Palike	Bengaluru Karnataka	40.0	Planning	NEG / Firm Green
22	Dhanbad Municipal Corporation	Dhanbad Jharkhand	6.0	Planning	Ramky Enviro Engineers
23	Allahbad Municipal Authorities	Allahabad Uttar Pradesh	6.0	Planning	NA
24	Jodhpur Nagar Nigam	Jodhpur Rajasthan	6.0	Planning	Jindal Urban Infrastructure
25	Guwahati Municipal Corporation	Guwahati Assam	5.0	Planning	Guwahati Waste Management Company (Ramky)
26	Srinagar Municipal Corporation	Srinagar Jammu & Kashmir	5.0	Planning	Highland Automobiles, Key Stone Energy and Astrix JV
27	Greater Chennai Corporation	Chennai Tamil Nadu	32.0	Planning	Not Appointed
28	Greater Chennai Corporation	Chennai Tamil Nadu	26.0	Planning	Not Appointed
29	Nagar Nigam Ghaziabad	Ghaziabad Uttar Pradesh	60.0	Announced	NA
30	Ludhiana Municipal Corporation	Ludhiana Punjab	8.0	Announced	A2Z Company
31	Coimbatore Municipal Corporation	Coimbatore Tamil Nadu	8.0	Announced	Not Appointed
32	Kota Nagar Nigam	Kota Rajasthan	5.0	Announced	Not Appointed
33	Gorakhpur Jal Board	Gorakhpur Uttar Pradesh	5.0	Announced	Not Appointed

34	Greater Warangal Municipal Corporation	Warangal Telangana	3.0	Announced	Not Appointed

The future of Waste-to-energy conversion looks promising with several factors such as integration with existing RE system, advancement in technology, and policy support are driving the growth of the sector. Generating energy from waste is a significant step in the quest for sustainability. By transforming waste into valuable energy, dual challenges of waste management and energy production can be addressed. Advances in chemical engineering have been instrumental in developing efficient and environmentally friendly WtE technologies. Innovative Waste-to-Energy Methods will play an increasingly important role in building a sustainable future as we continue to innovate and improve these processes.

7. OPPORTUNITY LANDSCAPE OF INDIA'S BIOGAS MARKET

7.1 Role of Biogas in India's CNG/PNG ecosystem

India's energy landscape is shifting towards cleaner alternatives, with biogas emerging as a key player in enhancing the CNG and PNG ecosystem. Once considered waste, biogas, rich in methane, is now valued as a renewable resource. By converting organic matter into clean fuel, biogas can be integrated into existing CNG and PNG infrastructure, reducing reliance on imported fossil fuels and supporting a sustainable energy future for India.

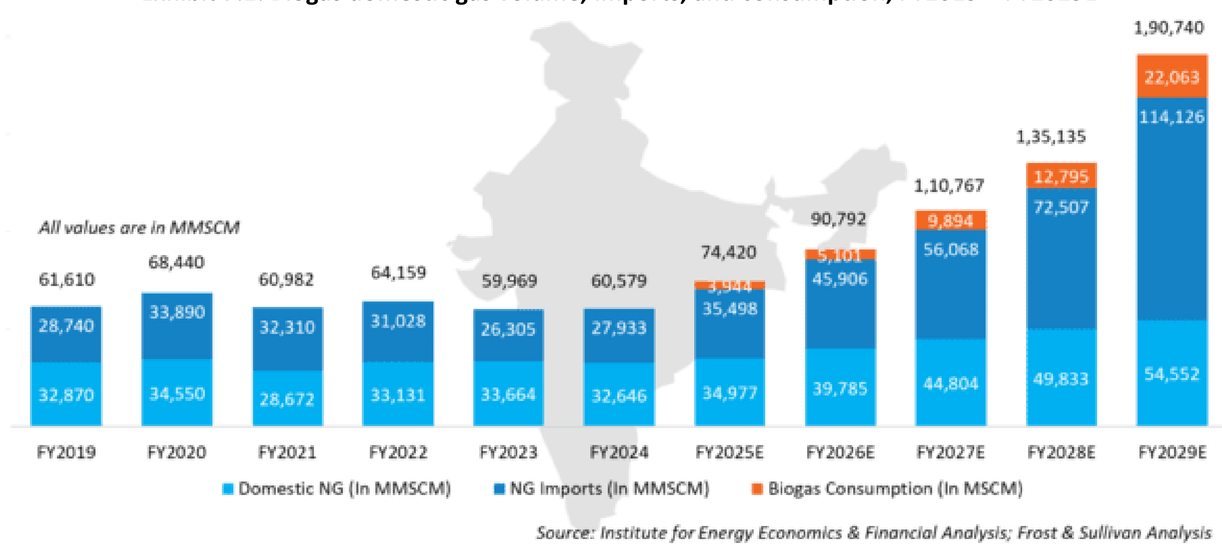
A. Biogas as a biofuel in India's decarbonization journey

India's shift towards renewable energy is critical for reducing carbon emissions. Biogas plays a key role with its potential to cut fossil fuel use by 6% by 2030. It contributes to emission reduction through methane mitigation, circular economy practices (using digestate as a natural fertilizer), clean energy substitution, and the use of biogenic CO2 for renewable processes.

B. Biogas can help in reducing India's LNG import

Biogas is set to significantly reduce India's reliance on imported LNG, with consumption projected to rise to 22,063 MMSCM by FY2029, potentially saving substantial import costs. Compressed Biogas (CBG) could decrease natural gas consumption by 11.5–12% by 2029.

Exhibit 7.1: Biogas domestic gas volume, imports, and consumption, FY2019 – FY2029E



Source: Institute for Energy Economics & Financial Analysis; Frost & Sullivan Analysis

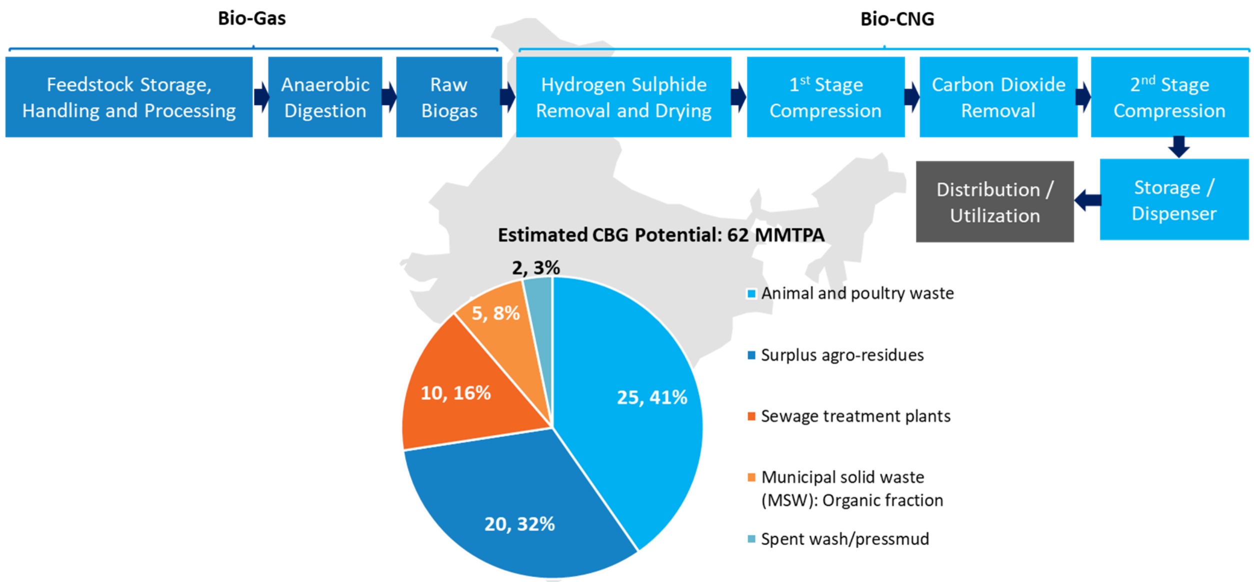
C. Reduce pollution and its effects that are generated from burning biomass

