Crisil
Intelligence

Assessment of the water and wastewater sector in India

December 2025

by S&P Global

Contents

1. Macroeconomic overview

Global GDP outlook

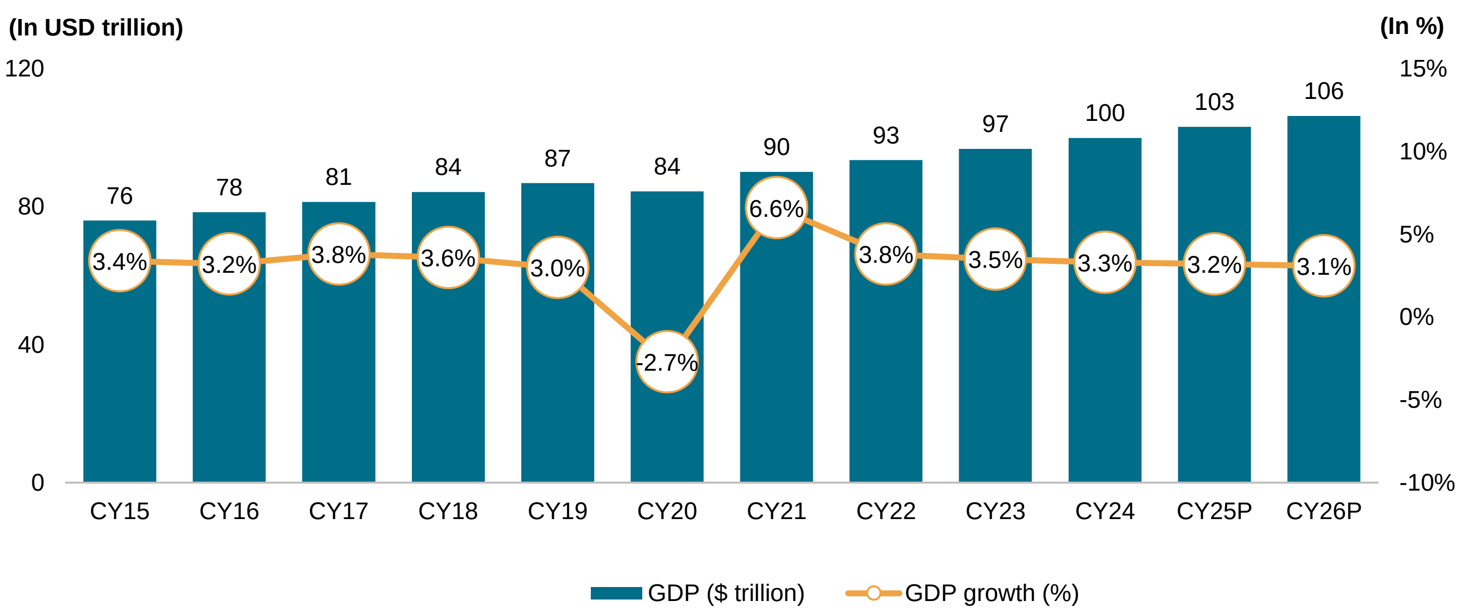
Global GDP is estimated to grow 3.0% in CY25 and 3.1% in CY26

The International Monetary Fund's (IMF) October 2025 update projected global gross domestic product (GDP) to moderate from 3.3% in 2024 to 3.2% in 2025 and to 3.1% in 2026, with the slowdown reflecting headwinds from uncertainty and protectionism, even though the tariff shock is smaller than originally announced.

After the United States introduced higher tariffs starting in February, subsequent deals and resets have tempered some extremes. However, uncertainty about the stability and trajectory of the global economy remains acute. Meanwhile, substantial cuts to international development aid and new restrictions on immigration have been rolled out in some advanced economies. Several major economies have adopted a more stimulative fiscal stance, raising concerns about the sustainability of public finances and possible cross-border spillovers.

Overall, risks to the outlook remain tilted to the downside. Prolonged policy uncertainty could dampen consumption and investment. Further escalation of protectionist measures, including nontariff barriers, could suppress investment, disrupt supply chains, and stifle productivity growth. Larger-than-expected shocks to labour supply, notably from restrictive immigration policies, could reduce growth, especially in economies facing aging populations and skill shortages

Global GDP trend and outlook (CY18-CY26P, USD trillion)



Note: E: Estimated, P: Projection

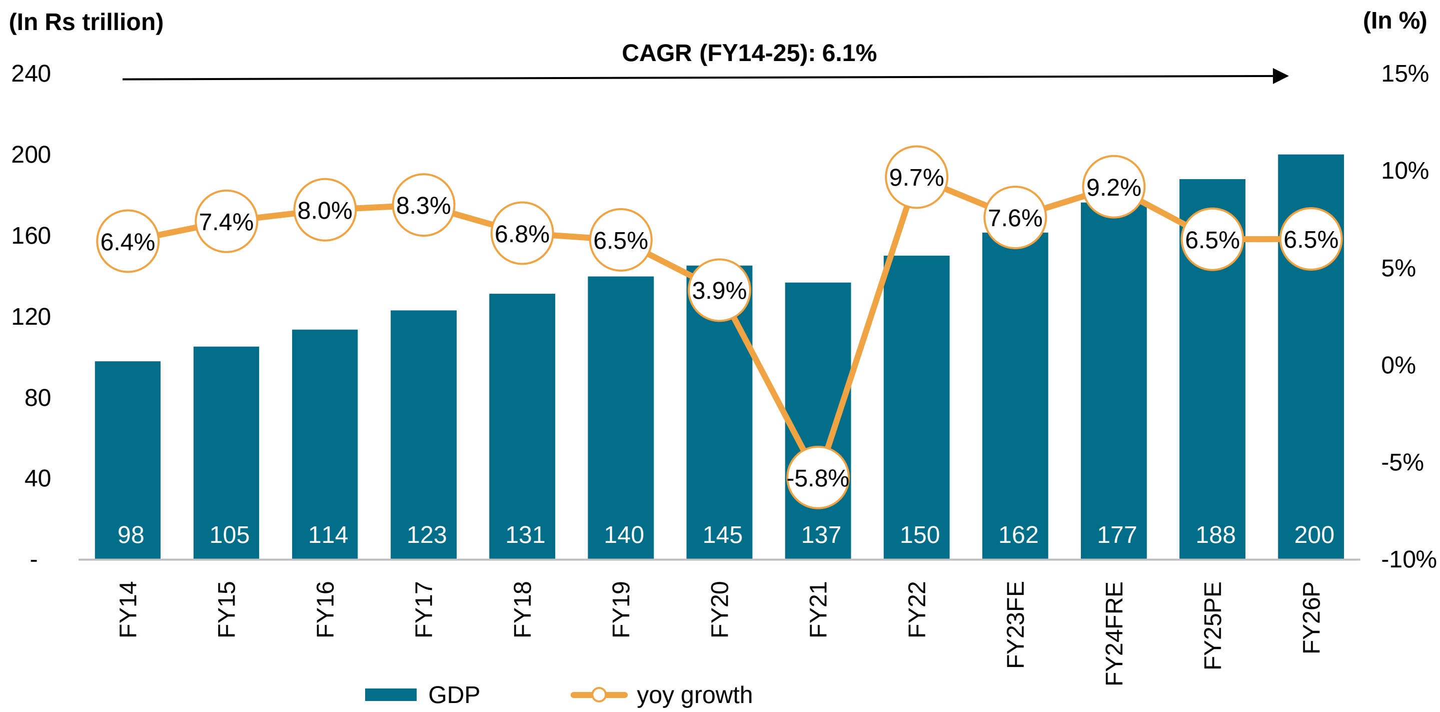
Source: IMF economic database, Crisil Intelligence

India GDP logged 6.1% CAGR between FY14 and FY25

India's GDP grew at 6.1% compounded annual growth rate (CAGR) between FY14 and FY25 to Rs. 188 trillion in FY25 from Rs. 98 trillion in FY14. This growth was primarily driven by expansion of nonagricultural economy, particularly the financial, state, and professional services sector, which recorded the highest CAGR of 7.4% during this period. In contrast, the agriculture, livestock, forestry, and fishing sector posted a comparatively modest CAGR of 4.0% during the considered period. A key contributor to GDP growth during this period was the rise in Private Final Consumption Expenditure (PFCE), which constitutes the largest share of GDP. This was complemented by improvements in exports and increase in Government Final Consumption Expenditure (GFCF).

Additionally, according to Provisional Estimates (PE) of FY25, India's GDP is projected to have grown at 6.5% in FY25, a moderation from the 9.2% growth recorded in FY24. Despite this deacceleration, growth remains close to the pre-pandemic decadal average of 6.6 % between FY11- 20, enabling India to retain its position as the fastest growing major economy.

Real GDP growth in India (2011-12 series) – constant prices



Note: FE: Final Estimates, FRE: First Revised Estimates, PE: Provisional Estimates, P: Projected
These values are reported by the government under various stages of estimates
Only actuals and estimates of GDP are provided in the bar graph
Source: Ministry of Statistics and Program Implementation (MoSPI), Crisil Intelligence

Moving forward, Crisil projects GDP growth to remain steady at 6.5% in FY26, despite potential headwinds arising from geopolitical developments and global trade uncertainties, including tariff actions by the United States. Factors expected to support growth includes easing food inflation, tax incentives announced in the Union Budget 2025-26, and lower borrowing cost, all of which are expected to boost discretionary consumption. However, India's Current Account Deficit (CAD) is projected to widen slightly in FY26, driven by challenges in exports amid subdued global demand and trade tensions. Nonetheless, a strong service trade surplus and continued growth in remittances are expected to mitigate the extent of the widening CAD.In the medium term (fiscals 2025-2031), Crisil expects India's GDP to grow 6.7% per year, with capital investments playing a dominant role and a bigger push from efficiency gains.

Comparison of India's GDP growth with global GDP and key geographies

The IMF's 3.0% on-year global GDP growth for 2025 and 3.1% for 2026 projection considers the current geopolitical uncertainties, increasing geoeconomic fragmentation, tighter inflation-tackling monetary policies and fiscal support withdrawal amid high debt and extreme weather conditions.

Economic review and outlook

Real GDP (on-year growth, in%)	2019	2020	2021	2022	2023	2024P	2025P	2029P
World	**2.9**	**-2.7**	**6.6**	**3.6**	**3.5**	**3.3**	**3.2**	**3.1**
Key countries								
Advanced economies	1.9	-4.0	6.0	2.9	1.8	1.8	1.6	1.6
Canada	1.9	-5.0	6.0	4.2	1.5	1.6	1.2	1.5
China, People's Republic of	6.1	2.3	8.6	3.1	5.4	5.0	4.8	4.2
Emerging market and developing economies	3.7	-1.7	7.0	4.1	4.7	4.3	4.2	4.0
Euro area	1.6	-6.0	6.3	3.5	0.5	0.9	1.2	1.1
India	3.9	-5.8	9.7	7.6	9.2	6.5	6.6	6.2
United Kingdom	1.6	-10.3	8.6	4.8	0.4	1.1	1.3	1.3
United States	2.6	-2.2	6.1	2.5	2.9	2.8	2.0	2.1

P: Projected (years mentioned on the horizontal axis correspond to the calendar years for the world and countries except India; for India year 2019 refers to fiscal 2020 and so on)

Source: Crisil Intelligence, industry, IMF

However, the GDP trajectory has varied for key economies, as detailed out below:

For advanced economies:

US: In the United States, with tariff rates settling at lower levels than those announced on April 2, looser financial conditions, offset from private demand cooling faster than expected and weaker immigration, the economy is projected to expand at a rate of 2.0% in 2025. Growth is projected to pick up slightly to 2.1% in 2026, with a near-term boost from the One Big Beautiful Bill Act (OBBBA) kicking in primarily through tax incentives for corporate investment.

Euro area: In the euro area, growth is expected to accelerate to 1.2% in 2025, largely driven by the strong GDP outturn in Ireland in the first quarter of the year, although Ireland represents less than 5% of euro area GDP. The forecast for 2026 stands at 1.1%.

In other advanced economies: growth is projected to decelerate to 1.6% in 2025 and pick up to 1.6% in 2026.

Emerging market and developing economies:

China: For China, CY2025 GDP growth forecast stands at 5.0%, reflecting a stronger-than-expected activity in the first half of 2025 and the significant reduction in US–China tariffs. The GDP outturn in the first quarter of 2025 alone implies a mechanical upgrade to the growth rate. A recovery in inventory accumulation is expected to partly offset payback from front-loading in the second half of 2025. Growth in 2026 is also revised upward to 4.2%.

India: In India, growth is projected to be 6.6% in 2025 and 6.2% in 2026, with both numbers revised, reflecting a more benign external environment.

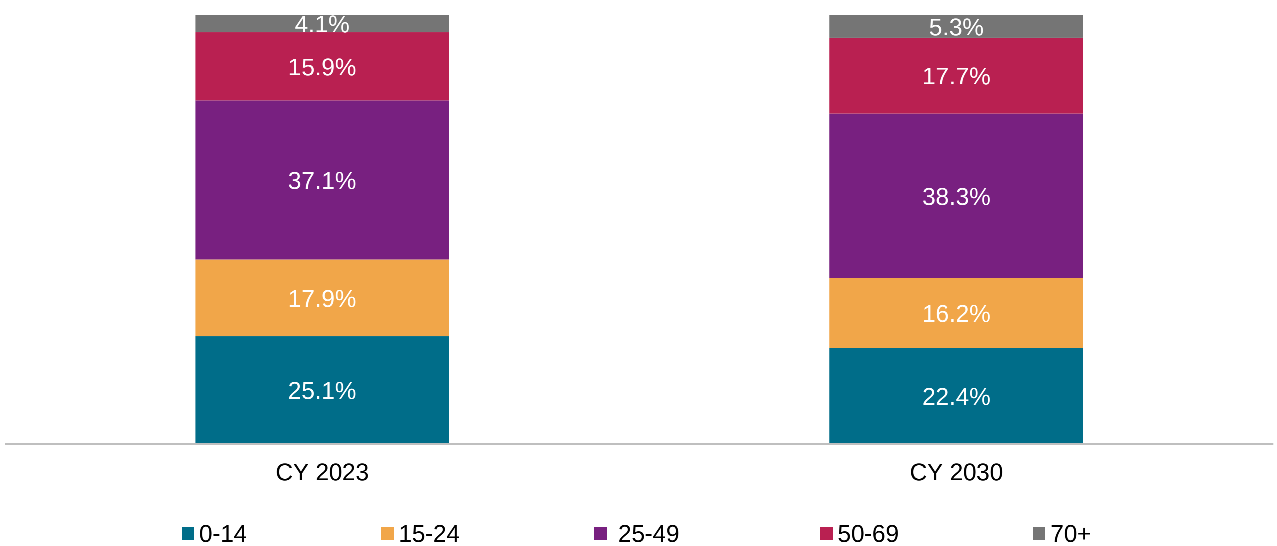
Overview of key fundamental growth drivers of India

India's population aged 25-49 years is projected to increase to ~38% indicates strong potential for disposable income, to contribute to discretionary consumer spending

Furthermore, the share of population aged 25-49 years as a percentage of total population stood at ~37% in CY2023 and is projected to increase to ~38% in CY2030, indicating a strong potential for disposable income.

This increasing share of working age population, coupled with overall economic growth will provide a larger consumer base for industries like entertainment, cruising, lifestyle products, etc. thereby driving greater consumer spending in consumer driven businesses.

Population split across age groups (%)



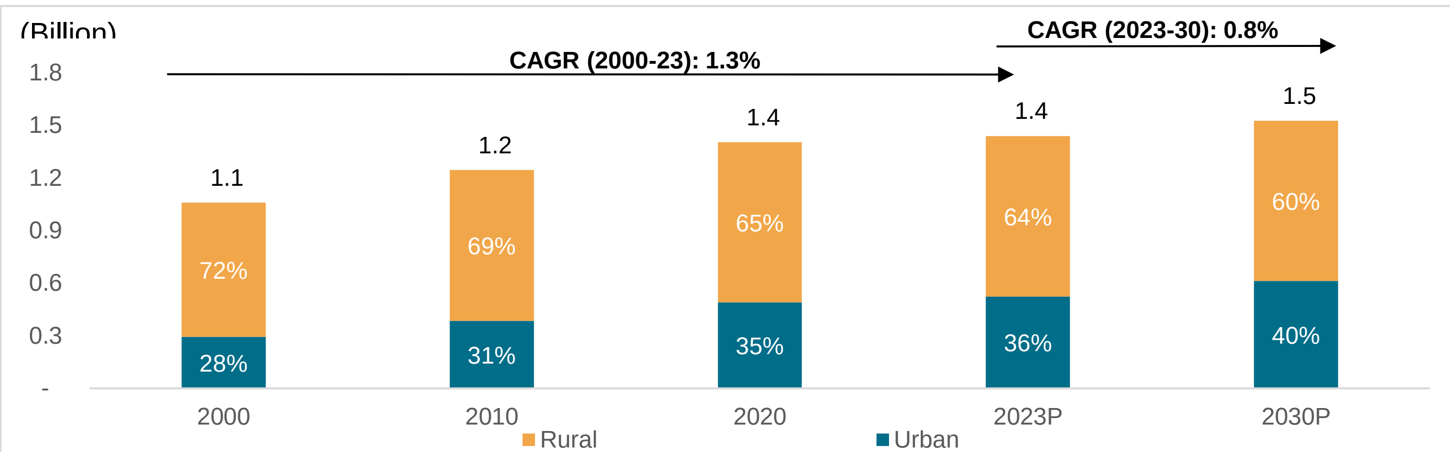
Note: P: Projected
Population is the above chart as of 1st January
Source: UN Department of Economic and Social Affairs, World Population Prospects 2024, Crisil Intelligence

Urbanisation likely to reach 40% by CY30

India's population is estimated to have grown to ~1.4 billion in 2023 as per World Population Prospects 2024, compared to 1.0 billion in 2000, thereby registering a CAGR of ~1.3%. Additionally, as per World Population Prospects 2024, the population of India is expected to remain the world's largest throughout the century and will likely reach its peak in the early 2060s at about 1.7 billion.

Furthermore, India's urban population has also been increasing over the years. The trend is expected to continue as economic growth increases. From ~31% of the total population in CY10, the country's urban population is projected to reach nearly 40% by CY2030, according to a UN report on urbanisation. People from rural areas move to cities for better job opportunities, education and quality of life. Typically, migration can be of the entire family or a few individuals (generally an earning member or students).

India's urban population versus rural



Note: P: Projected
Source: World Urbanization Prospects: The 2018 Revision, UN, Crisil Intelligence

Per capita net national income of India further improved in FY25

India's per capita income, a broad indicator of living standards, rose from Rs 68,572 in FY14 to Rs 114,705 in FY25 as per SAE, logging 4.8% CAGR. Growth was led by better job opportunities, propped up by overall GDP growth. Moreover, population growth remained stable at ~1% CAGR.

Per capita net national income at constant prices

	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23FE	FY24FRE	FY25PE	CAGR (FY14-25)
Per-capita NNI (Rs.)	77,659	83,003	87,586	92,133	94,420	86,034	94,054	100,163	108,786	114,710	4.8%
Y-o-Y growth (%)	6.7%	6.9%	5.5%	5.2%	2.5%	-8.9%	9.3%	6.5%	8.6%	5.4%	

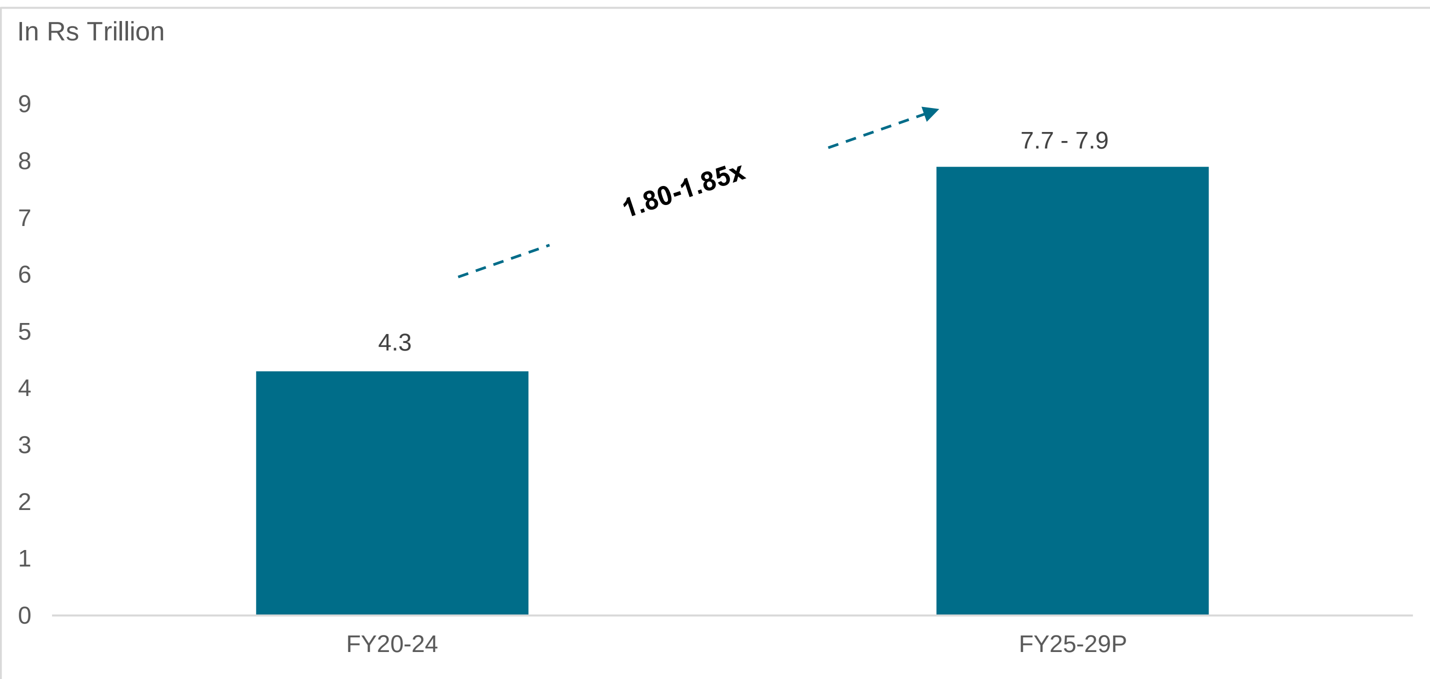
Note: FE: Final Estimates; FRE: First Revised Estimates; SAE: Second Advance Estimates;
Source: Second Advance Estimates of Annual GDP for 2024-25, MoSPI, Crisil Intelligence

Water supply & sanitation expected to contribute more than half of investments under urban infra

Between fiscal 2020 and 2024, investments in urban infrastructure experienced a significant growth rate of 33% per annum. The primary driver of this growth was spending on water supply and sanitation, which accounted for approximately 62-64% of total urban infrastructure investments. This was largely due to government initiatives such as the Swachh Bharat Mission, Jal Jeevan Mission, and AMRUT, as well as previously deferred investments in metro projects that have now achieved financial closure and are under implementation

Crisil Intelligence expects ~Rs 7.5-8 lakh crore spends on urban infrastructure between fiscals 2025 and 2029, which is ~80% higher than the amount invested in the previous five years. Urban infrastructure includes construction-intensive Mass Rapid Transit System (MRTS), Bus Rapid Transit System (BRTS), Water Supply and Sanitation (WSS) projects, smart cities, and related infrastructure development. WSS projects are expected to account for more than half of the total urban infrastructure investments over the next five years, driven primarily by state governments and through centrally sponsored programmes such as Jal Jeevan mission, AMRUT and Swach Bharat mission.

Construction spends in urban infrastructure



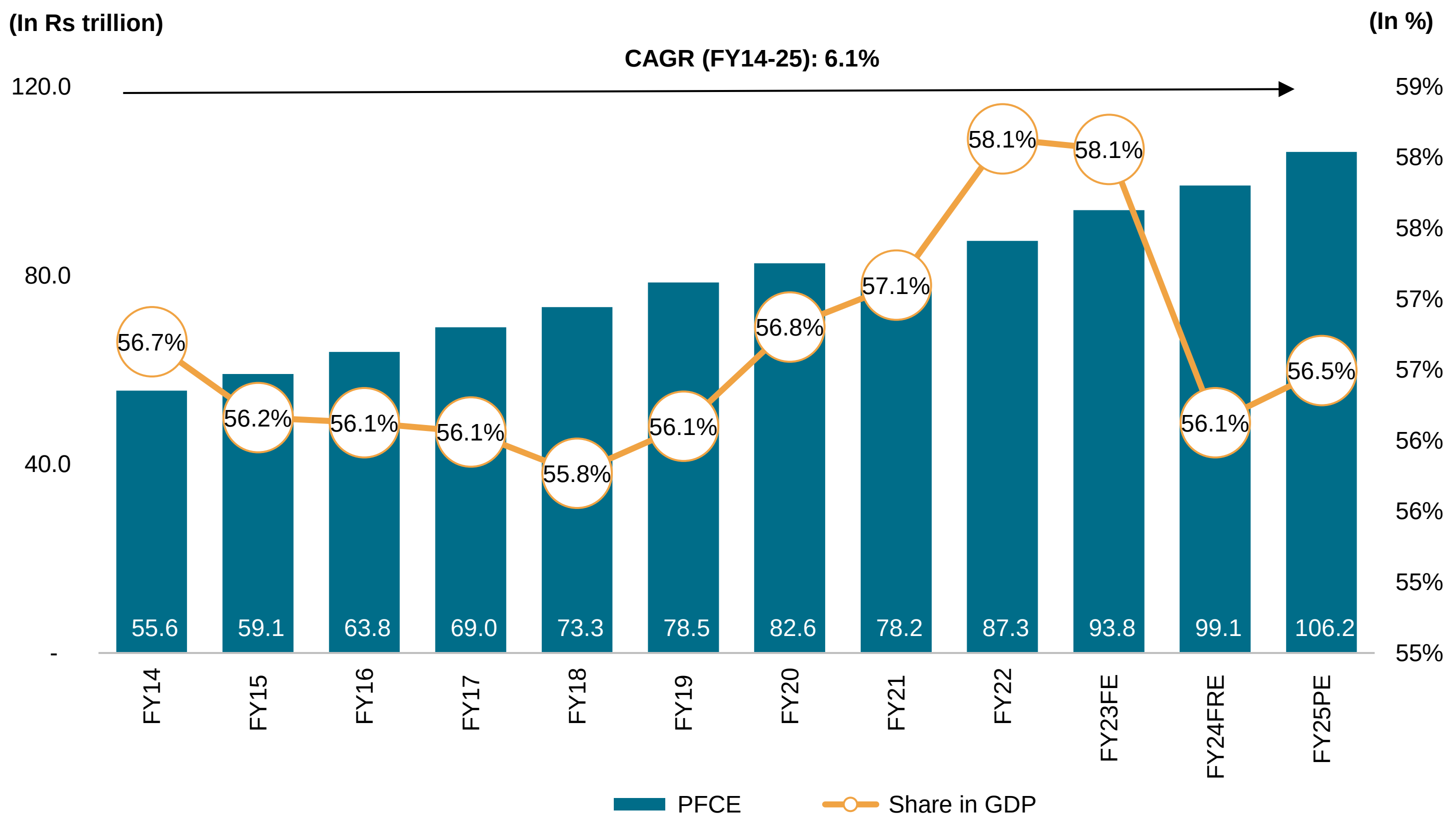
P: projected
Source: Crisil Intelligence

Private Final Consumption Expenditure to maintain dominant share in India’s GDP

Private Final Consumption Expenditure (PFCE) continues to be the largest component of India's GDP with the share of 56.5% in FY25. It recorded a CAGR of 6.1% between F14 and FY25, thereby mirroring the overall GDP growth rate during the same period and was estimated at Rs 106.2 trillion in FY25 compared to Rs 55.6 trillion in FY14.

Growth was led by healthy monsoon, wage revisions due to the implementation of the Seventh Central Pay Commission’s (CPC) recommendations (effective from 1st July 2017), benign interest rates, growing middle age population and low inflation. Furthermore, the tax benefits announced in the Union Budget 2025-2026 are also expected to positively boost the PFCE. As of FY25, PFCE is estimated to have increased to Rs. 106.2 trillion, registering a y-o-y growth of 7.6% and forming ~56.5% of India's GDP. Overall, PFCE has consistently led India's GDP growth from the demand side, underscoring sustained domestic consumption.

PFCE (at constant prices)



Note: FE: Final Estimates; FRE: First Revised Estimates; SAE: Second Advance Estimates;
Source: Second Advance Estimates of Annual GDP for 2024-25, MoSPI, Crisil Intelligence

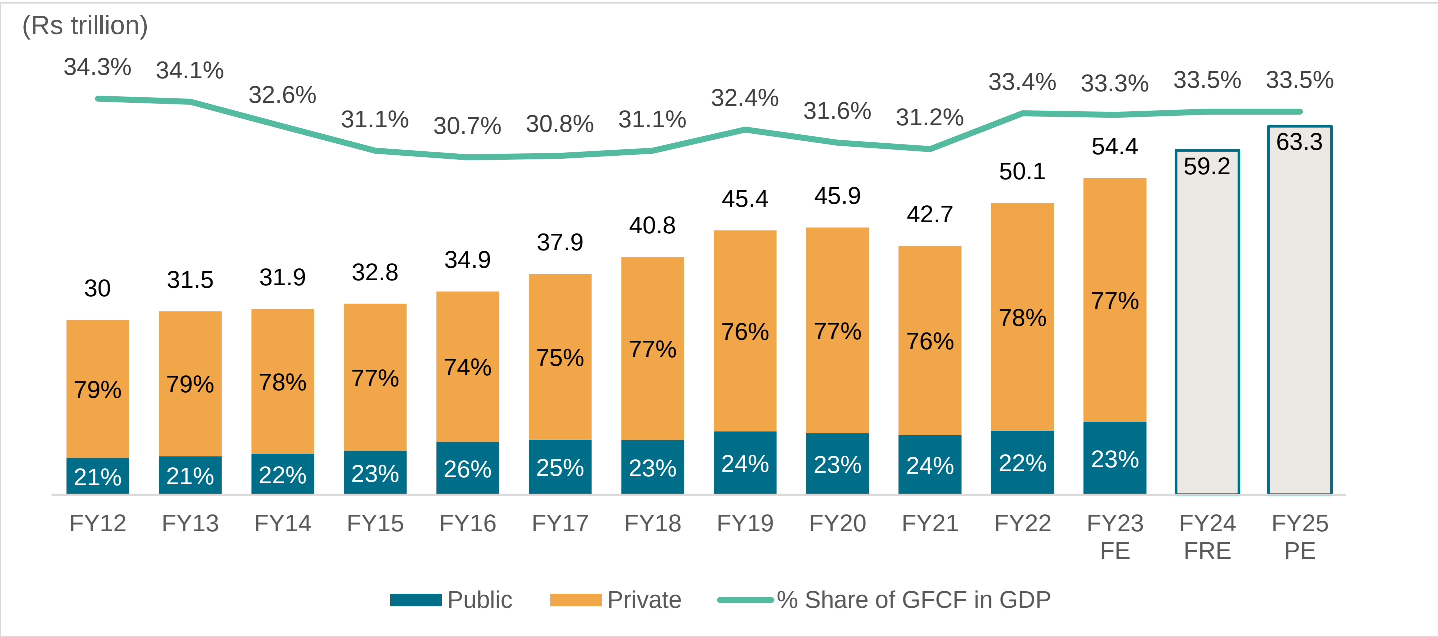
Consumption expenditure will continue to drive GDP growth led by discretionary spends

In the medium to long term, positive economic outlook and growth across key employment generating sectors (such as real estate, infrastructure, and automobiles) is expected to have a cascading effect on overall per capita income. This, in turn, is expected to drive discretionary spending. This rising share of discretionary spendings along with growing per capita income will positively impact industries like tourism, hospitality, entertainment, retail, etc which depends heavily on discretionary spends.

Private sector is a major contributor to Gross Fixed Capital Formation (GFCF)

The distribution of GFCF between the private and public sectors has been relatively constant in India, with the private sector consistently the predominant contributor. In fiscal 2023, the private sector accounted for ~77% of total GFCF.

Share of public and private sectors in GFCF



RE – revised estimate, PE – provisional estimate
Note: Private fixed capital formation includes household sector
Source: MoSPI, Crisil Intelligence

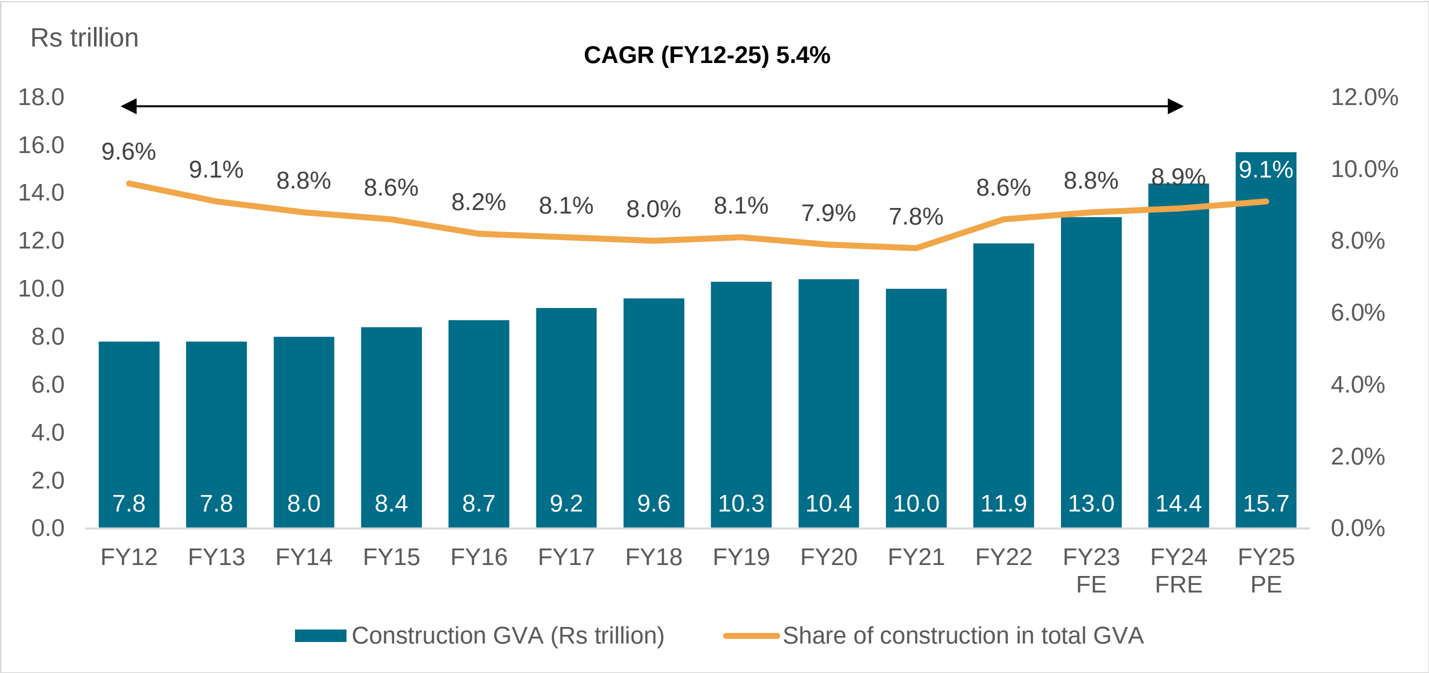
Construction sector's share in overall GVA estimated to have risen further in fiscal 2024

Construction GVA is a critical indicator of economic activity since it represents the value generated by the construction sector, which includes activities related to building infrastructure, real estate and other construction projects.

In India, construction GVA increased to Rs 15.7 trillion in fiscal 2025 PE from Rs 7.8 trillion in fiscal 2012, which was 5.4% CAGR. Several factors contributed to the growth, including economic expansion, the government's commitment to infrastructure development, particularly roads, railways and energy projects, and increase in foreign direct investment, which boosted private sector investment.

Furthermore, increasing demand for affordable housing, driven by rising urbanisation and an expanding middle-class population, has also played a significant role in elevating construction GVA. However, in fiscal 2021, the country's GVA was under pressure amid challenges heaped by the pandemic. In fiscal 2022, though, the share of construction GVA in the overall GVA rebounded to 8.6%, increasing further to 8.8% in fiscal 2023. As per the provisional estimates for fiscal 2025, construction GVA was Rs 15.7 trillion, thereby contributing to 9.1% in overall GVA.

Construction GVA



RE – revised estimate, PE – provisional estimates

Source: MoSPI, Crisil Intelligence

2. Global water and wastewater treatment market

Global water and wastewater treatment industry size

The world's freshwater resources are facing unprecedented stress, with the agriculture sector dominating withdrawals at 72%, followed by industry at 15% and domestic use at 13%, as per the UN World Water Development Report. The sectoral distribution of freshwater usage varies significantly across countries, influenced by their economic development stage. As a result, higher-income countries tend to use more water for industry, while lower-income countries allocate 90% or more of their water for agricultural irrigation. This trend is occurring against the backdrop of prevailing demand for freshwater, which continues to be a basic necessity and a critical natural resource. Furthermore, global freshwater withdrawals have risen by 14% between 2000 and 2021, driven primarily by rapid economic growth in cities, countries, and regions, at an average growth rate of 0.7% per year.