Biomass burning is a major source of air pollution and greenhouse gases, contributing to thousands of premature deaths annually, especially in North India. Converting crop residues into biogas can address this issue, and government initiatives like co-firing biomass in power plants have already reduced CO2 emissions by 1.2 Lakh Metric Tons.

7.2 Potential for Bio-CNG generation in the country from Agro-waste

India's diverse biogas feedstocks include animal waste, agricultural residue, municipal solid waste (MSW), and sewage sludge, with a total Compressed Biogas (CBG) potential of 62 MMTPA.

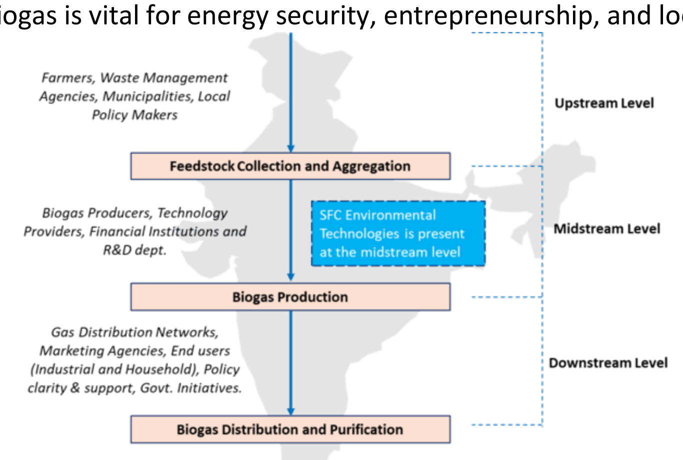
Exhibit 7.2: Bio-CNG generation potential from various feedstocks



Source: Petroleum Research, Vol 7, Issue 3; Frost & Sullivan Analysis

7.3 Value Chain of Indian Biogas Market

The Indian biogas market includes feedstock collection, processing, production, and distribution. Key players are government bodies, state departments, cooperatives, private firms, and renewable energy agencies. Biogas is vital for energy security, entrepreneurship, and local economies.



Source: Frost & Sullivan research and analysis

The Indian government supports the sector with financial aid for biomass machinery and mandates CBG blending in City Gas Distribution pipelines from FY2026, driving demand for biogas production technologies.

SFC Environmental Technologies Ltd. being a provider of such technology used in midstream level of biogas production is one of the leading integrated municipal solid waste-based biogas developer in India and is poised to be a key beneficiary of government initiative of blending of biogas. With over 8 years of operation, SFC's plant in North Goa holds the unique distinction of longest operating integrated MSW based biogas plant in India.

Exhibit 7.4: Roles and responsibilities of key stakeholders

STAKEHOLDER	ROLES	RESPONSIBILITIES
Government Agencies (e.g., MNRE) and Policy Makers	Policy Formulation and Promotion	Formulate and implement policies, provide financial assistance, promote biogas use, and create a conducive environment for the biogas industry
Training and Development Centers (e.g., BDTCs) and Educational Institutions	Training and Development	Provide training, development programs, and research for biogas production
Promotional Bodies (e.g., KVIC, NDDB)	Promotion	Promote biogas plants among rural communities and the use of waste for biogas production
Biogas Producers and Companies	Production and Distribution	Involved in various stages of the biogas value chain, from feedstock collection, processing, production, to distribution
Distribution Entities (e.g., OMCs)	Distribution	Distribute biogas using their infrastructure and network
Technology Suppliers	Technical Support	Provide technical support, specialized equipment, and solutions for biogas production
Financial Agencies	Financial Support	Provide financial backing, approve loans for biogas projects, and invest in the biogas sector

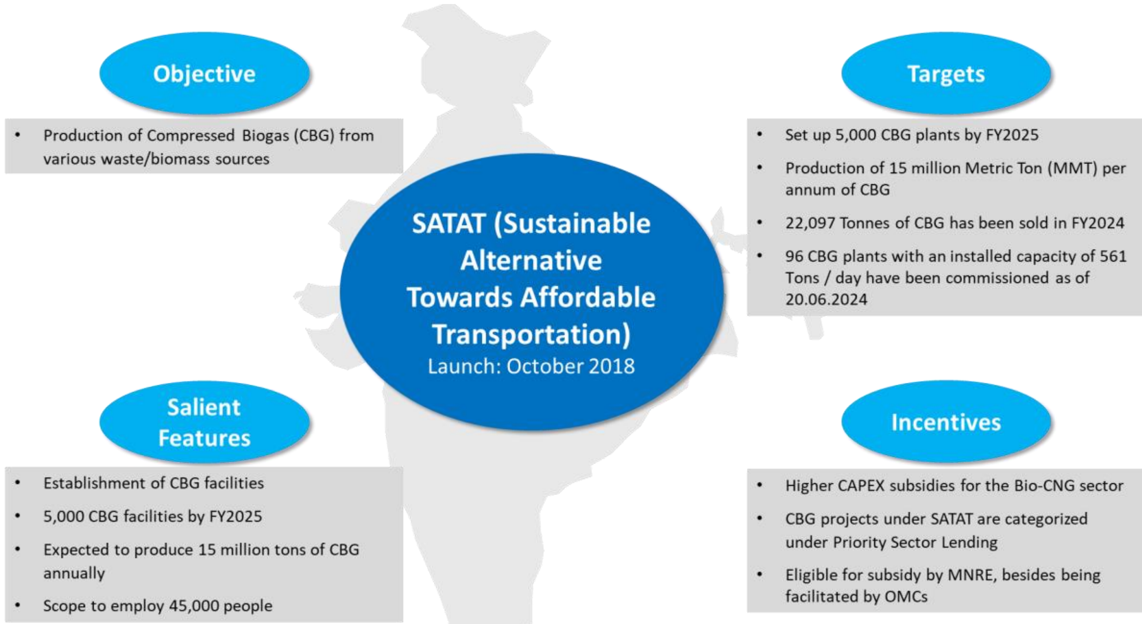
7.4 Government policies driving the growth of the Indian CBG sector