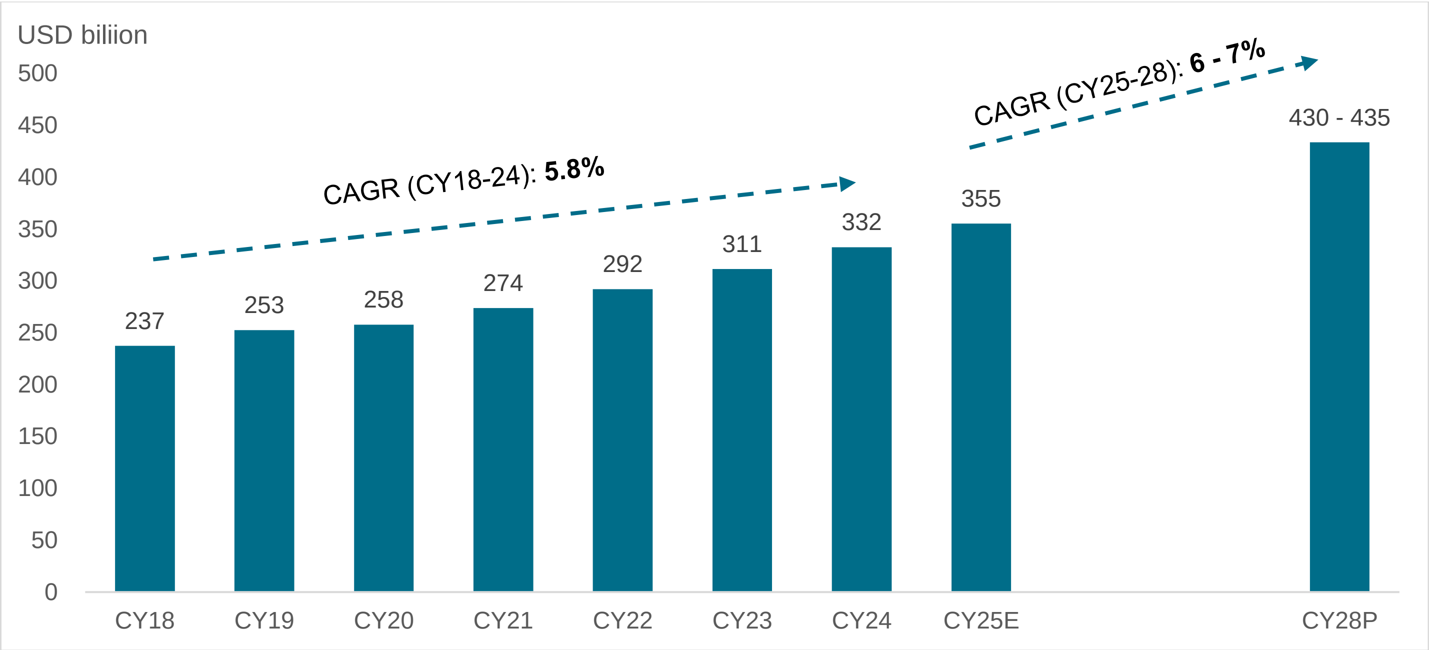
As per UN World Water Development Report, the scarcity of clean water is a significant concern, with 25 countries which are, home to one-quarter of the world's population, facing 'extremely high' water stress every year, and approximately 4 billion people, or half the world's population, experiencing severe water scarcity for at least part of the year. Climate change, pollution, land and ecosystem degradation, and natural hazards further compromise the availability of water resources. The finite nature of freshwater resources, with only 3% of the Earth's water being fresh and suitable for human consumption, exacerbates the issue.

The water treatment industry has seen significant growth and development in response to the escalating challenges posed by water scarcity, pollution, and increasing demand. The growth of the industry is fuelled by increasing awareness of water-related issues and the implementation of stringent regulations governing water quality and sanitation. Governments, environmental agencies, and international organizations have placed greater emphasis on promoting sustainable water management practices and investing in infrastructure for water treatment and distribution. This has spurred investments in research and development, fostering innovation and the adoption of eco-friendly treatment solutions. The water treatment sector is also witnessing a shift towards bespoke solutioning with greater focus on efficiency and recycling, catering to diverse needs and localized challenges.

The treatment of wastewater, also known as sewage treatment, is a crucial process that involves purifying water used by households, industries, and businesses before it is discharged back into the environment. According to the United Nations Environment Programme (UNEP) report, the global municipal wastewater generated is estimated to be 441 BCM (Billion Cubic meters) in 2025, with Asia being the largest contributor at 191 BCM, and is projected to reach 574 BCM globally. There is a need to drastically increase the expansion of wastewater collection and treatment capacity to meet SDG 6.3, By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials; halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally, with countries such as China, the United States, India, and Indonesia requiring significant increases in treatment capacity by 2030.

The global water and wastewater treatment market is poised for significant growth, with projected revenues reaching USD 430-435 billion by 2028, driven by a combined compound annual growth rate (CAGR) of 6-7% from 2025 to 2028. This growth is largely attributed to the increasing adoption of circular economy frameworks by countries, which enables the development of comprehensive water management strategies that prioritize the conservation and sustainable use of natural resources, including water sources. Additionally, the rising demand for high-quality water is further fuelling this growth, as governments, industries, and communities recognize the importance of access to clean and safe water for human consumption, economic development, and environmental sustainability.

Global water and wastewater treatment market:

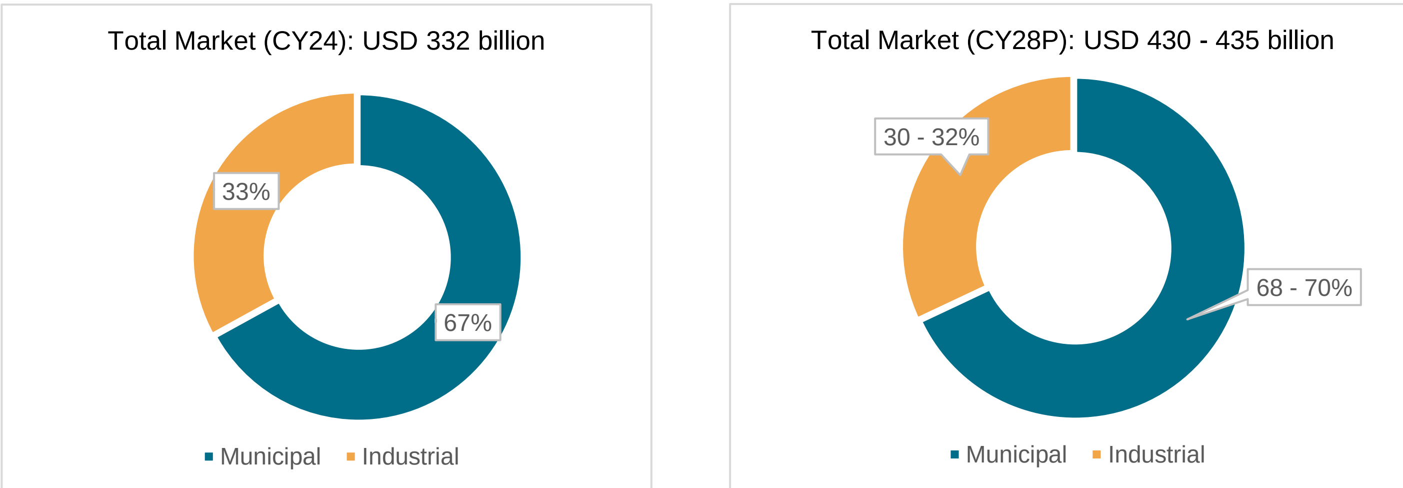


Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

The global water and wastewater treatment market is segmented into two primary categories: Municipal and Industrial. As of CY24, the Municipal segment accounts for 67% of the global market, while the Industrial segment holds a 33% share. However, by CY28, the Municipal segment is projected to increase its share to 68-70%, while the Industrial segment is expected to hold a 30-32% share. The growth of the Municipal segment can be attributed to several factors, including the increasing focus on providing access to clean water and sanitation in developing countries, particularly in Sub-Saharan Africa and other least developed countries. Additionally, rising investments in municipal water treatment and wastewater treatment infrastructure to meet the growing demands of urbanization and population growth.

The Industrial segment, on the other hand, is expected to experience a slight decline in its market share, despite being a significant contributor to the global water and wastewater treatment market. This can be attributed to the increased focus on reducing freshwater usage and promoting water conservation in industrial processes, as well as the growing adoption of treated wastewater and recycled water in industrial applications, reducing the demand for freshwater resources. Furthermore, the implementation of circular economy principles and sustainable practices in industrial operations, aiming to minimize water waste and reduce environmental impact, is also contributing to the decline in the Industrial segment's market share. However, heavy investments by companies in Effluent Treatment Plants (ETPs) and other wastewater treatment technologies to reduce their environmental footprint and comply with regulatory requirements are expected to continue driving the growth of the Industrial segment.

Global water and wastewater treatment split across Municipal and Industrial



Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

Despite the slight decline in market share, the Industrial segment is expected to continue playing a crucial role in the global water and wastewater treatment market, driven by the increasing demand for wastewater treatment and reuse in industries such as Oil and gas, textiles, pharmaceuticals, and food processing. The growing need for advanced wastewater treatment technologies to address the complex water pollution challenges in industrial settings, as well as the rising focus on reducing carbon footprint and achieving sustainability goals, is also expected to drive the growth of the Industrial segment. Moreover, stringent regulations and standards for industrial wastewater discharge are driving the demand for effective and efficient wastewater treatment technologies, highlighting the importance of effective wastewater management in industrial settings.

Water and wastewater treatment industry size in Middle East

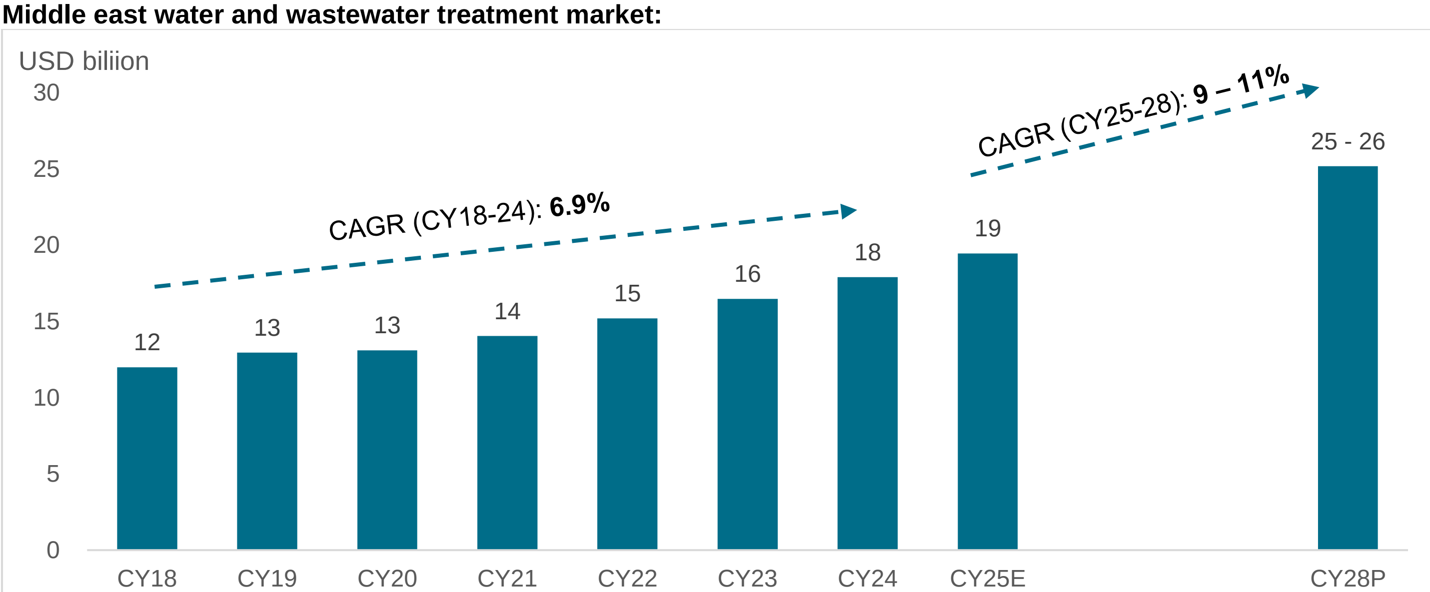
The Middle East and North Africa (MENA) region is one of the most water-scarce regions in the world, with a vast territory of 12.5 million square kilometres, accounting for 9.5% of the planet's land area, yet containing only 1% of the world's renewable freshwater as per FAO (Food and Agriculture Organization of the United Nations). The region is home to 5.4% of the world's population as per world bank population estimates, and its urban population is expected to increase by 10% by 2050, putting additional pressure on the already limited water resources. The average per capita renewable water resources availability in the MENA region is 10 times less than the worldwide average as per FAO, and eight countries in the region (Kuwait, United Arab Emirates, Saudi Arabia, Libya, Qatar, Yemen, Algeria and Bahrain) are among the top 10 most water-stressed countries globally.

In this context, water treatment and wastewater treatment have become essential components of the Middle east water management strategies. The UAE Water Security Strategy 2036, for example, aims to guarantee long-term sustainability and access to water in both regular and emergency situations, while other countries in the region, such as Jordan and Egypt, have also implemented national water strategies that prioritize wastewater treatment as a key component in the national water resources mix. In fact, treated wastewater is considered a constant and perennial resource in the MENA region, and its use is expected to play a crucial role in reducing water deficits, preserving the natural environment, and supporting socioeconomic development.

Agriculture is the largest user of water in the MENA region and is particularly susceptible to water availability, accessibility, and quality. However, the region has made significant progress in wastewater treatment, with about 60% of domestic wastewater being safely treated in 2020 as per UN SDG (Sustainable development goals) monitoring. Despite this progress, the region still faces significant challenges in terms of water scarcity, and demand for water treatment and wastewater treatment solutions is expected to continue growing in the coming years.

The Middle East water and wastewater treatment market is experiencing significant growth, driven by increasing urbanization, population growth, and the pressing need to address water scarcity in the region. The market is estimated to be valued at USD 19 billion in 2025, with a projected growth to USD 25 - 26 billion by 2028, reflecting a robust compound annual growth rate (CAGR) of 9%. This growth is fuelled by the region's focus on sustainable development, stringent environmental regulations, and the adoption of advanced treatment technologies to meet the United Nations Sustainable Development Goals (SDGs), particularly Goal 6 (Clean Water and Sanitation). The market growth is expected to be driven by government initiatives, increasing urbanization, and growing awareness about the importance of water conservation and sustainable use of water resources. As the region continues to prioritize water security and sustainability, the demand for effective and efficient water treatment and wastewater treatment solutions is expected to drive the market growth

Middle east water and wastewater treatment market:

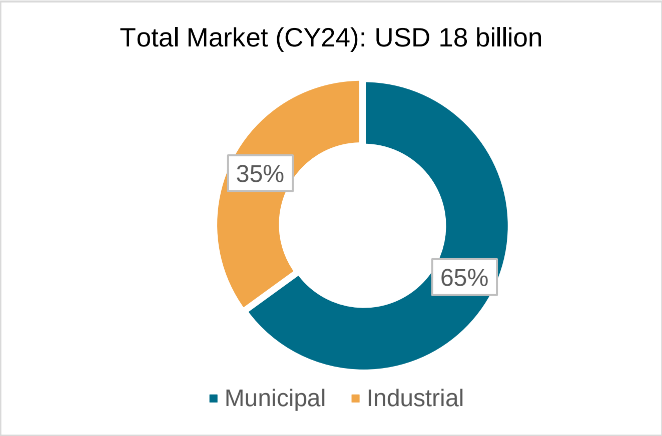


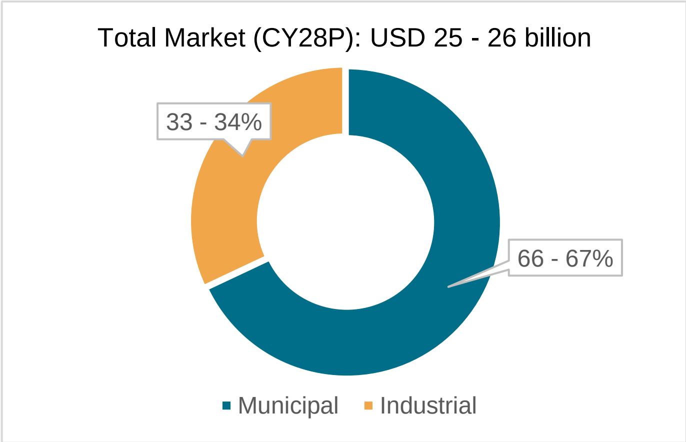
Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

The market is segmented into municipal and industrial sectors, with the municipal sector holding a dominant share due to the region's rapid urban expansion and government-led initiatives to improve water infrastructure. In 2024, the municipal sector accounted for 65% of the Middle East water and wastewater treatment market, driven by the high demand for potable water and sewage treatment in densely populated urban centers such as Dubai, Riyadh, and Doha. Governments across the region are investing heavily in upgrading municipal water treatment facilities to address water scarcity, with countries like Saudi Arabia and the UAE implementing large-scale desalination and wastewater recycling projects. By

2028, the municipal share is expected to slightly increase to 66 - 67%, reflecting continued investments in smart water management systems and public-private partnerships to enhance water reuse. For instance, Saudi Arabia's Vision 2030 emphasizes sustainable water management, with projects like the National Water Strategy aiming to treat and reuse over 90% of wastewater by 2030. These initiatives are supported by technologies such as reverse osmosis and membrane bioreactors, which enable efficient water treatment and recycling for municipal use.

Middle east water and wastewater treatment split across Municipal and Industrial





Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

The industrial sector, holding a 35% market share in 2024, is also a critical component of the Middle East's water and wastewater treatment market, driven by the region's heavy reliance on industries such as oil and gas, petrochemicals, and manufacturing. These sectors generate significant volumes of complex wastewater, necessitating advanced treatment solutions to comply with environmental regulations and achieve sustainability goals, including carbon neutrality and circular economy principles. By 2028, the industrial share is projected to slightly decrease to 33 – 34%, as municipal demand outpaces industrial growth due to rapid urbanization. However, industries are increasingly adopting technologies like Zero Liquid Discharge (ZLD) systems and anaerobic digestion to treat wastewater and recover resources, such as biogas, aligning with global trends toward sustainability. For example, oil companies in the are investing in produced water treatment systems to reduce environmental impact and comply with national and international regulatory frameworks

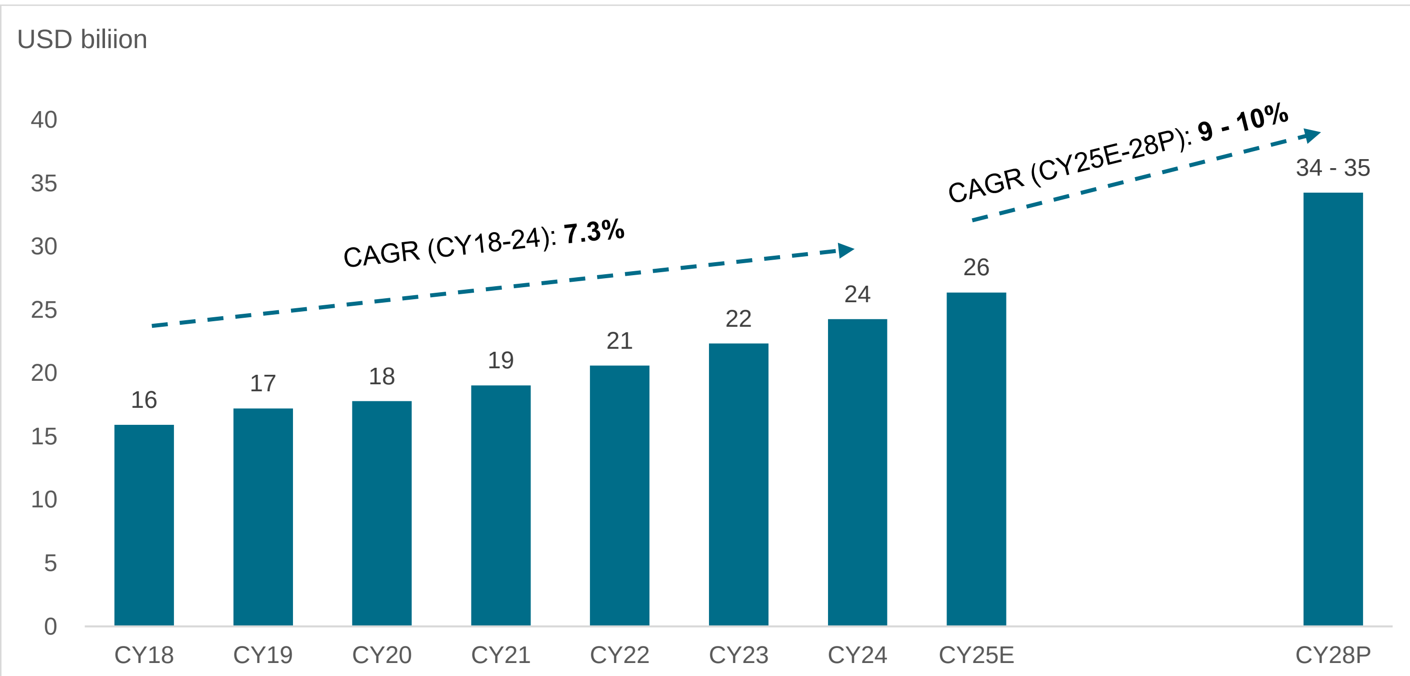
The slight shift in market share from industrial to municipal applications by 2028 underscores the region's prioritization of addressing water scarcity for its growing population. Nevertheless, the industrial sector remains a vital growth area, particularly in oil-rich nations like Saudi Arabia, the UAE, and Qatar, where compliance with environmental regulations and international sustainability commitments is driving investments in wastewater treatment and resource recovery. Both sectors benefit from technological advancements and government support, ensuring the Middle East water and wastewater treatment market remains a dynamic and rapidly evolving space, with significant opportunities for innovation and investment to meet the region's sustainability and economic goals.

Water and wastewater treatment industry size in South East Asia

The region's rapid population growth, urbanization, and industrialization are intensifying the demand for clean water, while pollution from industrial and agricultural activities is contaminating ecosystems and threatening public health. Water treatment and wastewater management are critical to addressing these challenges, enabling the reuse of water, reducing freshwater depletion, and mitigating environmental degradation.

The Southeast Asia water and wastewater treatment market is witnessing robust growth, driven by the region's rapid industrialization, urbanization, and evolving ESG and SDG linked regulatory requirements on environmental sustainability. The market is estimated to be valued at USD 26 billion in 2025, is projected to reach USD 34-35 billion by 2028, growing at a CAGR of 9 - 10%. This expansion is fuelled by the need to address water scarcity, comply with stringent environmental regulations, and meet the rising demand for clean water in both municipal and industrial sectors.

Southeast Asia water and wastewater treatment market:



Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

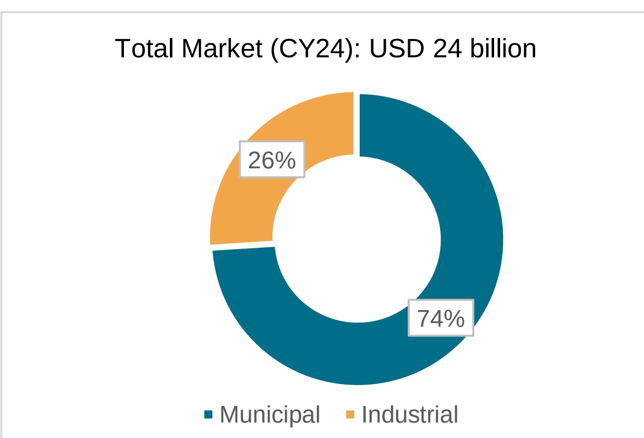
The municipal sector's dominance in Southeast Asia's water and wastewater treatment market, with a 74% share in 2024 and an anticipated increase to 76 - 77% by 2028, is driven by increased focus on water and wastewater treatment needs and population growth in countries like Indonesia, Thailand, Vietnam, and the Philippines. For instance, Indonesia is becoming increasingly urban, resulting in various challenges, including domestic wastewater management. Up to 90% of clean water consumption is discharged as wastewater in Indonesia. Urban centers such as Jakarta, Ho Chi Minh City, and Manila face significant pressure to provide clean drinking water and manage sewage effectively. Governments are investing heavily in water infrastructure to address these challenges. Singapore, for example, has developed a robust, diversified, and sustainable water supply from four water sources known as the Four National Taps. The NEWater process recycles treated used water into ultra-clean, high-grade reclaimed water. Singapore is also expanding its recycling system, with plans to invest around USD 7.4 billion in upgrading its water treatment infrastructure by 2025.

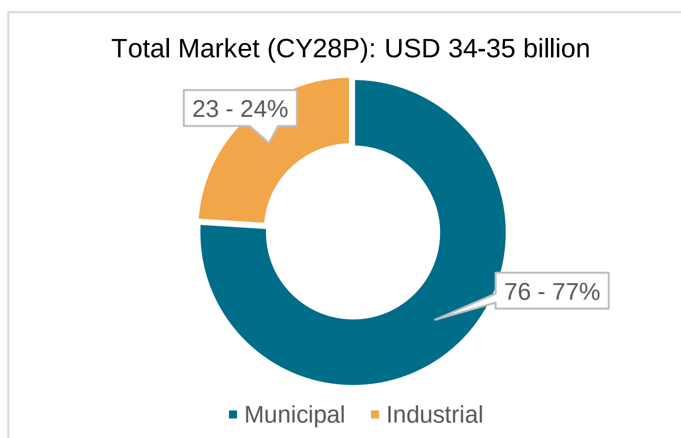
In early 2023, the Thailand government approved the draft Water Resources Action Plan 2024, under the 20-year Water Resources Management Master Plan. Thailand government aims to address issues in key areas within the water and wastewater segment such as Water management for consumption, Water security in the manufacturing sector, Flood and flood management, Water quality management and conservation of water resources, Conservation and rehabilitation of degraded watershed forests and prevention of soil erosion, Monitoring and management

Vietnam's water and wastewater treatment sector is driven by accelerating urbanization, escalating pollution from industrial activities, and a critical need for water recycling amid freshwater shortages, prompting greater adoption of treatment solutions in manufacturing hubs. Growth is further fuelled by robust government encouragement for private sector involvement and stricter environmental regulations that enforce wastewater quality standards, particularly in densely populated southern regions. Policy advancements feature the National Strategy on Integrated Solid Waste Management up to 2025 with a vision to 2050, promoting deployment of advanced schemes for environmental protection, and ongoing legal frameworks that incentivize foreign investments in treatment facilities. The China Plus One strategy has amplified these dynamics in Vietnam by diversifying global supply chains away from China, spurring industrialization in sectors like electronics and textiles, which in turn escalates water consumption and wastewater generation, necessitating expanded treatment infrastructure to mitigate environmental impacts from relocated manufacturing operations.

The industrial sector, accounting for 26% of the market share in 2024 and projected to decrease slightly in terms of market share to 23 - 24% by 2028, because of increased focus on municipal segment, Industries such as food and beverage, pharmaceuticals, and oil and gas generate significant wastewater volumes, necessitating advanced treatment solutions to comply with strict environmental regulations. Vietnam's rapid growth and industrialization have had a negative impact on the environment and natural assets of the country. Demand for water continues to increase, while water productivity is low.

Market size of Southeast Asia water treatment and supply split across Municipal and Industrial





Notes: E: Estimated, P: Projected
Source: Mordor Intelligence, Crisil Intelligence

The Southeast Asia water and wastewater treatment market is characterized by diverse development stages across countries, with Singapore and Thailand leading in technological adoption, while Vietnam, Indonesia, and the Philippines focus on infrastructure expansion. The region's water scarcity, with 269 million people lacking access to clean water, underscores the urgency of these investments. Myanmar, for example, is facing significant challenges in terms of waste management and treatment, with uncollected waste often dumped on the streets and in waterbodies, polluting the air, soil, and inland and marine waterbodies. To address these issues, the Ministry of Natural Resources and Environmental Conservation has launched the National Waste Management Strategy and Master Plan (2018-2030) in Myanmar. Government initiatives, such as Cambodia's USD 20 million Choeung Ek wastewater treatment plant, highlight the commitment to sustainable water management.

Global need for urban sewage recycling

The global need for urban sewage recycling has become increasingly critical as urbanization, population growth, and water scarcity intensify. According to the United Nations, over 55% of the world's population lives in urban areas, projected to rise to 68% by 2050, with much of this growth occurring in Asia and Africa. This rapid urbanization strains water resources and sanitation infrastructure, particularly in low- and middle-income countries where wastewater treatment is often inadequate. A 2024 UN World Water Development Report report highlights that only 76% of total wastewater in 73 countries (representing 42% of the global population) receives some level of treatment, and just 60% is safely treated, leaving significant gaps in managing urban wastewater effectively. Untreated sewage, often discharged into rivers and oceans, poses severe risks to human health, ecosystems, and food security, necessitating robust recycling systems to mitigate pollution and recover valuable resources like water, nutrients, and energy.

Urban sewage recycling is vital for addressing water scarcity and supporting sustainable development. The World Bank estimates that 36% of the global population lives in water-scarce regions, a figure expected to worsen as wastewater volumes are projected to increase by 24% by 2030 and 51% by 2050. Recycling wastewater can provide a reliable water source for non-potable uses like irrigation, industrial processes, and groundwater recharge, reducing pressure on freshwater supplies. For instance, a World Bank report from 2020 notes that in Mexico's San Luis Potosi, using treated wastewater for a power plant saved USD 18 million over six years while reducing groundwater dependency. Additionally, sewage sludge can be transformed into fertilizers or biogas, aligning with circular economy principles that view wastewater as a resource rather than waste. However, challenges like inadequate infrastructure and high costs persist, particularly in developing countries where only 4.2% of sewage is treated compared to 74% in high-income nations.

The UN Environment Programme (UNEP) emphasizes that effective sewage treatment could prevent 1.7 million deaths annually from waterborne diseases, with 90% occurring in developing countries. Moreover, recycling reduces greenhouse gas emissions from untreated sewage, which accounted for 5% of global emissions in 2016, according to the World Bank. Despite its benefits, global progress in urban sewage recycling faces significant hurdles.

Data gaps hinder effective planning, with only nine countries in Latin America providing complete wastewater treatment data, and globally, only 52% of sewage is treated, per a 2021 UN-Habitat report. Developing countries often rely on open dumping or basic treatment due to limited infrastructure, while high-income countries recycle 36% of waste compared to just 2% in low-income nations.

Innovative solutions, such as decentralized treatment systems and nature-based approaches like green roofs, are emerging to address these challenges. For example, Epic Cleantec's system in California recycles wastewater onsite for irrigation and produces fertilizers, diverting methane-emitting organics from landfills. Scaling such solutions requires cross-sector collaboration, public awareness, and significant investment to meet the UN's Sustainable Development Goal 6.3 target of halving untreated wastewater by 2030

Key projects across different regions

Middle East: The majority of Gulf countries now largely depend on desalinated water for their inhabitants' consumption: in the United Arab Emirates (UAE), 42% of drinking water comes from desalination plants producing more than 7 million cubic meters per day, in Kuwait it is 90%, in Oman 86%, and in Saudi Arabia 70%

- **Rabigh 3 IWP, Saudi Arabia:** A USD 750 million SWRO plant, jointly developed by ACWA Power and the Saudi Brothers Commercial Company, has been operational since 2022. The plant has an initial capacity of 600,000 cubic meters per day, with the potential to be expanded to 1.2 million cubic meters per day. Additionally, two more projects, Rabigh 4 in development and Rabigh 5 in pipeline. Rabigh 4 is expected to be commissioned by 2026, with a capacity of 600,000 cubic meters per day, along with a 1.2 million cubic meter per day water storage facility. Rabigh 5, which is still in the planning stage, will have a capacity of approximately 1.3 million cubic meters per day. These projects aim to increase Saudi Arabia's reliance on desalination to meet 90% of its water demand by 2030.

- **Al Khafji Solar SWRO, Saudi Arabia:** In 2018, Advanced Water Technology, completed a groundbreaking project, the world's first large-scale solar-powered Seawater Reverse Osmosis (SWRO) plant. With a capacity of 60,000 cubic meters per day, this innovative plant harnesses the power of photovoltaic panels to significantly reduce its reliance on fossil fuels. By leveraging solar energy, the plant addresses environmental concerns and sets a new standard for sustainable desalination solutions.

- **Hassyan IWP, UAE:** As per Utilities Middle East, these 545,000 cubic meters per day SWRO plant, commissioned by the Dubai Electricity and Water Authority (DEWA), set a global record for the lowest water tariff in 2022. DEWA aims to increase Dubai's desalination capacity to 750 MIGD (Millions of Imperial Gallons per Day) by 2030

- **Fujairah 1 SWRO Expansion, UAE:** Since its inception in 2004, this desalination plant has consistently demonstrated high reliability over the past 16 years, with a capacity of 67.5 million gallons per day. In a bid to enhance sustainability, the plant's expansion will incorporate solar-based capacity, effectively reducing its dependence on gas power plants. Although the company has not publicly disclosed the specific capacity of the project or the details of the projects currently under consideration.

Southeast Asia: Southeast Asia's SWRO (Seawater Reverse Osmosis) adoption is growing due to urbanization and groundwater depletion. Key projects include:

- **Jurong Island Desalination Plant, Singapore:** As per PUB (Public Utilities Board) Singapore, this 137,000 Cubic meter per day SWRO plant, operational since 2021, is Singapore's fifth desalination facility, supporting the goal of meeting 30% of water demand through desalination by 2060. It uses advanced membrane technology and energy-efficient systems.

- **Tseung Kwan O Desalination Plant, Hong Kong:** The desalination plant, which was completed in 2024, has a production capacity of 135,000 cubic meters per day, with the potential to be expanded to 270,000 cubic meters per day. This increased capacity is aimed at alleviating Hong Kong's water scarcity issues, which have been worsened by the territory's reliance on imported water. The plant features cutting-edge technology, including advanced pretreatment and energy recovery systems, to optimize its operations and efficiency

- **Perur Desalination Plant, Chennai:** This project is set to become the largest SWRO plant in Southeast Asia, with a capacity to produce a staggering 450,000 cubic meters of water per day. Scheduled to be commissioned by 2026, this massive desalination facility will play a crucial role in addressing the region's growing water needs.

Other countries: Globally, SWRO projects are expanding to address diverse water scarcity challenges. Notable examples include:

- **Carlsbad Desalination Plant, USA**: The 190,000 cubic meters per day SWRO plant, which has been operational since 2015, holds the distinction of being the largest in the Western Hemisphere. This massive facility provides a significant portion of San Diego County's water supply, accounting for approximately 10% of the region's needs.
- **Desalination Plant - Sorek B, Israel**: A desalination plant in reverse osmosis with a production capacity of about 200 million cubic meters per year.
- **Ashkelon Desalination Plant, Israel:** This desalination plant, operational since 2005 with a capacity of 118 million cubic meters per day, is nearing the end of its concession period. Plans are underway to renew the concession and expand the facility, doubling its capacity to make it the largest in Israel, increasing annual production from 120 million to 220 million cubic meters.
- **Magtaa Desalination Plant, Algeria:** Algeria's 500,000 cubic meters per day Seawater Reverse Osmosis (SWRO) plant is a key component in the country's ambitious plan to provide 40% of its population with desalinated water by 2025. With its initial concession period now coming to a close, the plant is slated for an upgrade, ensuring continued and enhanced support for the nation's water security goals.

Government policy and initiatives around SWRO

Country	Details
Saudi Arabia	• Saudi Arabia's National Water Strategy, spearheaded by the Ministry of Environment, Water, and Agriculture, aims to meet 90% of the country's water demand with desalinated water by 2030, primarily using SWRO technology. • To achieve this goal, the Saline Water Conversion Corporation (SWCC) plans to increase production to 8.5 million cubic meters per day by 2025, with a significant investment of USD80 billion. Notably, the Al Khafji plant has set a benchmark for energy efficiency, achieving a remarkable 2.27 kWh/m
Algeria	• The Algerian government has unveiled a significant USD 3 billion investment for the second phase of its national desalination expansion project, set to take place from 2025 to 2030. • This ambitious initiative involves the construction of seven new desalination plants in key locations including Tlemcen, Mostaganem, Tizi Ouzou, Chlef, Jijel, and Skikda, marking a major step forward in the country's efforts to enhance its water infrastructure.
United Arab Emirates	• UAE's Water Security Strategy 2036 aims to increase desalination capacity to 7.5 million cubic meters per day, with SWRO dominating due to lower energy costs. Projects like Hassyan and Mirfa IWPPs use project finance to lower tariffs, and the "Rethink Brine" challenge (2020) promotes brine management.
Egypt	• As part of the Egypt 2030 strategy, the Egyptian government is planning at least 14 new desalination plants as of 2022, followed by a second and third phase, aimed at reaching a desalination capacity of 6.4 million cubic meter per day in 2050, with about 142 plants.
Singapore	• Singapore's NEWater and desalination program is another key component of Singapore's water strategy. Currently supplying about 25% of Singapore's water needs, desalinated water is expected to meet 30% of demand by 2060.
Israel	• The desalination plant began with the cabinet decision of August 3, 2000, on the construction a seawater desalination plant on the southern coast for 50 million cubic meter of water a year. • The cabinet decision of June 1, 2008 (decision number 3533) stated an increase in the volume of seawater desalination in Israel from 505 million cubic meter as of 2013 (in keeping with cabinet decision 1882 of July 1, 2007) to 750 million cubic meters by 2020. In Government Decision 3866 dated June 10, 2018, the desalination targets were updated such that the volume of desalinated water in 2030 will be 1,100 million cubic meters.

Country	Details
Australia	• Australia has launched National Urban Water and Desalination Plan assisted major towns and cities to secure their water supplies and reduce their reliance on rainfall dependent sources by supporting infrastructure projects and research in desalination, water recycling and stormwater harvesting and reuse. • Government has provided funding for National projects as well as funding to all six federated states as well

Note: The above list is not exhaustive and only an indicative list of policies
Source: Crisil Intelligence

Key growth drivers for the water and wastewater treatment industry with focus on Middle East and South East Asia

The water treatment and wastewater management landscape is undergoing significant transformations, driven by a combination of factors that are redefining the industry's growth trajectory. Rapid urbanization, population growth, and industrialization are putting immense pressure on existing water resources, while stringent environmental regulations and government initiatives are driving the adoption of advanced treatment technologies. As a result, the demand for efficient and sustainable water treatment solutions is on the rise, with governments, private sector players, and technological innovations playing a crucial role in shaping the future of the industry.