Following are various government initiatives to promote consumption of CBG in the country:

- **National Bio Energy Programme**: Launched by the MNRE on 2nd November 2022, this program aims to promote power, biogas/BioCNG, and briquette/pellet production with a budget of INR 17 billion (Phase 1: INR 8.6 billion). It supports the use of surplus biomass from rural areas, providing additional income for rural households.
- **Sustainable Alternative Towards Affordable Transportation (SATAT):** This initiative promotes the production of CBG from waste/biomass, aiming to reduce reliance on fossil fuels and air pollution from crop stubble burning. It is expected to produce 15 million tonnes of gas, reducing the CNG bill by 40%.
- **PM-PRANAM Scheme:** A proposed program to reduce chemical fertilizer use by promoting bio and organic fertilizers. It aims to reduce the subsidy burden on chemical fertilizers and encourage states to adopt alternatives.

- **Financial Assistance for Biomass Aggregation Machinery:** This scheme supports CBG producers in purchasing machinery for biomass aggregation, facilitating CBG production and overcoming funding challenges.

Exhibit 7.5: SATAT Scheme, targets, salient features and incentives



Source: MoPNG (Ministry of Petroleum & Natural Gas); Frost & Sullivan Analysis

- **CBG Blending Obligation (CBO):** In India, the compressed biogas ("CBG") blending obligation mandates oil marketing companies to blend CBG into their fuel infrastructure. The mandatory blending obligation will begin in FY 2025-26, starting at 1% and gradually increasing to 5% from FY 2028-29 onwards. This initiative mandates OGMCs to set up projects for CBG production from organic waste and biomass.

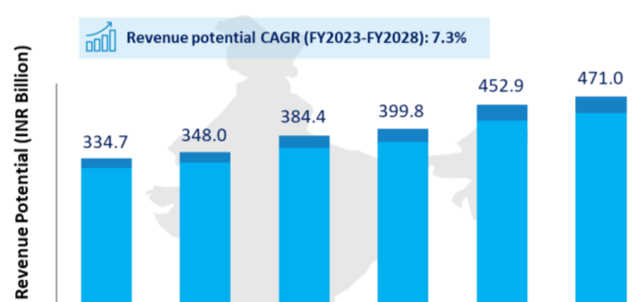
7.5 Revenue potential from Surplus Agro Residue and Press Mud (CBG and Briquettes)

Both Compressed Biogas and Briquettes can be produced from Surplus Agro Residue and Pressmud – the current availability of these two feedstocks has been estimated at approx. 150 MT and 20 MT respectively.

Exhibit 7.6: Revenue potential from Surplus Agro Residue and Press Mud, India, INR billion, FY2023-FY2028

Note / Assumptions:

1. *The revenue potential has been calculated based on only two feedstocks – Surplus Agro Residue and Pressmud.*
2. *Even though annual CBG potential of the above-mentioned feedstocks are 20 MMTPA & 2 MMTPA, considering realistic availability, the revenue has been calculated at 25%*
3. *CBG price is expected to increase from INR 57 / Kg in FY2023 to INR 65 / Kg*
4. *Briquette's sale (quantity) has been considered as 10% of feedstock considering the mix of feedstock and marketability*
5. *Briquette price for FY2023 has been considered as INR 5 / Kg which is expected to increase to INR 7/ Kg by FY2028*



	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028
Briquette	21.2	22.0	27.5	28.6	34.6	36.0
CBG	313.5	326.0	356.9	371.2	418.2	435.0

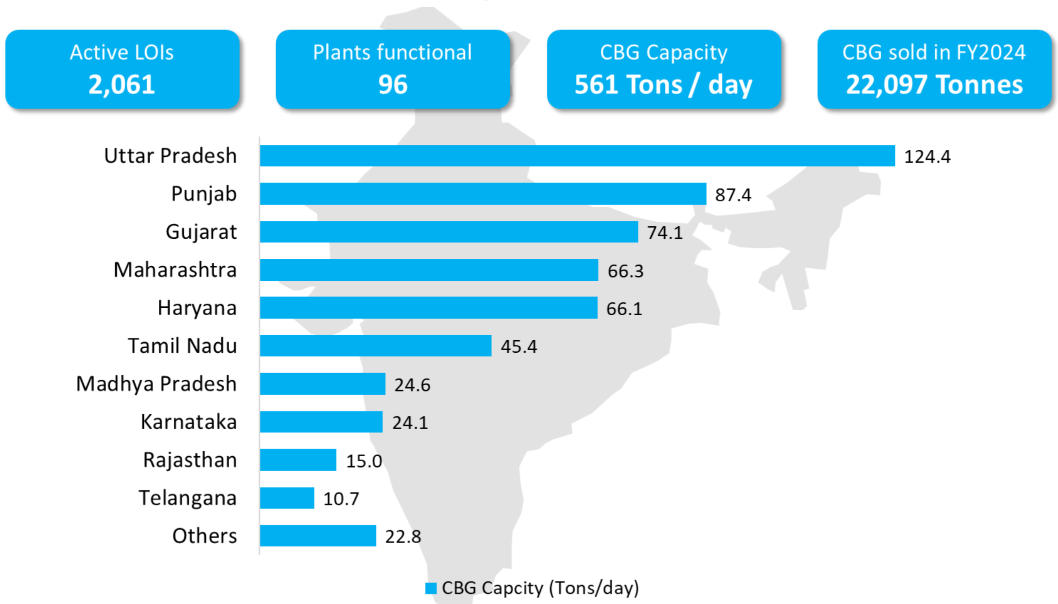
Source: Stakeholder Consultations, Frost and Sullivan Analysis

For the purpose of this calculation, it has been assumed that only 25% of the feedstock would realistically be available for CBG and Briquette production – this is in line with assumptions considered for the SATAT scheme. Basis these assumptions, revenue potential from the above-mentioned businesses in FY2023 were INR 314.9 billion. The potential is likely to increase to INR 436.9 billion by FY2028, growing at a CAGR of 7.3%.

7.6 Current state of CBG production in India

According to the information available on SATAT and GOBARdhan portal of Government of India, there are 96 functional CBG plants in India as on 20.06.2024 with a cumulate CBG production capacity of 561 Tons / day.

Exhibit 7.7: Status of CBG production, India, as of 20.06.2024

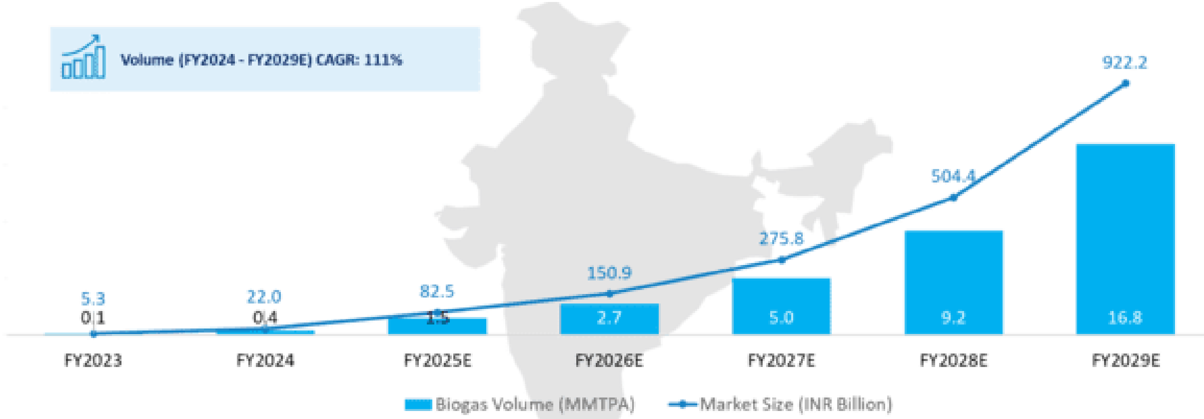


Besides, there are 2,061 active Letters of Intent (LOI) for setting up similar plants and in FY2024, 22,097 tonnes of CBG have been sold in the country. The above chart indicates approximately 2.5 times increase from 38 CBG plants, 225 Tons/day capacity at the end of October 2022. Advancements in technology have made the production of CBG more efficient and cost-effective, further boosting the market growth. Some of the renowned producers of CBG at present are Verbio India (33 TPD), Lakhimpur Kheri RNG (21.2 TPD), Jakraya Sugar (20 TPD), Reliance Bio Energy (20 TPD), Reliance Industries (20 TPD), Inodore Clean Energy (17 TPD), Sangrur RNG (14.8 TPD), Patiala RNG (14.8 TPD), Circle CBG India (14.6 TPD), HPCL (14.3 TPD), Bharat Biogas Energy (14.0 TPD) etc.

7.7 Current size of Indian Biogas Market and its growth

Government programs and policies are set to drive exponential growth in India's CBG sector. According to the 'Gobardhan' portal, there are 90 operational CBG plants, 8 completed, 161 under construction, and 372 in planning. These numbers are expected to increase significantly. Frost & Sullivan estimates that CBG production in India was 0.4 MMTPA in FY2024 and is projected to reach 16.8 MMTPA by FY2029. The market value is expected to grow from INR 5.3 billion in FY2024 to INR 922 billion by FY2029, with a conservative CAGR of 70–75%. For example, HPCL has set up a plant in Budaun with an investment of INR 1,330 million, processing 100 MTPD of rice straw to produce 14 MTPD of CBG and 65 MTPD of solid manure. This plant will reduce stubble burning on 17,500-20,000 acres, cutting 55,000 tons of CO2 emissions annually, and generating employment for 1,100 people. The government plans to establish 100 similar plants in Uttar Pradesh

Exhibit 7.8: Growth of Indian CBG market, in MMTPA and INR billion, FY2023 – FY2029E



Note:
1. *Density of CBG has been considered as 0.76 kg / SCM*
2. *Price of CBG considered as Rs. 55 / kg*

Source: Statista, Frost & Sullivan Research and Analysis

7.8 Growth drivers and restraints of the Indian CBG market

The growth of the Indian CBG sector is fuelled by several factors that include supportive government, an abundant supply of organic waste, and a growing awareness about environmental sustainability. This could pave the way for a thriving CBG sector for the country.

Exhibit 7.9: Key drivers for the growth of Indian Biogas Market

SL. NO.	FACTORS	SHORT-TERM IMPACT	LONG-TERM IMPACT
1.	**Mandatory blending of 5% CBG from waste into the CGD network by FY2029**	This will stimulate demand for CBG in the CGD sector. It will promote production and consumption of CBG in the country.	The CBG Blending Obligation (CBO) will encourage significant investment and facilitate establishment of numerous CBG projects. It will lead to import substitution for Liquefied Natural Gas (LNG), saving in foreign exchange, and promoting circular economy.
2.	**Increasing awareness towards environmental sustainability**	Immediate increase in demand for biogas solutions.	Sustained growth as more people adopts renewable energy solutions.
3.	**Government initiatives promoting renewable energy**	Increased funding and support for biogas projects.	Creation of a favorable policy environment for renewable energy.
4.	**Rising adoption of renewable resources**	Increased market demand for biogas.	Shift towards renewable energy sources, reducing dependence on fossil fuels.
5.	**Increasing installation of energy sources**	Growth in the biogas industry due to increased installations.	Widespread adoption and normalization of biogas as a primary energy source.
6.	**Increasing utilization of wastes**	More efficient use of waste materials, boosting biogas production.	Establishment of waste-to-energy as a standard practice, contributing to a circular economy.

However, the sector is also affected with a few present-day challenges that have been listed below:

Exhibit 7.10: Restraints hindering the growth of the Indian CBG Market

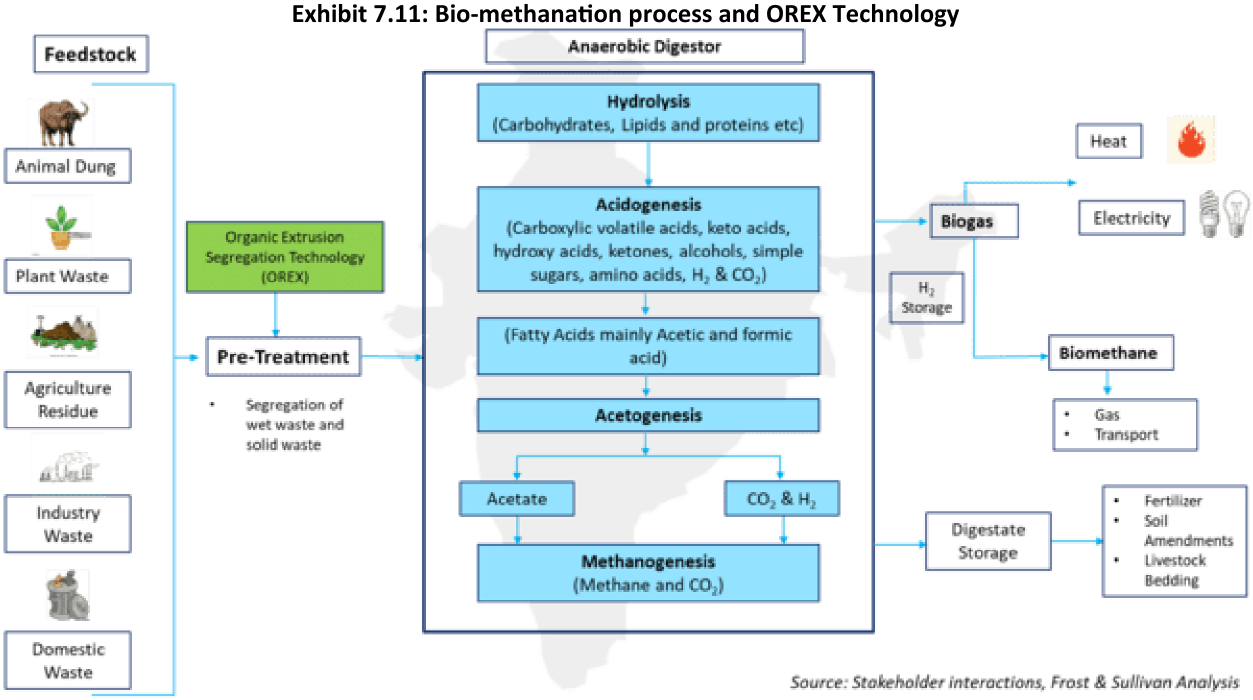
SL. NO.	FACTORS	SHORT-TERM IMPACT	LONG-TERM IMPACT
1.	**High capital expenditure**	Potential deterrent for new entrants due to high initial costs.	Consolidation of the market, with larger players dominating.
2.	**Supply chain related bottlenecks / availability of feedstocks**	Limited availability or fluctuations in the supply of feedstock could lead to delays or cancellations of ongoing projects and is a major operational challenge	Potential long-term disruptions in the supply chain, affecting future projects.