Key growth drivers	Description
Rapid urbanization and population growth	• Urbanization and population growth significantly increase water consumption and wastewater generation, necessitating expanded treatment infrastructure. • In the Middle East, the GCC countries expect urban populations to grow by 20% by 2030, driving demand for wastewater treatment plants to manage increased sewage volumes • In Southeast Asia, urban centers like Jakarta (population >10 million) and Manila face sanitation challenges, with only 7% of Indonesia's urban wastewater treated, pushing investments in centralized treatment systems,
Stringent environmental regulations	• Governments are enforcing strict regulations on wastewater discharge to protect ecosystems and public health, driving the adoption of advanced treatment technologies. In the Middle East, Saudi Arabia's National Water Strategy (NWS) requires wastewater treatment plants to meet Zero-Liquid Discharge (ZLD) standards for industrial effluents, aiming to treat 100% of urban wastewater by 2030 • The UAE mandates Environmental Impact Assessments (EIAs) for treatment facilities, targeting 95% wastewater reuse by 2030. In Southeast Asia, Singapore enforces WHO Water Safety Plan guidelines, promoting MBRs and ultraviolet (UV) disinfection,

Key growth drivers	Description
Government investments and Public-Private Partnerships (PPPs):	• Scaling water and wastewater treatment infrastructure requires significant investment, which can be facilitated through government funding and public-private partnerships (PPPs). In line with this, there is a growing trend of increasing government efforts globally to mobilize private sector investments to bridge the funding gap in water infrastructure. For example, Saudi Arabia's Vision 2030 allocates USD 80 billion for wastewater treatment projects, and Indonesia's National Strategic Projects invest USD 4.5 billion in wastewater treatment, with PPPs supporting plants like Bandung's Bojongsoang.
Industrialization and industrial wastewater management	• Rapid industrialization in sectors like oil and gas, chemicals, and food and beverage (F&B) generates complex wastewater, necessitating advanced treatment systems • In the Middle East, Saudi Arabia’s petrochemical industry requires treatment of high-salinity effluents, with ZLD systems mandated for compliance.
Technological advancements in treatment systems	• Innovations such as MBRs, nanofiltration, and anaerobic digestion are driving market growth by improving treatment efficiency and reducing costs. Few select examples of the same are: • In the Middle East, Kuwait’s Sulaibiya plant, one of the world’s largest wastewater treatment facilities, uses MBRs to treat 600,000 Cubic meters/day, achieving 98% water recovery • In Southeast Asia, Singapore’s Tuas Nexus facility integrates MBRs and anaerobic digestion to treat wastewater and produce biogas, cutting energy costs by 30%

Source: Crisil Intelligence

Key challenges for the water and wastewater treatment industry with focus on Middle East and South East Asia

Despite the growing demand for water treatment and wastewater management solutions, the industry faces several key challenges that hinder its growth and development. One of the primary obstacles is the funding and investment gap, with many countries struggling to secure sufficient financing for large-scale infrastructure projects, resulting in a significant shortfall in the necessary investment to meet the region's water security needs. Additionally, the high capital and operational costs associated with advanced treatment technologies, such as reverse osmosis and zero liquid discharge systems, pose a significant barrier to entry for many companies, particularly smaller players. Furthermore, the complex nature of industrial wastewater in the region, which requires specialized and costly treatment solutions, compresses profit margins and creates a competitive advantage for larger firms. These challenges, combined with market entry barriers and the need for cutting-edge technology to treat complex effluents, underscore the need for innovative solutions and collaborative approaches to address the region's water treatment and wastewater management needs.

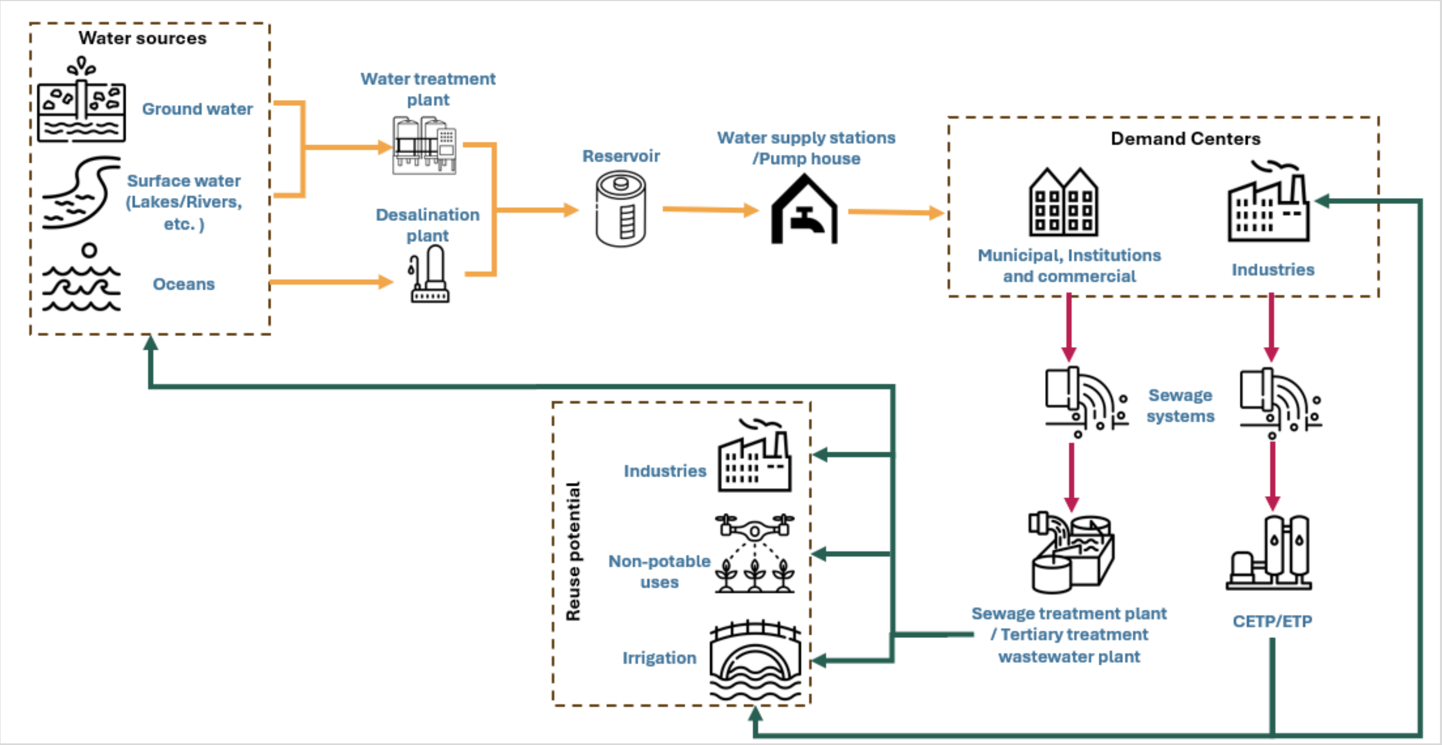
Key challenges	Description
Funding and Investment Gaps	• Limited public funding and reliance on private investment hinder infrastructure development, certain countries in both regions struggle with financing large-scale projects. • GCC countries invest ~USD 20 billion annually in water infrastructure, but non-GCC countries like Yemen face funding shortages • As per ADB "Financing water security in Asia", ASEAN countries need USD 200 billion by 2030 for water infrastructure, but only 20% is currently funded
High capital and operational costs	• Companies face significant upfront costs for advanced treatment technologies (e.g., reverse osmosis, zero liquid discharge) and ongoing expenses for energy, chemicals, and maintenance. • In the Middle East, desalination and ZLD systems requires high operational and maintenance costs, while in Southeast Asia, companies struggle with cost-effective solutions for diverse wastewater streams
Market Entry Barriers	• The GCC countries have implemented stringent standards for water reuse and wastewater treatment, necessitating the use of advanced systems such as Zero Liquid Discharge (ZLD) and Reverse Osmosis (RO) treatment. However, the high costs associated with these systems create a barrier to entry for smaller firms, giving larger players a competitive advantage
Complex industrial wastewater	• The Middle East and Southeast Asia are home to industries such as oil and gas, textiles, and food processing, which produce complex effluents containing high levels of chemical oxygen demand (COD), hydrocarbons, dyes, and heavy metals, requiring specialized treatment to meet stringent discharge standards. • The treatment of these industrial effluents demands cutting-edge technology, which comes at a significant cost, thereby compressing the profit margins of wastewater treatment companies operating in Southeast Asia and non-GCC countries in the MENA region.

Source: Crisil Intelligence

3. Indian water and Wastewater treatment market

Indian water treatment, water supply and waste water treatment landscape

Urban water treatment, water supply, wastewater treatment and reuse flowchart



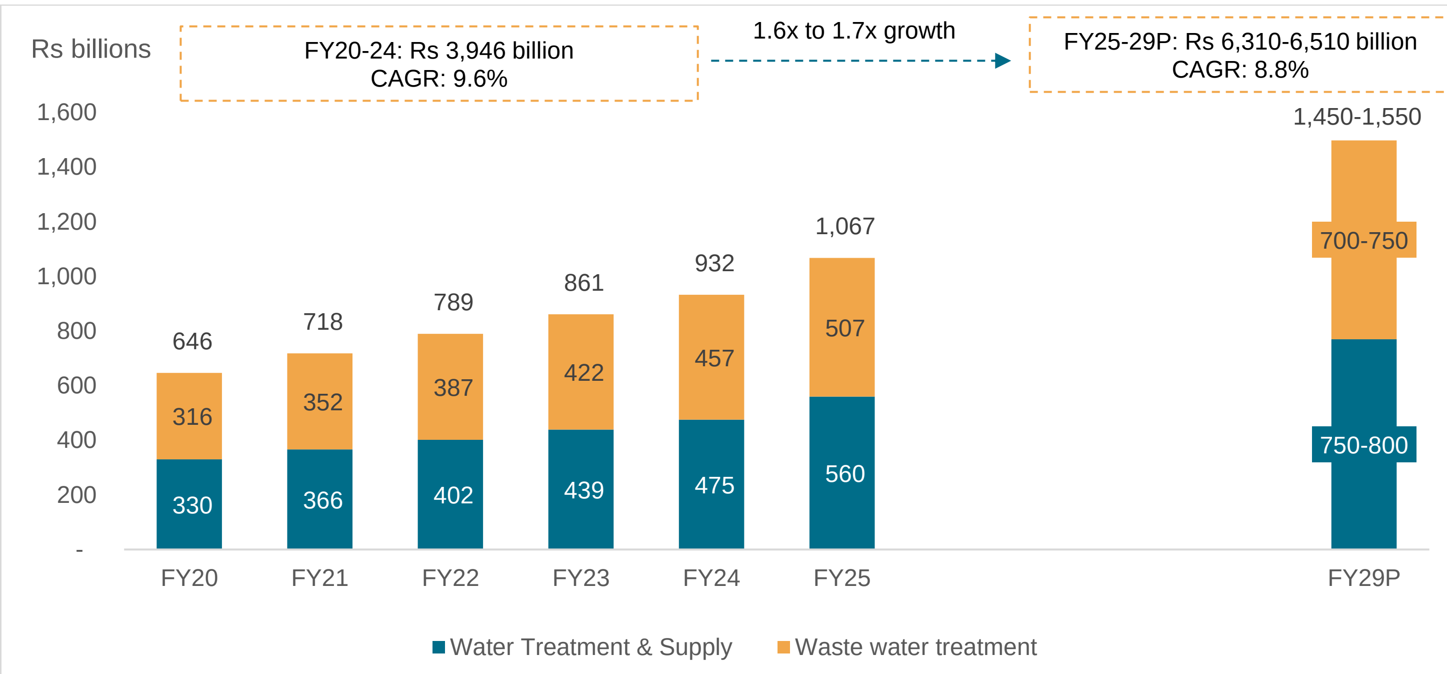
Source: Crisil Intelligence

In India, water treatment begins with the collection of water from various sources such as reservoirs, surface waters, and oceans. This raw water is then transferred to water treatment plants where it undergoes various treatment processes to make it potable. The treated water is then stored in reservoirs and pumped through pumping houses to municipal and industrial demand centers. The water supply infrastructure is designed to meet the growing demands of urbanization and industrialization, with a focus on providing clean and safe drinking water to the population. As the water is transferred to the demand centers, it is stored in reservoirs and pumped through a network of pipes to reach the end-users, including households, industries, and institutions.

The wastewater generated from municipal and industrial sources is collected and transferred to Sewage Treatment Plants (STPs). Industries also create their own ETPs to clean the wastewater generated by them and reuse the same in line with their respective SDG goals. Large industrial parks, such as those housing leather, fertilizer, and pharmaceutical firms, use Common Effluent Treatment Plants (CETPs) to treat their wastewater. Many STPs are also equipped with tertiary treatment plants to improve the quality of the treated water, making it suitable for reuse. The treated water is then transferred to canals for irrigation purposes, while industries such as power plants reuse the treated water to reduce their freshwater consumption. Non-potable uses, such as horticulture, toilet flushing and cleaning, are also a significant segment for water reuse. STPs located near water bodies discharge the excess treated water into the rivers or any water source.

The total market size is expected to reach Rs 6,310-6,510 billion during fiscals 2025-2029, driven by the emerging demand in wastewater infrastructure and efficient water and wastewater treatment solutions. With continued urbanization and industrialization, the country's demand for clean water is on the rise, creating a pressing need for efficient water treatment solutions.

Total Water and wastewater market of India



Note: P — projected
Source: Crisil Intelligence

Water treatment and its importance across India

India, with its vast and diverse population of 1.46 billion, accounting for 18% of the world's population, is focusing on optimizing its water resources. Although the country has a relatively small share of the world's freshwater, approximately 4%, it is taking proactive steps to manage this precious resource effectively. The government and various stakeholders are working together to address the challenges posed by the contamination of water bodies, which are vital for the health and well-being of both the environment and the population.

The country's water bodies, including rivers, lakes, and groundwater, are being revitalized through sustainable practices and innovative solutions. Efforts are being made to reduce the impact of industrial and agricultural activities on water quality, and to implement efficient wastewater treatment and management systems. This will not only improve the health and safety of the water supply but also help to preserve the natural beauty and biodiversity of India's water ecosystems.

As the nation continues to grow and develop, it is essential to prioritize water security and ensure that all citizens have access to clean and safe water. To achieve this, India is investing in cutting-edge water treatment technologies and infrastructure, which will enable the recycling and reuse of water, reducing the strain on freshwater resources. This effort is being supported by a policy push and regulatory focus in the water supply and wastewater treatment industries. By adopting a holistic approach to water management, India aims to create a more sustainable and resilient water system, capable of meeting the needs of its vast and diverse population.

The importance of water treatment in India cannot be overstated, as it plays a critical role in maintaining the health and well-being of the population. By removing impurities and contaminants from water, treatment processes help to prevent the spread of waterborne diseases, promoting a healthier and more productive society. Furthermore, effective water treatment and management will also help to support the country's rapid urbanization and industrial growth, while minimizing the environmental impact of these activities.

In response to the challenges posed by water scarcity and pollution, India is embracing innovative solutions and collaborative approaches to water management. By working together, the government, private sector, and civil society can help to ensure that India's water resources are used efficiently, effectively, and sustainably, securing a brighter future for generations to come. The country's water management strategy is focused on creating a more resilient and adaptive water system, capable of responding to the changing needs of the population and the environment.

Far reaching societal Impact of water treatment

The water treatment sector has a profound influence on the well-being of Indian society, with its effects being felt across multiple areas. The significance of this sector can be gauged by its contributions to:

- **Enhanced Public Well-being**: By providing access to clean water, effective treatment significantly reduces the occurrence of water-related illnesses, which are still a major concern in India This, in turn, leads to improved life expectancy, reduced healthcare expenditures, and an overall better quality of life.
- **Economic Growth**: The water treatment sector supports various economic activities by supplying reliable water to industries, agriculture, and households. Moreover, treated wastewater can be reused for irrigation, decreasing the reliance on freshwater and boosting agricultural productivity. The construction, operation, and maintenance of water treatment plants also generate employment opportunities, contributing to local economic development.
- **Environmental Conservation**: The discharge of untreated wastewater can have devastating effects on the environment, including the degradation of water bodies, loss of biodiversity, and disruption of aquatic ecosystems. Water treatment helps mitigate these impacts by removing harmful pollutants and preventing the contamination of rivers, lakes, and groundwater, thereby preserving ecosystems that are crucial for maintaining ecological balance and supporting livelihoods.
- **Social Inclusion and Equity**: Improved water treatment facilities help bridge the gap in access to safe water, particularly for marginalized and rural communities. This reduces health disparities and supports inclusive growth. Furthermore, by alleviating the burden of water collection, which often falls on women and children, communities can benefit from increased participation in education and economic activities, leading to greater social equity and empowerment.

Impact of climate change on water security in India

Climate change poses a significant threat to India's water security, exacerbating existing challenges and creating new ones. The effects of climate change on water resources are multifaceted and can be understood through the following aspects:

- **Changes in rainfall patterns**: India's water supply is heavily dependent on the monsoon season, which accounts for 70-80% of the country's annual rainfall. However, climate change has led to unpredictable monsoon patterns, with some regions experiencing delayed onset, reduced intensity, or prolonged dry spells. This unpredictability affects groundwater recharge, reservoir levels, and river flows, making water management and planning more complex.
- **Increased frequency of extreme weather events**: The frequency and intensity of extreme weather events such as floods, droughts, and cyclones have increased due to climate change. Floods can overwhelm water treatment infrastructure, contaminate freshwater sources, and disrupt supply chains, while droughts reduce water availability, increase competition among users, and strain existing treatment capacities.
- **Growing water stress**: According to Niti Aayog, a significant number of districts in India are experiencing water stress or scarcity, with the per capita water availability decreasing steadily due to the combined pressures of population growth and over-extraction of water resources. Furthermore, the impacts of climate change are exacerbating this situation, leading to a decline in the reliability of both surface and groundwater sources, and thereby intensifying the existing water stress.
- **Melting of Himalayan glaciers**: The Himalayan glaciers feed major rivers such as the Ganges, Brahmaputra, and Indus, which are lifelines for millions of people. Rising temperatures are accelerating glacier melt, initially increasing river flows but ultimately leading to reduced water availability in the long term. This threatens water security in northern India, especially during dry seasons.

As the impacts of climate change on India's water security continue to grow, it is essential to address these challenges through proactive and innovative solutions to mitigate the effects of climate change on water resources. To achieve this, India can prioritize investment in resilient water infrastructure and advanced water treatment technologies, such as expanding wastewater treatment capacity, adopting decentralized water treatment systems, and implementing water reuse and recycling programs. By integrating climate risk assessments into water resource planning, India can build adaptive and flexible systems that can respond to changing climate conditions. Additionally, promoting innovative technologies such as membrane filtration, UV disinfection, and bio-remediation can improve treatment efficiency and reduce environmental impacts. By strengthening policy frameworks and governance, India can ensure sustainable water management, encourage public-private partnerships, and promote water conservation and efficiency, ultimately enhancing the country's water security and resilience to climate change.

Key water statistics

Declining per capita water availability in India

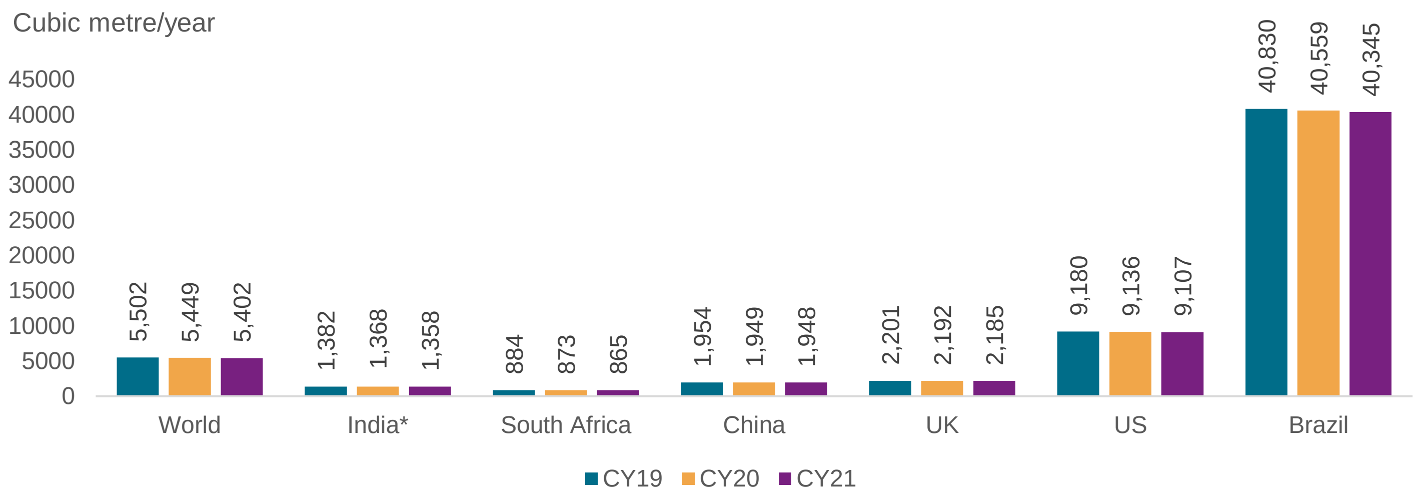
India has been experiencing water stress over the past two decades, with per capita water availability consistently below the threshold of 1,700 cubic meters per year, according to the Niti Aayog's Composite Water Management Index (CWMI) report. Furthermore, estimates by the CWC – Water and related statistics, indicate a declining trend in per capita water availability, from 1,486 cubic meters per year in 2021 to 1,219 cubic meters per year by 2050, highlighting the growing water scarcity concerns in the country

	CY2001	CY2011	CY2015	CY2021	CY2023	CY2024	CY2025P	CY2031P	CY2050P
Per capita water availability in India (Cubic meters)	1,820	1,651	1,508	1,486	1,461	1,449	1,434	1,367	1,219

P: Projected,
Source: CWC, Crisil Intelligence

As per FAO-Aquastat, in calendar year 2019, India's water availability per capita stood at 1,382 cubic metre/year. In 2020 and 2021, the availability per capita stood at 1,368 and 1,358 cubic metre/year, respectively. The decline in water availability per capita is a concern as it can significantly impact the country's economic growth, food security and well-being of its population. With a large and growing population, India's water resources are under increasing pressure, making the adoption of efficient water management practices essential and conservation of the precious resource.

Per capita water availability across key geographies



Note: Data is based on the latest public information, Brazil includes amazon hence the higher availability, India numbers are different because the data in table is from Centre for water commission and data in above chart is from UN - Aquastat database
Source: Food and Agriculture Organization (FAO) – AQUASTAT Database, Crisil Intelligence

The availability of water per capita for all countries, except South Africa and India, is above the threshold of 1,700 cubic metre/year. China is at a risk of turning water stressed. The availability of water per capita below 1,700 cubic metre/year for India over 2019-21 highlights the need for urgent water conservation and management measures to ensure sustainable development and to meet the growing demand of the population. India must adopt a multi-faceted approach to address water scarcity, including improved use of water, promotion of water-saving technologies and better water storage and recharge systems.

Additionally, India must also focus on protecting its water sources from pollution and degradation and ensure efficient allocation of water across sectors. The country must prioritise water reuse and recycling by implementing effective systems for treating and reusing wastewater in industries, agriculture and urban areas for non-potable purposes such as irrigation, flushing and industrial processes. By promoting reuse, India can reduce its freshwater withdrawals, minimise wastewater discharge and lift the pressure off its water resources.

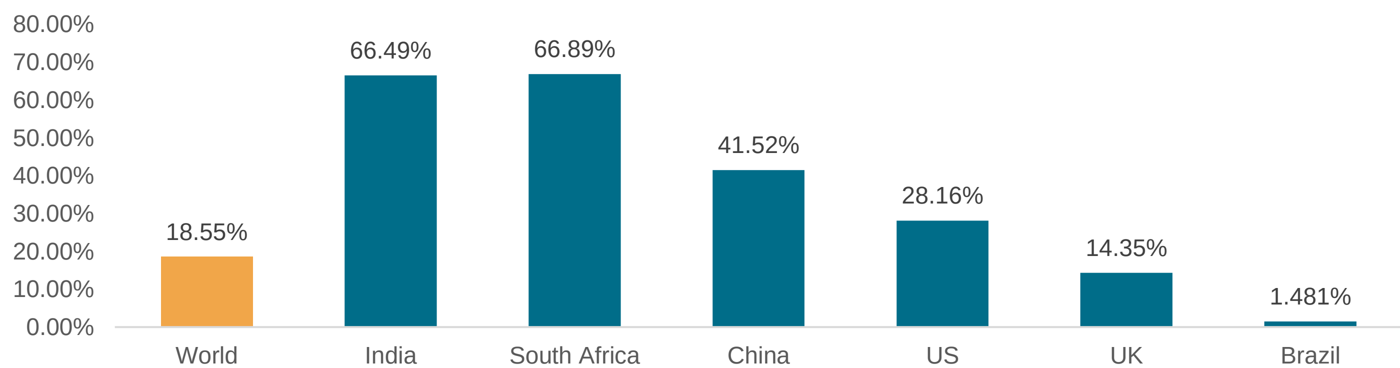
Water stress across major economies

According to the Central Water Commission (CWC) report of 2023, several river basins are experiencing water stress or scarcity. The Mahanadi and Tapi basins are water-stressed, while the Subarnarekha, Krishna, Mahi, Sabarmati, the west flowing rivers of Kutch and Saurashtra, including Luni, Pennar, the east flowing rivers between Mahanadi and Pennar, Indus (up to the border), Cauvery and those flowing between the Pennar and Kanyakumari basins are facing water scarcity. The Central Ground Water Board (CGWB) assessed 7,089 groundwater units in 2022, categorizing their status as follows: 14% as over-exploited, 12% as semi-critical, 4% as critical, and 2% as having saline groundwater. On the other hand, 67% of the units were found to be safe. Notably, the majority of the over-exploited units are concentrated in the north-western part of India, indicating a region of high groundwater stress and potential vulnerability to water scarcity

India’s water stress level stood at 66.49% in 2021, level of groundwater extraction in Haryana, Punjab, Rajasthan, Dadra and Nagar Haveli, and Daman and Diu exceed 100%, indicating that annual groundwater consumption surpasses the annual extractable groundwater resources. In contrast, groundwater extraction levels in Delhi, Tamil Nadu, Uttar Pradesh, Karnataka and the union territories of Chandigarh, Lakshadweep and Puducherry range between 60% and 100%, while the rest are below 60%.

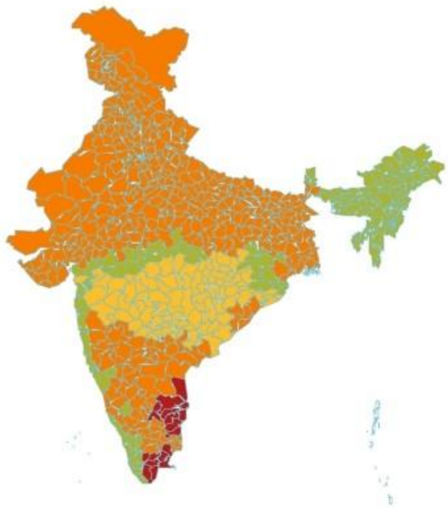
Following the findings, the government has been focusing on the development of water resources. Initiatives on water management, including conservation and rainwater harvesting are primarily the states' responsibility. However, the Centre has taken important measures for conservation, management of groundwater and effective implementation of rainwater harvesting in the country, including facilitating tap water connection to every household under the Jal Jeevan Mission (JJM)

Water Stress level across geographies and world (CY21)

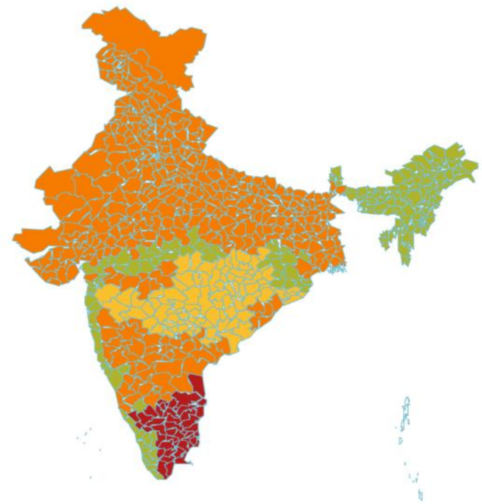


Note: Latest public information, Brazil is shown no water stress levels because of large fresh water source in amazon basin
Source: FAO – AQUASTAT Database, Crisil Intelligence

Per capita water availability across districts (CY25)



Per capita water availability across districts (CY50)



Per capita water availability	Absolute scarcity (<500 m^3)	Scarcity (500 – 1,000 m^3)	Stress (1,000 – 1,700 m^3)	No stress (>1,700 m^3)

Note: Latest public information
Source: Niti Aayog, India Climate and Energy Dashboard, Crisil Intelligence

In addition, several states have undertaken significant water conservation and harvesting measures, such as Rajasthan's Mukhyamantri Jal Swavlamban Abhiyan, Maharashtra's Jalyukt Shivar Abhiyan, Gujarat's Sujalam Sufalam Jal Abhiyan, Telangana's Mission Kakatiya, Andhra Pradesh's Neeru Chettu, Bihar's Jal Jeevan Hariyali Abhiyan and Haryana's Jal Hi Jeevan Hai, among others.

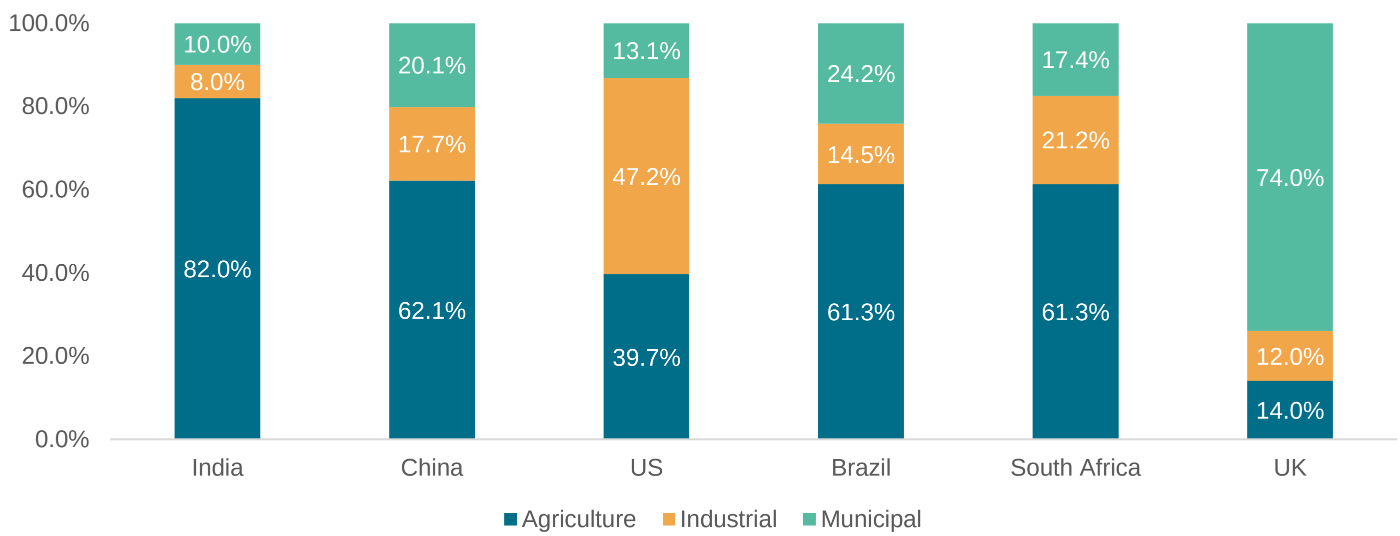
The government launched multiple initiatives to address water stress, including the Jal Shakti Abhiyan (JSA) in 2019, a time-bound campaign aimed at improving water availability, including groundwater conditions in 256 water-stressed districts. The government has also launched the Jal Shakti Abhiyan-II (JSA-II): Catch the Rain to generate awareness. Furthermore, the Atal Bhujal Yojana, a Rs 60 billion central sector scheme is being implemented in 80 water-stressed districts of seven states (Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh) to promote sustainable management of groundwater resources with community participation.

Agriculture dominates water usage in developing nations

According to data from the Food and Agriculture Organization (FAO), the use of water in sectors varies significantly across countries. A comparison with China, a major economy, reveals that India's water use in agriculture is significantly higher than that in China. However, China's industrial and municipal water use is substantially higher than that in India. Notably, the UK and US have a different pattern of water allocation, with a greater emphasis on industrial uses.

The above highlights the varying priorities and needs of different countries in terms of water allocation, with some placing more importance on industrial and municipal uses, while others, such as India, relying heavily on agriculture.

Water uses across sectors (CY22)



Note: Latest public information
Source: FAO – AQUASTAT Database, Crisil Intelligence

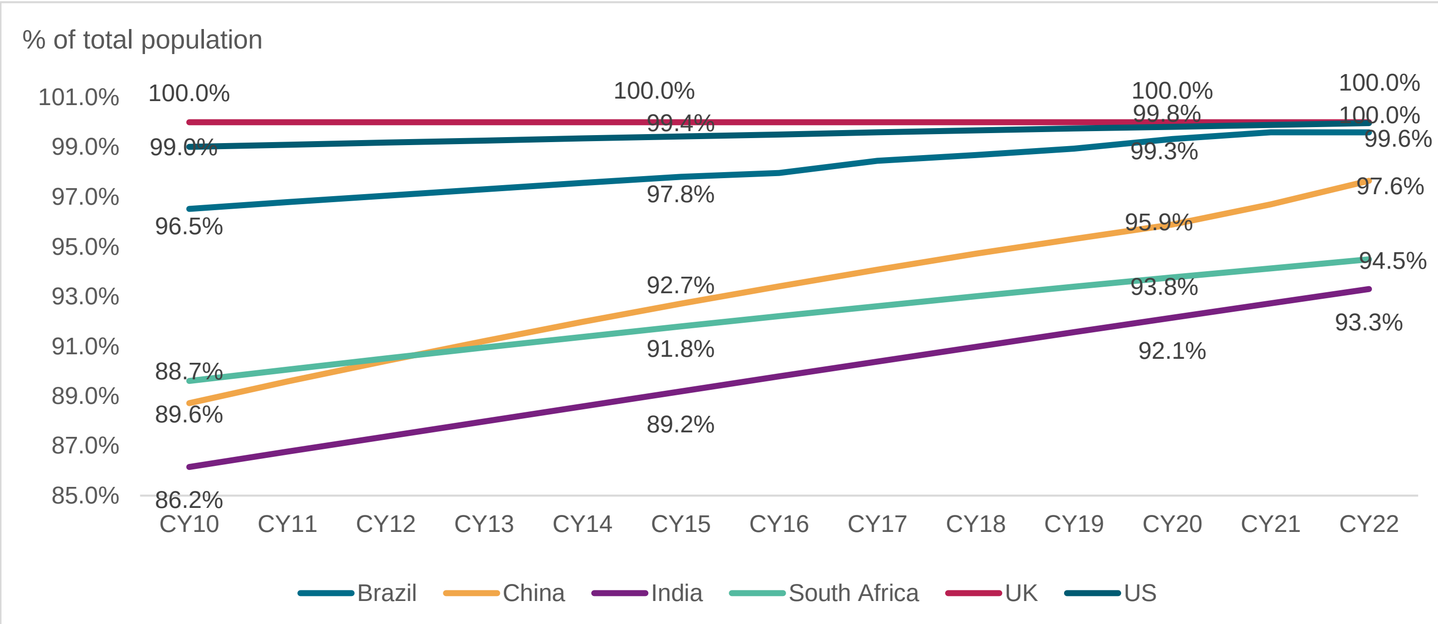
Central Ground Water Board (CWGB) assessment, 2023, highlights the significant role of groundwater in India's irrigation sector, accounting for ~87% of the total groundwater utilisation, which amounts to 209.74 BCM. Majority groundwater is used for cultivating water-intensive crops, with about 74% and 65% constituting the areas under wheat and rice cultivation, respectively.

As demand for water continues to rise from the industrial and municipal segment, it is likely to put an additional pressure on India's water resources, underscoring the need for efficient water management and conservation measures to ensure sustainable use of groundwater and other sources. To cater to the growing needs, the government recognises the need to improve efficiency in agriculture, which is the largest user of groundwater. To achieve this, the Centre has formulated the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) with an aim of extending the coverage of irrigation and improving water use efficiency. The scheme aims to achieve the goals of Har Khet Ko Paani (water to every field) and More Crop Per Drop, thereby optimising water use in agriculture and making water more available for other sectors, while also ensuring sustainable and efficient use of the vital resource.

Developing countries achieve major gains in drinking water access

Over the years, access to drinking water has undergone a significant transformation, with a growing focus on water quality, in addition to availability. In India, significant progress has been made in increasing access to basic drinking water, with nearly 95% of population having access to piped water, wells and tubewells. According to the National Compilation on Dynamic Ground Water Resources of India, 2023, ground water constitutes ~85% of total rural water supply and 50% of urban water supply.

% of population with access to drinking water



Note: Latest public information
Source: United Nations-Water Sustainable Development Goals 6 data portal, Crisil Intelligence

India has made significant strides in improving access to safe and adequate drinking water, particularly in rural areas, with 75% of the rural population having access to piped water systems within their premises as of fiscal 2024, compared with less than 40% in fiscal 2016.