7.9 Bio-methanation process and OREX as an Organic waste pre-treatment technology

Bio-methanation is a process that converts hydrogen (H2) and carbon dioxide (CO2) into methane (CH4) through several key stages:

- **Hydrolysis**: Complex organic compounds are broken down into simpler molecules by bacteria, preparing them for further processing.
- **Acidogenic Fermentation**: These simpler molecules are further broken down, producing volatile fatty acids (VFAs) like acetic acid.
- **Hydrogen-Producing Acetogenesis**: VFAs are converted into hydrogen (H2) and carbon dioxide (CO2), essential for methane production.
- **Methanogenesis**: Methanogens use the H2 and CO2 to produce methane (CH4).
- OREX technology enhances this process by efficiently segregating municipal waste into organic and inorganic fractions.

Exhibit 7.11: Bio-methanation process and OREX Technology



Source: Stakeholder interactions, Frost & Sullivan Analysis

The organic fraction, rich in moisture and organic matter, is used for bio-methanation, while the inorganic fraction is converted into high-quality Refuse Derived Fuel (RDF). This technology has capability to yield more than 150 Nm^3 of biogas per ton of organic waste, higher than the industry average of 80-100 Nm^3 per ton.

7.10 Plans of OMCs to enter Indian Biogas Market

Oil Marketing Companies (OMCs) are entering the Indian biogas market, driven by the rising demand for clean energy and the government's biogas production targets. With their extensive infrastructure, OMCs are expected to boost the sector's growth, advancing India's energy security and sustainability goals.

In this evolving market, incumbents like SFC Environmental Technologies have a clear edge over Original Equipment Manufacturers (OEMs). SFC's expertise in waste-to-energy solutions, strong regulatory relationships, and proven technologies make them well-suited to lead in biogas production and distribution. Collaborating with OMCs, established players like SFC can accelerate market penetration and promote sustainable energy practices across India, reinforcing the nation's shift towards a greener future.

Exhibit 7.12: OMC (Oil Marketing Companies) and their interest in Indian Biogas Market

OMC	PLAN
Indian Oil Corporation Limited (IOCL)	IOCL has shown interest in the SATAT initiative and is planning to procure CBG from potential entrepreneurs.
Bharat Petroleum Corporation Limited (BPCL)	BPCL is also part of the SATAT initiative and is planning to set up CBG plants across the country.
Hindustan Petroleum Corporation Limited (HPCL)	HPCL is planning to offer a delivered price for procurement of CBG, with additional incentives based on the delivery distance and current CNG market price.
GAIL (India) Limited	GAIL has signed a MoU with Carbon Clean Solutions Limited (CCSL) to increase the number of CBG plants in India.
Reliance Industries Limited (RIL)	RIL plans to set up more than 50 compressed biogas (CBG) plants in the next two years at a cost of over INR 50 billion. They have already set up two CBG demo units at its refinery facility in Jamnagar and commissioned the first commercial-scale CBG plant at Barabanki in Uttar Pradesh.
Essar Oil	Essar Oil has shown interest in the SATAT initiative and is planning to procure CBG from potential entrepreneurs.
Nayara Energy	Nayara Energy is also part of the SATAT initiative and is planning to set up CBG plants across the country.

Source: Frost & Sullivan research

7.11 Municipal Wet Waste to Biogas generation and selling as CNG/PNG

Municipal wet waste, such as food scraps and yard trimmings, can be converted into biogas through shredding, mixing with water, and anaerobic digestion, producing methane and carbon dioxide. This biogas can be purified to create Compressed Natural Gas (CNG) or Piped Natural Gas (PNG). The Ministry of New and Renewable Energy supports Waste to Energy projects for Biogas, Bio-CNG, and Power from various wastes. For example, a plant processing 20 tons of fruit and vegetable waste daily can yield about 2,400 m^3 of Bio-CNG. Key factors for successful conversion include waste availability, collection costs, and digester facilities.

7.12 Leading Biogas Technology Suppliers

The Indian biogas market is dynamic, with key biogas technology suppliers shaping its trajectory. In the table above, we spotlight the leading biogas technology suppliers operating within India. These companies contribute significantly to the nation's sustainable energy objectives by advancing biogas adoption, waste-to-energy initiatives, and environmental stewardship.

Exhibit 7.13: Leading MSW treatment companies providing Waste to Energy (WTE) Solutions

COMPANY	PRODUCTS / SOLUTIONS	DESCRIPTION
SFC Environmental Technologies	Technology solutions for solid waste treatment comprising design, engineering, turnkey solutions and O&M	SFC provides solutions for Solid Waste Treatment, including project development, design and engineering, equipment supply, construction and commissioning, and long-term operation and maintenance. SFC also offer turnkey solutions through an engineering, procurement and construction ("EPC") model. SFC's principal technology is OREX, which is their proprietary technology, designed to separate biodegradable organics from inorganic materials and lignocellulosic fibres from mixed municipal wastes.
Ecogreen Energy	Waste Collection & Transportation, Waste Processing & Treatment, Waste to Energy, Construction & Demolition Waste Management	Ecogreen Energy is a waste management and waste-to-energy company in India. It provides door to door waste collection service, transportation of waste to plant sites where the waste is segregated and then converted into organic compost, electricity, and RDF (Refuse Derived Fuel).
Antony Lara Renewable Energy	Waste-to-Energy	The company focuses on comprehensive operations of collection, transportation, treatment and disposal of municipal solid waste.
Abellon Clean Energy	Waste to Energy, Extended Producer Responsibility, Biomass Heat & Transport, EPC3	Abellon Clean Energy is an integrated sustainable energy solutions provider. The company's primary business is energy generation from the wastes. The company has entered into a technical agreement with Germany's Agraferm Group for setting up biogas plants across India. In the first phase, the company will set up biogas plants in Gujarat and later, on a pan-India basis, with technical support from Agraferm Group.

7.13 Threats and challenges to SFC Technologies and its products and services

A. Challenges specific to the End user industry

Municipal Authorities: Ageing infrastructure, inadequate collection systems, and weak enforcement of industrial pre-treatment are major challenges, leading to pollution. Upgrading infrastructure, enhancing waste collection, and enforcing stricter regulations are needed.

Households and Residential Communities: Inefficient waste management stems from poor source segregation, mixing recyclables, food scraps, and non-biodegradables. Encouraging waste segregation and promoting composting are vital for improved management.

Industries: High installation and maintenance costs deter biogas adoption. Limited awareness of financial benefits and technology also hampers uptake. Government incentives and awareness programs can boost adoption.

Challenges specific to SFC Environmental Technologies

SFC Environmental Technologies faces standard industry risks, including competition from both established and new players, and economic fluctuations affecting project budgets and investment. Domestic market uncertainties and changes in government policies, such as levies or exemptions on imported materials, can impact sales and profit margins. For example, fluctuations in steel or plastic prices and changes in government subsidies may influence project costs and demand for SFC's solutions.

8 COMPETITIVE BENCHMARKING

Leading players in the waste management market are crucial to India's sustainability goals. Increased urbanization and industrial activities have led to higher wastewater generation, making its treatment and reuse vital for addressing water scarcity and preventing pollution. Companies specializing in wastewater treatment are advancing sustainable practices and addressing environmental challenges, paving the way for a more sustainable future.

8.1 Operational Benchmarking

A. Profile 1: SFC Environmental Technologies Pvt. Ltd.

Company Overview (Origin and Incorporation year must be included)	• Established in 2005 and based in Navi Mumbai, India, SFC Environmental Technologies Ltd. is an environmental technology company offering technologies and engineering solutions in the field of wastewater treatment (“WWT”) and solid waste treatment (“SWT”)	
Key Technologies	• C-Tech • OREX	
Solutions Offerings	• Waste water treatment	• Solid waste treatment • Agro waste treatment
Key Clients	• Enviro Infra Ltd. • EMS Ltd. • GVPR Engineers Ltd. • Gharpure Engineering & Constructions Pvt. Ltd.	• Ramky Infrastructures • Toshiba Water Solutions Pvt. Ltd. • HNB Engineers Pvt. Ltd. • Goa Waste Municipal Corporation

B. Thermax

Company Overview (Origin and Incorporation year must be included)	• Founded in 1966 and headquartered in Pune, India, Thermax is an engineering company providing sustainable solutions in the areas of energy and environment. The company's reach spans 86 countries, serving industrial and commercial clients with energy-efficient and eco-friendly operations.	
Key Technologies	• Eco-friendly power • Water recycling	• Cooling from heat waste • Emission control

	• Waste heat energy	
Product Offerings	• Waste Heat Recovery • Waste to Energy Conversion • Water and Waste Solutions	• Oil and Gas Sector Services • Energy Environment Solutions • Steam Accessories
Key Clients	• GAIL India • Daimler • Tata Communications	• ONGC Mangalore Refinery • JK Cement Works • Tata Sponge Iron

C. Profile 2: Praj Industries

Company Overview (Origin and Incorporation year must be included)	• Established in 1983 and headquartered in Pune, India, the company specializes in biofuels, bioenergy, renewable energy, circular economy, green fuels, brewery, beer, alcohol, ethanol, water and wastewater treatment, process equipment, distillation, oil and gas, bio CNG, bio methanation, bio mobility, and renewable chemicals and materials.	
Key Technologies	• EcoCool™ • MAXIMOL™ • PROFIIT™ (Process Optimized Flexible Integrated Incineration Technology)	• RenGas™ • efinity™ • Celluniti™ • BIOSYRUP™
Product Offerings	• Bio Energy- 1G Ethanol, Bio Ethanol and Compressed Biogas • Praj Hipurity Systems • Critical Process Equipment & Skids	• ZLD & resource recovery • Solvent recovery system • Total Water Management • VAS (value-added services)
Key Clients	• Incauca • Addax Petroleum • Bajaj Hindustan Ltd • Globus Spirits	• British Sugars • Seagrams • Vivergo Fuels • ThaiBev

D. Profile 3: Ion Exchange

Company Overview (Origin and Incorporation year must be included)	• Established in 1964 and headquartered in Mumbai, India, Ion Exchange is a solution provider in water and environment management solutions. The company provides comprehensive solutions for water, wastewater, solid waste, and waste-to-energy sectors.	
Key Technologies	• Complete Environmental Management Solutions	
Product Offerings	• Membranes • Instruments & Automation • Consumer Products • Zero Liquid Discharge (ZLD) Systems	• Activated Sludge Plants • Membrane Bioreactor (MBR) Systems • Sewage Treatment Plants (STPs)
Key Clients	• Emirates Steel • SAIL	• Rockwool • Dabur

	• Unilever	• Ranbaxy

E. Profile 4: Xylem Water Solutions

Company Overview (Origin and Incorporation year must be included)	• Established in 2011 and headquartered in Bengaluru, Karnataka, Xylem Water Solutions India Private Limited is a solution provider in the global water technology sector. Xylem offers a comprehensive range of solutions including water and wastewater transport, treatment, test, and efficient use.	
Key Technologies	• Water Reuse Technology • Energy Efficient Pumping Solutions	
Product Offerings	• Analysis, Monitoring & Control Instruments and Equipment • Communications & Data Transfer • Gas Infusion Systems • Hydro Turbines	• Metrology for Utilities • Mixing & Mixing Equipment • Pumps & Packaged Pump Systems • Water and Wastewater Treatment Solutions
Key Clients	• AC Fire pump • Bell & Gossett • Flojet • Flygt	• Godwin • Jabsco • Leopold • Lowara

F. Profile 5: Alfa Laval

Company Overview (Origin and Incorporation year must be included)	• Alfa Laval, founded in 1883 and based in Lund, Sweden, is a leading global provider of first-rate products in the areas of heat transfer, separation, and fluid handling. Alfa Laval's innovative solutions are used to heat, cool, separate, and transport products such as oil, water, chemicals, beverages, foodstuffs, starch, and pharmaceuticals.	
Key Technologies	• Heat Transfer • Separation • Fluid Handling	
Product Offerings	• Automatic back-flushing filters • Ballast Water Treatment Systems • Boilers • Brewery solutions • Bulk solutions	• Freshwater generation • Heat exchangers. • Heaters • Membranes • Pump control system.
Key Clients	• Arkema • Rhodia Brasil • BASF	• Lanxess • Dow Wolff Cellulosics • Balaji Amines

8.2 Financial benchmarking

Exhibit 8.1: Revenue from the operation, Revenue from operations Y-O-Y growth, EBITDA, EBITDA Margin of key competitors, value in INR Million, FY2020 – FY2024