Percentage of population using an improved drinking water source in India

	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
% of total population	94.57	94.35	95.23	95.98	96.96	98.56	98.64	99.25	99.29

Note: Latest public information
Source: DDWS Ministry of Jal Shakti, Crisil Intelligence

Furthermore, by May 31, 2022, the Department of Drinking Water and Sanitation reported that 75% of rural households had a tap connection within their premises. The progress is a testament to the government's JJM, which aims to provide piped water to all households by 2030. It has not only improved access to drinking water but also enhanced water quality, reducing the risk of water-borne diseases. The government's focus on decentralised water management, involving local bodies, has also contributed to the success of these initiatives. With continued efforts, India is poised to make further progress in providing all its citizens access to water.

Water demand on the rise due to rapid urbanisation and industrialisation

Various agencies, including the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWRRDGR), National Commission for Integrated Water Resources Development (NCIWRD) and the Planning Commission, have conducted assessments to estimate the future water demand in India. Although the predicted numbers vary, the demand for water is expected to increase significantly by 2030. The total water demand by 2050 is projected to be 1,447 BCM. In contrast, the NCIWRD predicts the total water demand at 1,180 BCM in a high-demand scenario. The

Planning Commission and Water Resource Group data, published in Niti Aayog's CWMI report, estimates the demand in 2030 to be 1,498 BCM.

India faces challenges in water management due to its growing population, urbanization, and industrialization, highlighting the need for effective water management and conservation strategies to meet the growing demands of various sectors, including agriculture, industry and municipal use.

Water demand projections until 2050

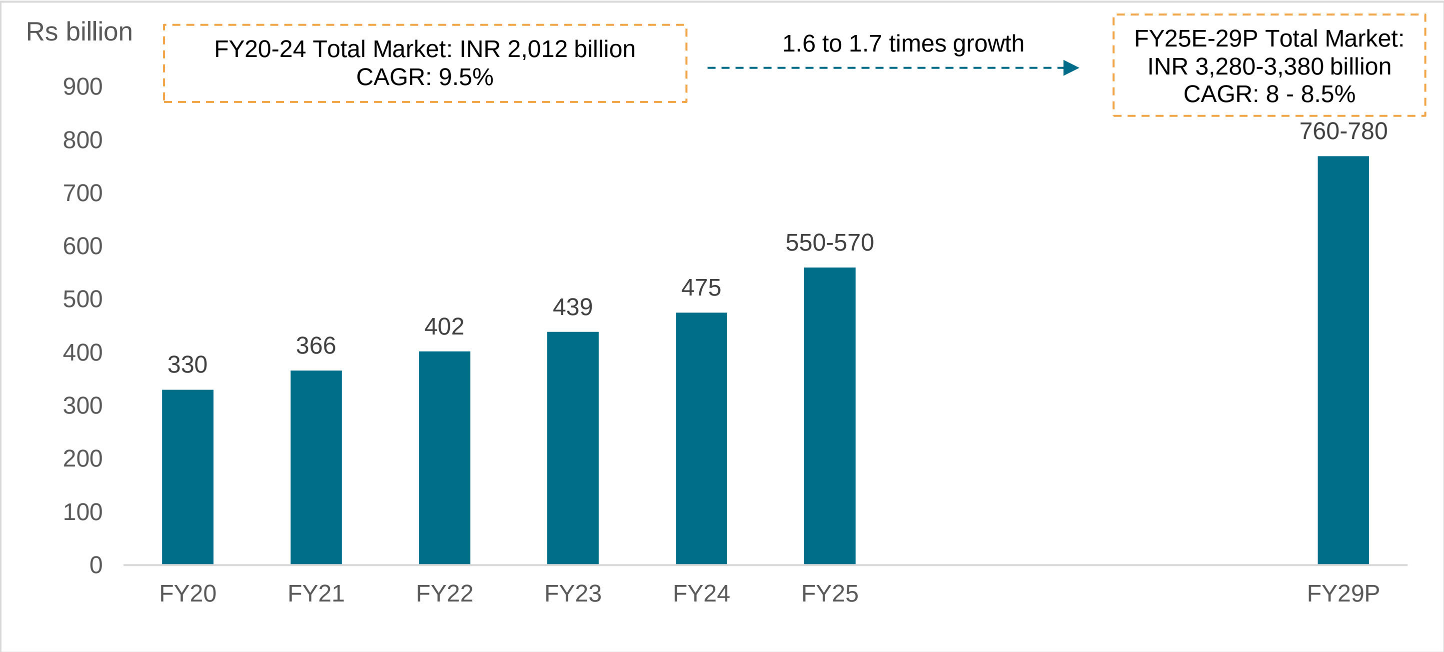
In BCM	By MoWRRDGR			By NCIWRD					
Sectors	2010	2025	2050	2010		2025		2050	
				Low	High	Low	High	Low	High
Irrigation	688	910	1,072	543	557	561	611	628	807
Drinking water	56	73	102	42	43	55	62	90	111
Industry	12	23	63	37	37	67	67	81	81
Energy	5	15	130	18	19	31	33	63	70
Others	52	72	80	54	54	70	70	111	111
Total	**813**	**1,093**	**1,447**	**694**	**710**	**784**	**843**	**973**	**1,180**

Note: MoWRRDGR, NCIWRD
Source: CWMI, Crisil Intelligence

Water treatment and supply market

The Indian water treatment market has grown remarkably over the past five years, fuelled by the government's initiatives to enhance water supply and sanitation infrastructure. The Har Ghar Jal scheme for rural areas under the Jal Jeevan Mission and the 24x7 water supply plan for 500 cities under the AMRUT (Atal Mission for Rejuvenation and Urban Transformation) programme have been instrumental in driving this growth, with additional support from other schemes such as the Smart City Mission (SCM). As a result, the market size is expected to expand by 1.6 to 1.7 times growth from fiscal 2020-24 to 2025-29. This rapid growth can be attributed to significant investments in water infrastructure, including the augmentation of Water Treatment Plant (WTP) capacity, renovation of existing WTPs and expansion of pipeline infrastructure. The integration of cutting-edge technologies, such as SCADA systems for smart water metering and leakage detection systems, has played a crucial role in modernising the sector. With continued urbanisation and industrialisation, the country's demand for clean water is on the rise, creating a pressing need for efficient water treatment solutions.

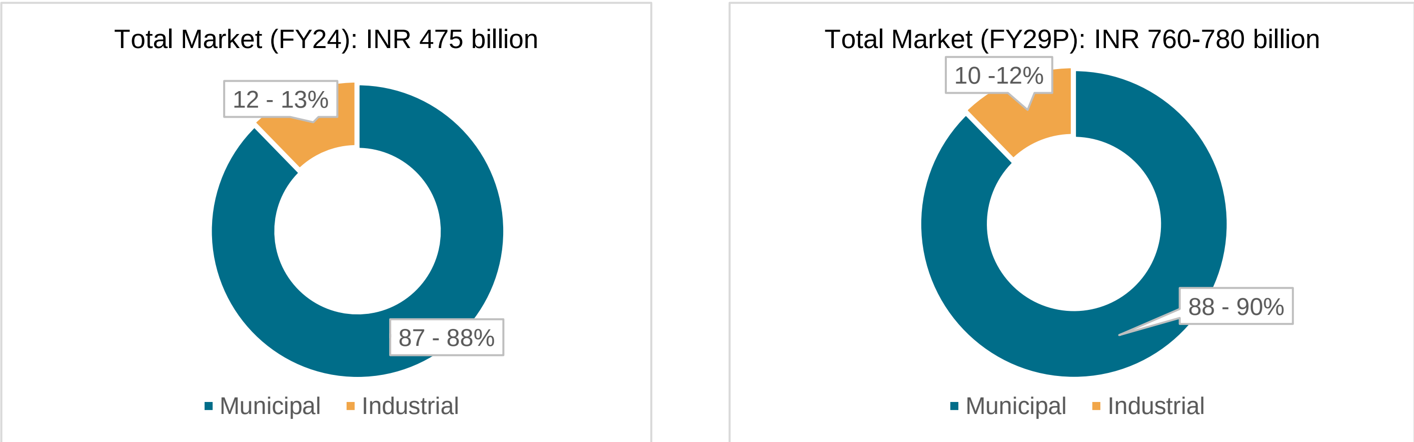
Market size of water treatment and supply (FY20-29P)



Note: P — projected
Source: Crisil Intelligence

The Jal Jeevan Mission has already led to substantial investment in rural water infrastructure, with rural household tap water connections increasing from 16.1% in 2019 to 80% just five years later, the next phase of growth is expected to be driven by urban development. The government's plans to provide 24x7 water supply and reduce non-revenue water (NRW) in urban areas are anticipated to be major growth drivers.

Market size of water treatment and supply split across Municipal and Industrial



Note: P — projected
Source: Crisil Intelligence

Overview of key water treatment technologies

Water treatment is a critical process that ensures quality and safety. The goal is to remove contaminants and impurities from raw water to produce drinking water that meets regulatory standards. The key processes and equipment used in the process include filtration, disinfection, adsorption, desalination and testing, among others.

Filtration: Removes suspended solids and contaminants from water using a porous medium, such as sand or membranes. It helps remove particulate matter, sediment and other impurities that affect water quality.

Disinfection: Kills or deactivates microorganisms that can cause waterborne diseases. Common methods include chlorination, UV light, ozone treatment and chlorine dioxide treatment.

Adsorption: Removes contaminants by exposing them to activated carbon. It is commonly used to remove organic compounds such as pesticides

Desalination: Removes salt and minerals from seawater or brackish water to produce fresh water. Methods include reverse osmosis, distillation and electrodialysis.

Testing: Monitors water quality and ensures it meets regulatory standards. Common tests include pH measurement, turbidity measurement and analysis of chemical and biological parameters.

Other key processes: Include coagulation and flocculation, sedimentation, biological treatment, advanced oxidation processes, membrane bioreactors, and UV/H2O2 treatment. These processes help remove contaminants, improve water quality and protect public health and environment.

Key technologies used for water supply

The following technologies are being used extensively by water utilities to improve the efficiency, reliability and sustainability of their operations. By leveraging the technologies, utilities can reduce water loss, optimise system performance and provide better service to their customers.

Hydraulic modelling: Is a crucial technology used to simulate and analyse the behaviour of water distribution systems. It helps utilities predict pressure, flow and quality in the network, allowing identification of potential issues and optimisation of system performance. Hydraulic models can be used to design new systems, upgrade existing ones and respond to emergencies such as main breaks or contamination.

Advanced Metering Infrastructure (AMI): Is a technology that enables remote reading of water meters, providing real-time data on water consumption patterns. The data can be used to detect leaks, identify areas of high-water usage and optimise water distribution. AMI systems can also enable smart metering, which allows utilities to implement time-of-use pricing, demand response programmes and other conservation measures.

Automated Meter Reading (AMR): Systems automatically collect water consumption, diagnostic, and status data from meters using radio signals, drive-by, or walk-by methods, eliminating manual readings. Tracks real-time consumption for accurate billing and demand forecasting. Identifies leaks or unusual usage patterns to reduce non-revenue water losses.

Real-Time Monitoring and Control: Technologies enabling continuous oversight and adjustment of water treatment and supply processes to ensure quality and operational efficiency. Connected IOT sensors monitoring parameters like pH, turbidity, dissolved oxygen, conductivity, temperature, pressure, and flow, transmitting data via wireless networks (e.g., Wi-Fi, LoRaWAN, cellular). It also tracks and detects anomalies in equipment performance (e.g., irregular pump flow) to schedule maintenance before failures occur. Along with chemical levels (e.g., chlorine, coagulants) in real time, triggering alerts or automated dosing to maintain treatment efficacy.

GIS: Is a powerful tool used to manage and analyse spatial data related to water distribution systems. It enables utilities to map their infrastructure, track assets and visualise data such as pressure, flow and quality. GIS can also be used to identify areas of high risks, such as zones prone to flooding or contamination and optimise maintenance and repair activities.

Predictive Analytics and Automation: Technologies using data analysis and autonomous systems to optimize operations, predict issues, and automate processes. Integrated data analytics and AI using machine learning models to analyze IoT and metering data to identify trends, predict outcomes, and optimize treatment and supply processes

Pressure monitoring systems: Are used to measure the pressure of water in the distribution network, allowing utilities to identify areas of high or low pressure. The data can be leveraged to optimise system performance, reduce energy consumption and prevent pipe bursts and other failures. Pressure monitoring systems can also be used to detect leaks and other anomalies in the system.

Supervisory Control and Data Acquisition (SCADA) systems: Are used to monitor and control water distribution systems in real time. They enable utilities to collect data from sensors and other devices, analyse it and respond to changes in the system. SCADA systems can be used to optimise system performance, respond to emergencies and implement conservation measures such as demand response programmes.

Leak detection technologies: Technologies, such as acoustic sensors and ground-penetrating radar, are used to identify and locate leaks in the water distribution network. They can help utilities reduce water loss, prevent property damage and optimise maintenance activities.

Water quality monitoring systems: They play a vital role in assessing the quality of water in distribution networks by tracking key parameters such as pH, turbidity and bacterial levels. The implementation of such systems has become increasingly crucial as states are now required to monitor and report water quality, in accordance with the standards set by the CWC. By leveraging such systems, utilities can swiftly detect contamination events, pinpoint high-risk areas and fine-tune water treatment processes to ensure compliance with regulatory requirements and provide safe drinking water to consumers.

Asset management systems: Asset management systems are used to manage and optimise the maintenance and repair of water distribution infrastructure. They enable utilities to track the condition and performance of assets, prioritise maintenance activities and optimise resource allocation.

Seawater Reverse Osmosis (SWRO): It is a critical desalination technology that employs semi-permeable membranes to remove salts and impurities from seawater, producing potable water. The demand for SWRO technology is on the rise globally, with innovations such as energy recovery devices (ERDs) further reducing energy consumption. In 2020 alone, the construction of more than 35 desalination plants was announced in China, as well as six in the Philippines, and six in Taiwan. Southeast Asia is an emerging hub for SWRO, driven by rapid urbanization and declining freshwater resources, as per the Asian Development Bank. Globally, over 21,000 desalination plants were operational in 2022. However, challenges such as high capital costs, energy intensity, and environmental impacts from brine discharge remain, necessitating 21 technological and policy advancements to address these concerns and ensure the sustainable adoption of SWRO technology.

Key projects in Water treatment and supply sector in India

Sr no	Project	State / Union territory	Capacity	Total cost (Rs Mn)	Status
1	Water Treatment Plant (Bhandup)	Maharashtra	2,000 MLD	41,238.8	Planning
2	Water Treatment Plant (Bilga, Ludhiana)	Punjab	580 MLD	15,460.0	Planning
3	Water Treatment Plant (Aluva) and associated transmission network	Kerala	190 MLD	4,950.0	Planning
4	Water Supply Scheme (Indore)	Madhya Pradesh	400 MLD	5,797.8	Planning
5	Water Treatment Plant (Jite, Raigarh)	Maharashtra	270 MLD	4,264.7	Planning
6	Water Treatment Plant (Bidkin) and associated transmission network	Maharashtra	70 MLD	4,000.0	Planning
7	Water Treatment Plant (Vallah) associated transmission network and over head service reservoirs	Punjab	440 MLD	6,653.2	Under execution
8	Water Treatment Plant & its ancillary structures for improvement of water supply to Bhubaneswar city	Odisha	130 MLD	3,120.0	Under execution
9	Water Treatment Plant (Dighi Port Industrial Area)	Maharashtra	50 MLD	1,771.6	Under execution
10	Telangana Drinking Water Supply Scheme for Adilabad, Karimnagar, Warangal, Khammam, Nalgonda, Mahaboobnagar, Medak, Nizamabad and Rangareddy districts of Telangana	Telangana	1,30,000 km – covering 26 internal grids, 62 intermediate pumping stations, 16 intake wells, 110 water treatment plants and 37,573 Overhead Service Reservoirs.	428,530.0	Under execution
11	Pipe Water Supply Scheme (Mathura)	Uttar Pradesh		33,115.0	Under execution

Note: The above list is not exhaustive and only an indicative list of projects
Source: Projects Today, Crisil Intelligence

Key growth drivers for the water treatment industry

The water treatment and water supply market is poised for growth, driven by several key factors. The increasing water demand, rapid urbanization, and rising population, coupled with the development of smart cities, are creating a surge in the need for efficient water management systems. Furthermore, the government's intensifying focus on water security, initiatives to reduce non-revenue water (NRW), and growing private sector participation are also driving the market's growth, increasing water requirements for emerging industries are expected to have a significant impact on the market, making these factors the key drivers of the water treatment and water supply market.

Growth drivers	Details
Government's focus on water security intensifies	• The government has intensified its focus on water security, with central and state authorities working towards implementing effective and equitable water management systems • The Union government has proposed offsetting up an Integrated Water Resources Management Authority (IWRMA) in each state as part of its vision for a developed India by 2047. A draft model Bill has been circulated to all states for consideration. • The IWRMA is expected to play a crucial role in developing comprehensive water security plans for various administrative tiers, including villages, cities, districts and states. Its responsibilities will also encompass groundwater and floodplain management, and river conservation, all of which are critical components of a robust water management framework
Initiatives to reduce non-revenue water (NRW)	• The government is taking steps to reduce NRW levels by metering the supply lines; AMRUT 2.0 targets to reduce NRW in cities to 20% • Thane Municipal Corporation and Thane Smart City Ltd have installed 105,000 smart water meters in October 2024 across Thane under its Smart Water Meter project
Growing private sector participation	• There is a growing trend of private sector participation in the water management sector, with companies increasingly bidding for government projects under various models such as one city, one operator (under the hybrid annuity model), performance-based contracting and payments • This increased engagement of private players is expected to bring in expertise, efficiency and investment, ultimately enhancing the country's water infrastructure and services
Requirement of large volume of water in emerging industrial sectors	• India's push to become a global leader in both semiconductor and solar manufacturing is driving a surge in water demand, making water treatment a critical growth sector. • Semiconductor fabs can require over 5 million gallons of Ultra-Pure Water (UPW) daily. As the government invests USD 10 billion to establish domestic chip manufacturing, major projects are being planned in states like Gujarat and Tamil Nadu will intensify the need of treated water • The Indian government's emphasis on renewable energy, particularly solar energy, is driving growth in the solar panel manufacturing sector. However, this growth comes with a significant water footprint, as the production of solar panels requires substantial amounts of water, especially in the processes of silicon purification and cell fabrication. As a result, the increasing demand for solar panels is, in turn, driving up water demand

Source: Crisil Intelligence

Key challenges for the water treatment industry

Water treatment has assumed increased importance with its need growing every day considering the state-of-affairs regarding water availability. The water treatment industry is vital for public health, environmental sustainability, and economic development. However, the industry faces several challenges:

Challenges	Details
Lack of water network and coverage	• Indian cities face significant challenges in providing adequate water supply and sewerage services, with notable deficiencies in network coverage and service quality • Despite their size, even million-plus cities have substantial backlogs, with gaps greater than 20% in network coverage, highlighting the need for infrastructure expansion and upgrading to meet the growing demands of urban populations.
Economic challenges to replace aging infrastructure	• Most WTPs in India are outdated and need modernisation with new technologies. However, most Urban Local Bodies (ULBs) lack the financial resources to upgrade them, relying heavily on government grants and schemes to build and operate WTPs, which hinders their effective operation and maintenance
Technical inadequacies of ULBs	• Most ULBs lack adequate manpower and technical capacity for meter reading. As a result, they continue with a fixed rate billing system and the meters are unread • As per the CWC, only 20-30% of current water supply is metered, which is leading to revenue losses for ULBs
Lack of formal reuse standards	• A few states have drafted water reuse policies, but many lack clear guidelines on the processes and technologies for water reuse, as well as criteria to select suitable business models

Overview of wastewater treatment landscape

In India, the wastewater sector is facing significant challenges, with a large portion of the population lacking access to proper sanitation and wastewater treatment facilities. The National Commission for Integrated Water Resources Development (NCIWRD) projects the country's water requirements to reach approximately 1,180 billion cubic metres by 2050, with around 70% allocated for agriculture, 9% for drinking water, 7% for industrial purposes, 6% for energy generation and the rest for other uses.