Financial Indicators	Years	SFC Environmental	Thermax	Praj Industries	Ion Exchange	Xylem India	Alfa Laval
Revenue from Operations INR Million	FY2020	3,149.2	57,313.1	11,023.7	14,798.3	5,460.8	13,554.1
	FY2021	2,726.9	47,912.5	13,046.7	14,495.2	4,492.8	11,637.7
	FY2022	4,967.3	61,283.3	23.432.7	15,768.7	4,867.1	13,211.4
	FY2023	5,196.9	80,898.1	35,280.4	19,896.1	4,927.9	16,873.3
	FY2024	6,583.9	93,234.6	34,662.8	23,478.5	5,924.3	NA
Revenue from Operations Y-O-Y Growth in %	FY2020	NA	NA	NA	NA	NA	NA
	FY2021	-13%	-16%	18%	-2%	-18%	-14%
	FY2022	82%	28%	80%	9%	8%	14%
	FY2023	5%	32%	51%	26%	1%	28%
	FY2024	27%	15%	-2%	18%	20%	NA
EBITDA INR Million	FY2020	462,4	4,061.8	780.6	1,345.7	496.8	2,312.7
	FY2021	329.0	3,551.9	1,123.5	2,023.0	-793.9	2,017.8
	FY2022	1,088.0	4,215.0	2,058.5	2,132.1	166.9	2,733.4
	FY2023	1,240.7	5,973.3	3,180.0	2,549.9	262.0	2,685.8
	FY2024	1,935.9	7,965.7	3,878.1	2,719.4	489.3	NA
EBITDA Margin in %	FY2020	14.7%	7.1%	7.1%	9.1%	9.1%	17.1%
	FY2021	12.1%	7.4%	8.6%	14.0%	-17.7%	17.3%
	FY2022	21.9%	6.9%	8.8%	13.5%	3.4%	20.7%
	FY2023	23.9%	7.4%	9.0%	12.8%	5.3%	15.9%
	FY2024	29.4%	8.5%	11.2%	11.6%	8.3%	NA

Source: Annual Reports of Companies published in RoC, MCA; Frost & Sullivan Analysis

Revenue from Operations Y-O-Y growth is calculated as (Current year revenue – previous year revenue)/ previous year revenue

EBITDA is calculated as profit before tax, depreciation and amortisation expense and finance costs less other income as per the Restated Consolidated Financial Information.

EBITDA Margin is calculated as EBITDA/Revenue from Operations

Exhibit 8.2: PAT, PAT Margin, RoCE, RoE of key competitors, India, in percentage, FY2020 – FY2024

Financial Indicators	Years	SFC Environmental	Thermax	Praj Industries	Ion Exchange	Xylem India	Alfa Laval
PAT INR Million	FY2020	371.2	2,124.5	704.3	941.5	100.6	2,032.4
	FY2021	317.2	2,065.8	810.5	1,433.2	-380.7	1,914.6
	FY2022	851.6	3,123.1	1,502.4	1,616.9	163.5	2,215.0
	FY2023	948.1	4,507.0	2,398.2	1,949.7	105.4	2,101.8
	FY2024	1,441.7	6,431.9	2,833.9	1,953.5	213.2	NA
PAT Margin in %	FY2020	11.8%	3.7%	6.4%	6.4%	1.8%	15.0%
	FY2021	11.6%	4.3%	6.2%	9.9%	-8.5%	16.5%
	FY2022	17.1%	5.1%	6.4%	10.3%	3.4%	16.8%
	FY2023	18.2%	5.6%	6.8%	9.8%	2.1%	12.5%
	FY2024	21.9%	6.9%	8.2%	8.3%	3.6%	NA
RoCE in %	FY2020	18.1%	12.6%	11.4%	32.0%	7.4%	29.8%
	FY2021	13.5%	10.2%	13.8%	38.4%	-12.4%	40.2%
	FY2022	31.2%	11.7%	21.9%	32.7%	3.6%	49.6%
	FY2023	28.6%	14.0%	30.3%	30.3%	5.2%	39.8%
	FY2024	29.1%	15.7%	30.6%	24.1%	11.7%	NA
RoE in %	FY2020	NA	NA	NA	NA	NA	NA
	FY2021	13.4%	6.6%	10.6%	32.9%	-11.7%	24.1%
	FY2022	28.7%	9.3%	17.5%	27.9%	5.2%	35.9%
	FY2023	25.4%	12.2%	24.1%	26.2%	3.2%	30.0%
	FY2024	29.8%	15.5%	24.1%	21.1%	6.8%	NA

Source: Annual Reports of Companies published in RoC, MCA; Frost & Sullivan Analysis

PAT Margin is calculated as PAT/Revenue from Operations

RoCE is calculated as a percentage of earnings before interest and taxes (EBIT) / total equity plus total borrowings plus deferred tax liabilities minus deferred tax assets as per the Restated Consolidated Financial Information. EBIT is calculated as profit before tax and share of profit of joint ventures / associate plus finance costs.

RoE is calculated as total profit after tax for the year divided by average total equity.

Exhibit 8.3: Debt to Equity, Inventory Days, Trade Receivable Days, Trade Payable Days, FY2020 – FY2024

Financial Indicators	Years	SFC Environmental	Thermax	Praj Industries	Ion Exchange	Xylem India	Alfa Laval
Debt to Equity	FY2020	0.36	-0.09	-0.07	-0.77	-0.44	-0.13
	FY2021	-0.47	-0.50	-0.17	-0.92	-0.63	-0.19
	FY2022	-0.24	-0.17	-0.17	-0.74	-0.56	-0.20
	FY2023	-0.19	-0.08	-0.13	-0.59	-0.55	-0.21
	FY2024	-0.10	0.06	-0.17	-0.44	-0.51	NA
Inventory Days	FY2020	NA	NA	NA	NA	NA	NA
	FY2021	70	62	60	54	63	130
	FY2022	51	55	59	60	61	142
	FY2023	73	59	56	59	72	138
	FY2024	NA	53	52	57	90	NA
Trade Receivable Days	FY2020	NA	NA	NA	NA	NA	NA
	FY2021	121	98	107	117	170	72
	FY2022	97	78	74	108	161	52
	FY2023	133	70	67	108	150	48
	FY2024	NA	74	85	124	135	NA
Trade Payable Days	FY2020	NA	NA	NA	NA	NA	NA
	FY2021	68	78	73	127	204	53
	FY2022	52	76	59	119	189	48
	FY2023	65	65	48	97	165	48
	FY2024	NA	58	52	95	120	NA

Source: Annual Reports of Companies published in RoC, MCA; Frost & Sullivan Analysis

Debt to Equity ratio is calculated as Net Debt/Total Equity, Net Debt is calculated as (Long-Term borrowings + Short-Term borrowings) – (Cash & Cash Equivalents + Bank Balance Other than Cash and Cash Equivalents)

Inventory days has been calculated as average inventory/cost of goods sold or revenue multiplied by 365; Trade receivable days has been calculated as average trade receivables/total income multiplied by 365; Trade payable days has been calculated as average trade payables/total income multiplied by 365.

ANNEXURE

Exhibit: Inventory of Sewage Treatment plants in the country, by States, FY2021[3]

SR.NO	STATE	SEWAGE GENERATION (IN MLD)	NUMBER OF STPs*	INSTALLED TREATMENT CAPACITY (IN MLD)
1	Andaman and Nicobar Island	23	-	0
2	Andhra Pradesh	2,882	37	833
3	Arunachal Pradesh	62	-	0
4	Assam	809	-	0
5	Bihar	2,276	0	10
6	Chandigarh	188	6	293
7	Chhattisgarh	1,203	3	73
8	Dadra & Nagar Haveli	67	3	24
9	Goa	176	9	66
10	Gujarat	5,013	68	3,378
11	Haryana	1,816	155	1,880
12	Himachal Pradesh	116	59	136
13	Jammu & Kashmir	665	12	218
14	Jharkhand	1,510	2	22
15	Karnataka	4,458	100	2,712
16	Kerala	4,256	5	120
17	Lakshadweep	13	-	0
18	Madhya Pradesh	3,646	45	1,839
19	Maharashtra	9,107	130	6,890
20	Manipur	168	0	0
21	Meghalaya	112	0	0
22	Mizoram	103	0	10
23	Nagaland	135	0	0
24	NCT of Delhi	3,330	35	2,896
25	Orissa	1,282	4	378
26	Pondicherry	161	3	56
27	Punjab	1,889	96	1,781
28	Rajasthan	3,185	56	1,086
29	Sikkim	52	6	20
30	Tamil Nadu	6,421	63	1,492
31	Telangana	2,660	27	901
32	Tripura	237	1	8
33	Uttar Pradesh	8,263	92	3,374
34	Uttarakhand	627	52	448
35	West Bengal	5,457	24	897
	Total	**72,368**	**1,093**	**31,841**

Note: This is the most recent, published, government and credible source available published in March 2021

**Includes functional STPs only*

3 https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMTIyOF8xNjE1MTk2MzIyX21lZGlhcGhvdG85NTY0LnBkZg==

Exhibit: Technology-wise Break-up of STPs in various States, by installed capacity in MLD, FY2021[4]

STATE	TECHNOLOGY								
	ASP	EA	FAB	MBBR	OP	SBR	UASB	WSP	OTHERS
Andhra Pradesh	321	20	3	39	57	17	130	31	235
Bihar	150	0	0	0	0	327	0	0	154
Chandigarh	5	0	0	136	0	107	45	0	0
Chhattisgarh	73	0	0	0	0	0	0	0	0
Dadra Nagar Haveli	0	0	0	0	0	24	0	0	0
Goa	0	0	0	0	0	103	0	0	1
Gujarat	1,254	60	0	175	46	1,285	491	0	67
Haryana	297	0	0	447	14	754	368	0	0
Himachal Pradesh	155	0	0	0	0	0	0	0	0
Jammu & Kashmir	9	0	3	3	0	10	1	0	0
Jharkhand	0	0	0	0	0	1	0	0	11
Karnataka	667	166	20	35	85	1,079	63	61	536
Kerala	112	0	0	0	0	0	0	0	8
Madhya Pradesh	120	0	0	0	0	358	0	178	1,268
Maharashtra	930	146	1	826	36	2,452	240	0	5,188
Mizoram	0	0	0	0	0	10	0	0	0
NCT Delhi	2,575	69	3	0	0	245	0	0	4
Odisha	100	0	0	0	0	183	0	35	60
Puducherry	0	0	0	0	0	20	36	0	3
Punjab	207	0	13	165	0	838	501	54	3
Rajasthan	445	0	0	10	30	428	33	137	112
Sikkim	0	0	20	2	0	2	0	0	6
Telangana	85	13	0	133	24	105	541	0	0
Tamil Nadu	1,011	0	6	0	6	319	9	112	29
Tripura	0	0	0	0	0	8	0	0	0
Uttar Pradesh	681	0	122	14	101	1,176	1,095	27	158
Uttarakhand	0	0	0	20	0	351	1	0	143
West Bengal	191	0	41	0	63	392	0	160	355
Total	**9,492**	**474**	**244**	**2,034**	**462**	**10,647**	**3,563**	**795**	**8,957**

Note: This is the most recent, published, government and credible source available published in March 2021

[4] *Source: https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMTIyOF8xNjE1MTk2MzIyX21lZGlhcGhvdG85NTY0LnBkZg==*

Exhibit: Technology-wise Break-up of STPs in various States, by operational number of STPs, FY2021

STATE	TECHNOLOGY								
	ASP	EA	FAB	MBBR	OP	SBR	UASB	WSP	OTHERS
Andhra Pradesh	7	2	2	10	2	2	5	3	4
Chandigarh	1	0	0	1	0	3	1	0	0
Chhattisgarh	3	0	0	0	0	0	0	0	0
Dadra Nagar Haveli	0	0	0	0	0	3	0	0	0
Goa	0	0	0	0	0	5	0	0	4
Gujarat	14	3	0	5	8	24	7	0	8
Haryana	7	0	0	83	4	49	10	0	0
Himachal Pradesh	59	0	0	0	0	0	0	0	0
Jammu & Kashmir	4	0	3	1	0	4	0	0	0
Jharkhand	0	0	0	0	0	1	0	0	1
Karnataka	12	9	1	1	10	24	2	8	30
Kerala	2	0	0	0	0	0	0	0	1
Madhya Pradesh	4	0	0	0	0	6	0	7	28
Maharashtra	18	2	1	24	2	52	6	0	25
NCT Delhi	25	4	1	0	0	4	0	0	1
Odisha	0	0	0	0	0	0	0	2	2
Puducherry	0	0	0	0	0	1	2	0	0
Punjab	4	0	1	24	0	42	7	16	1
Rajasthan	13	0		2	2	22	4	9	5
Sikkim	0	0	3	0	0	0	0	0	2
Telangana	10	3	0	8	0	3	3	0	0
Tamil Nadu	49	0	1	0	1	5	1	2	4
Tripura	0	0	0	0	0	1	0	0	0
Uttar Pradesh	19	0	3	3	11	31	24	2	6
Uttarakhand	0	0	0	6	0	32	1	0	13
West Bengal	8	0	2	0	6	1	0	2	5
Total	**259**	**23**	**18**	**168**	**46**	**315**	**73**	**51**	**140**

Note: This is the most recent, published, government and credible source available published in March 2021

Legend: ASP- Activated Sludge Process, EA- Electrocoagulation, FAB - Forward Activated Sludge, MBBR - Moving Bed Biofilm Reactor, OP - Oxidation Pond, SBR - Sequencing Batch Reactor, UASB - Upflow Anaerobic Sludge Blanket, WSP - Waste Stabilization Pond