The increasing trend of urbanisation is expected to shift the priority from irrigation to drinking water. According to the United Nations, 64% of the country's population resides in rural areas, while 36% is connected to metropolitan centres. By 2050, 50% of the country's population (877 million) is estimated to be living in cities, which are rapidly expanding as a result of economic development and reforms.

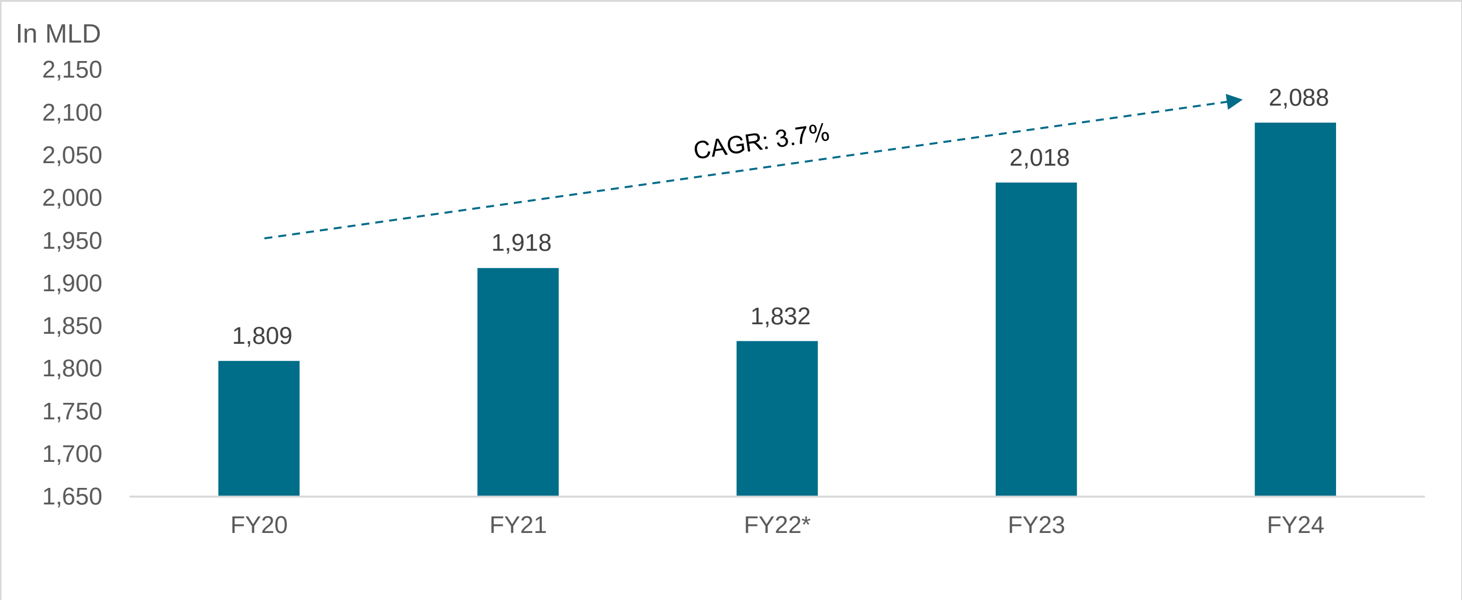
Many towns are situated on riverbanks, where freshwater is used by the population and wastewater is discharged back into the river, thereby affecting the drinking and irrigation water supply. Research conducted by the Ministry of Jal Shakti shows the quality of rivers has shown some improvement, with 46% of rivers examined in 2022 designated as contaminated, compared with 70% in 2015. The Central Pollution Control Board (CPCB) has identified the release of industrial waste and untreated or partially treated municipal wastewater into water bodies, and inadequate solid waste management as some of the primary causes of water pollution.

A 2021 assessment by NITI Aayog indicates that India is one of the most water-stressed regions globally, with approximately 600 million Indians facing high water stress. By 2030, the demand for the water is expected to be twice the available supply, potentially leading to water scarcity for millions of people and impacting the country's GDP. Effective management of water resources, and reusing and recycling them, is essential for a sustainable future.

The Indian wastewater treatment landscape is characterized by the presence of three primary types of treatment plants: Common Effluent Treatment Plants (CETP), Sewage Treatment Plants (STP), and Effluent Treatment Plants (ETP). While STPs are designed to treat domestic sewage and municipal wastewater, ETPs are employed to treat industrial effluent, and CETPs are used to treat effluent from multiple industries at a single location. The key differentiator among these treatment plants lies in their treatment capacity, technology, and ownership structure.

A deeper dive into CETPs reveals that they are designed to treat effluent from multiple industries, such as textiles, pharmaceutical, and chemical, at a single location. CETPs are typically owned and operated by a group of industries or a government agency and are equipped with advanced treatment technologies to handle a wide range of pollutants. The treatment process in CETP typically involves physical, chemical, and biological treatment methods, followed by tertiary treatment and sludge management. The use of CETPs has gained significance in recent years, particularly in industrial clusters, where a large number of industries generate substantial amounts of effluent, and a centralized treatment system is more efficient and cost-effective. The Indian government has also emphasized the importance of CETPs in reducing pollution and promoting sustainable industrial development and has implemented policies to encourage the adoption of CETPs in industrial estates and clusters.

CETP Capacity across the years



Note: For states where NGT monthly progress reports for March were not available, data from the nearest available month was used. Additionally, data for Chandigarh and Arunachal Pradesh has not been published and therefore was not included in the analysis

**Several CETPs were closed or underwent renovation, contributing to the reduced capacity in FY22*

Source: NGT monthly progress reports, Niti Aayog, CPCB, Crisil Intelligence

The Common Effluent Treatment Plant (CETP) capacity in India witnessed an increasing trend over fiscal 2020 to 2024 except a dip in fiscal 2022, with a capacity of 1,832 MLD. This decline can be attributed to the COVID-19 pandemic, which led to a slowdown in industrial activity and consequently, several CETPs were closed or underwent renovation, contributing to the reduced capacity in FY22. However, increase in the capacity has increased and reached to 2,088 MLD in fiscal 2024, indicating a positive outlook for the sector.

Sewage Treatment Plants (STPs) are another crucial component of India's wastewater treatment infrastructure, designed to treat domestic sewage and municipal wastewater. Unlike CETPs, which cater to industrial effluent, STPs focus on treating wastewater generated from residential, commercial, and institutional sources. The primary objective of an STP is to remove pollutants, contaminants, and pathogens from sewage, producing treated water that can be safely discharged into water bodies or reused for non-potable purposes.

According to the Wastewater Assessment Program, high-income countries treat around 70% of the wastewater they generate, upper-middle-income countries treat 38%, lower-middle-income ones 28% and low-income ones 8%. In India, wastewater treatment capacity is 27.3% of wastewater generated, as per the CPCB’s Status of STP — 2020-21 report. Although India’s waste and sewage treatment capacity is higher than the global average which is estimated to be ~20% of total wastewater generated, it still needs improvement given the magnitude of the problem, as highlighted by the CPCB and other bodies.

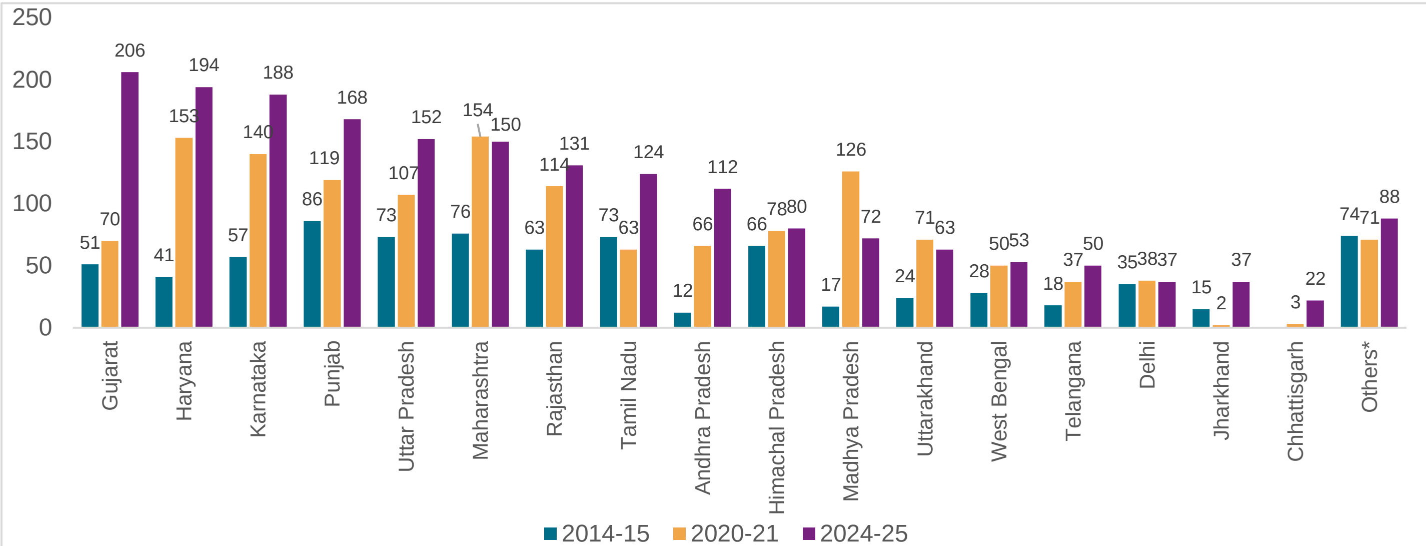
Comparative statistics on the STP inventory for fiscals 2015 and 2021

	Number of STPs			Capacity (MLD)			CAGR - Capacity	
STP status	**FY15**	**FY21**	**FY24**	**FY15**	**FY21**	**FY24**	**FY15-24**	**FY21-24**
Total no. of current STPs	601	1,195	1,951	20,120	31,841	42,012	8.0%	9.7%
Under construction	145	274	783	2,528	3,566	10,192	5.9%	41.9%
Proposed	70	162	1,385	629	4,827	16,284	40.4%	50.0%

Notes: FY15 and FY21 information is from CPCB, FY 24 Information is collated basis latest updated MPR report published by each state
Source: CPCB Status of STP report, MPR report, NMCG, Crisil Intelligence

There is a positive trend in the development of sewage treatment infrastructure, with a significant increase in the number of STPs and their capacity over the years. The substantial rise in the number of proposed and under-construction STPs indicates a proactive approach by the authorities to address the growing need for effective wastewater management. However, the fact that the number of proposed STPs has increased more rapidly than those under construction or already operational suggests that there may be challenges in implementing these projects. The state-wise distribution of STPs reveals that the top six states, namely Gujarat, Haryana, Karnataka, Punjab, Uttar Pradesh, and Maharashtra account for approximately 54% of the total number of STPs in fiscal 2024caters to 65.2% of total capacity (27,408 MLD). Gujarat leads the pack with 206 STPs, followed closely by Haryana with 195 STPs.

Number of STPs across states

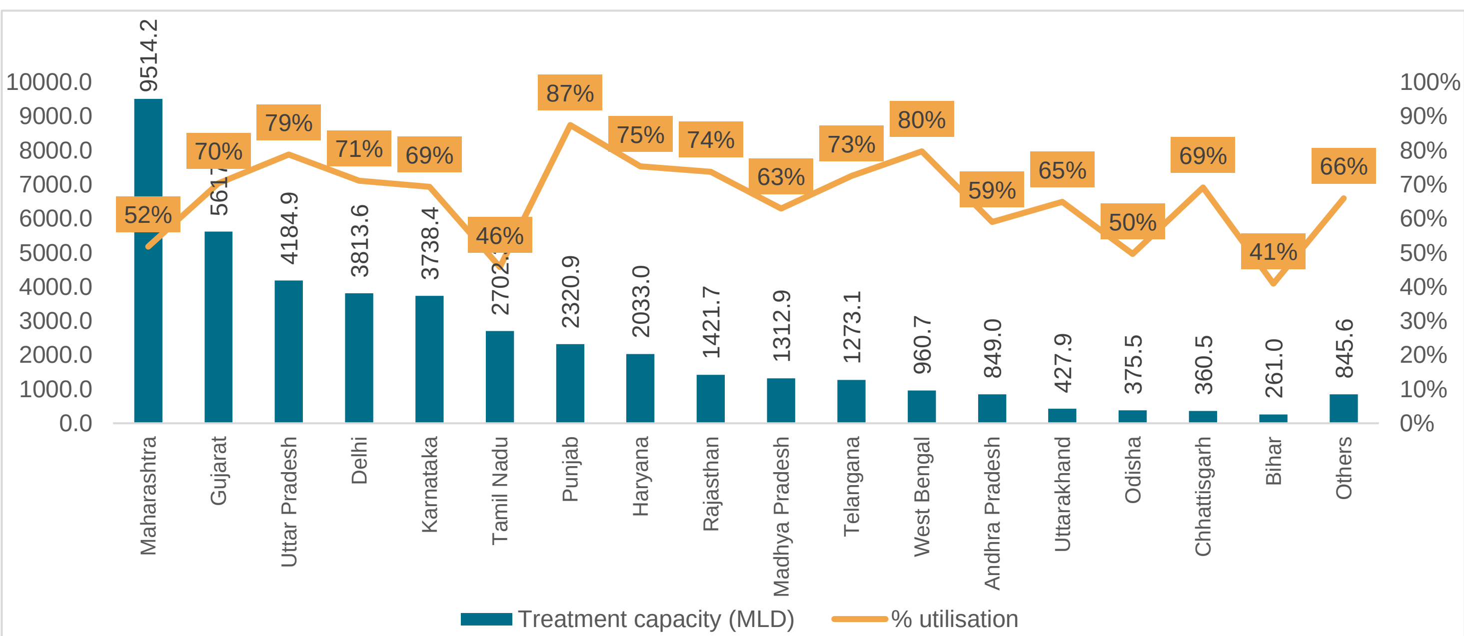


*Notes: * Others includes states with less than 20 operational STPs such as J&K, Odisha, Goa, Sikkim, Puducherry, Bihar, Kerala, Mizoram, Daman & Diu, Tripura*

Source: CPCB Status of STP report, MPR report published by each SPCBs, Crisil Intelligence

Certain states, including Gujarat, Haryana, Karnataka, and Uttar Pradesh, have not only established a large number of Sewage Treatment Plants (STPs) but have also demonstrated remarkable growth in their numbers between 2015 and 2024, with some even achieving triple-digit growth. This surge suggests that these states are prioritizing the development of smaller, ULB-based STPs, which has contributed to the significant increase in their overall numbers.

STP capacity across states (FY24)

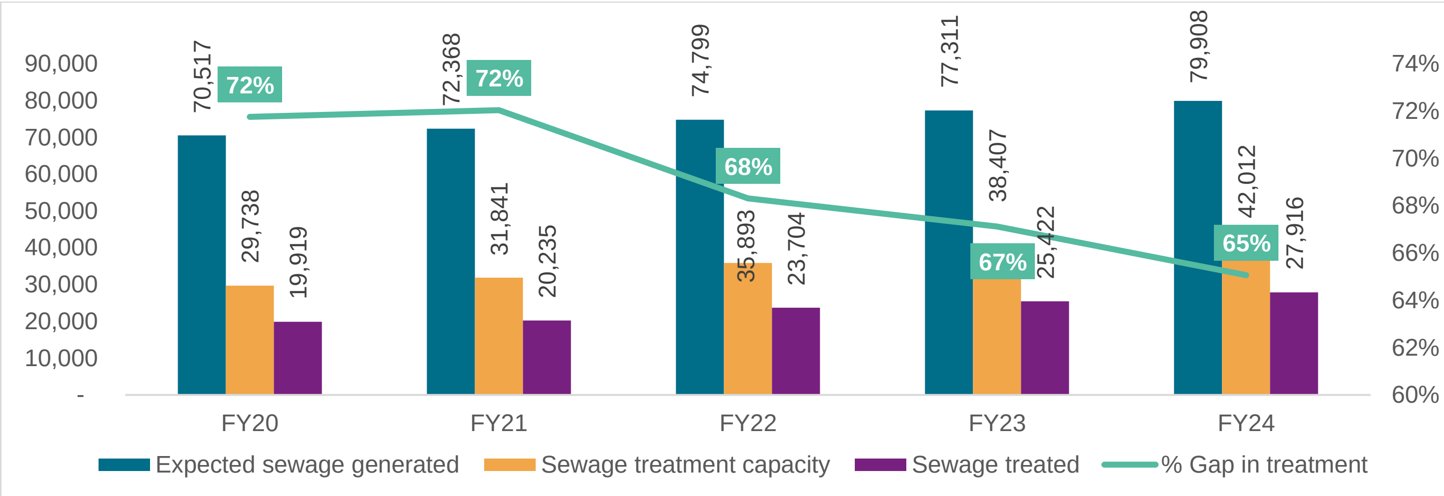


Note: For states where NGT monthly progress reports for March were not available, data from the nearest available month was used. Additionally, data for Chandigarh and Arunachal Pradesh has not been published and therefore was not included in the analysis

Others include states Jharkhand, J&K, Kerala, Himachal Pradesh, Goa, Puducherry, Manipur, Nagaland, Sikkim, Dadra & Nagar Haveli, A&N Island, Mizoram, Tripura, Assam, Meghalaya, and Lakshadweep

Source: NGT monthly progress reports, Crisil Intelligence

STP capacity vs utilisation (In MLD, %)



Note: For states where NGT monthly progress reports for March were not available, data from the nearest available month was used. Additionally, data for Chandigarh and Arunachal Pradesh has not been published and therefore was not included in the analysis

Source: NGT monthly progress reports, Niti Aayog, CPCB, Crisil Intelligence

The expected sewage generated has increased steadily over the years, from 70,517 MLD in fiscal 2020 to 79,908 MLD in fiscal 2024, based on population growth and rapid urbanisation. Sewage treatment capacity has also increased from 29,738 MLD to 42,012 MLD during this period, based on monthly reports submitted by state pollution control boards to the National Green Tribunal (NGT). This is a positive step towards addressing the country's wastewater management challenges.

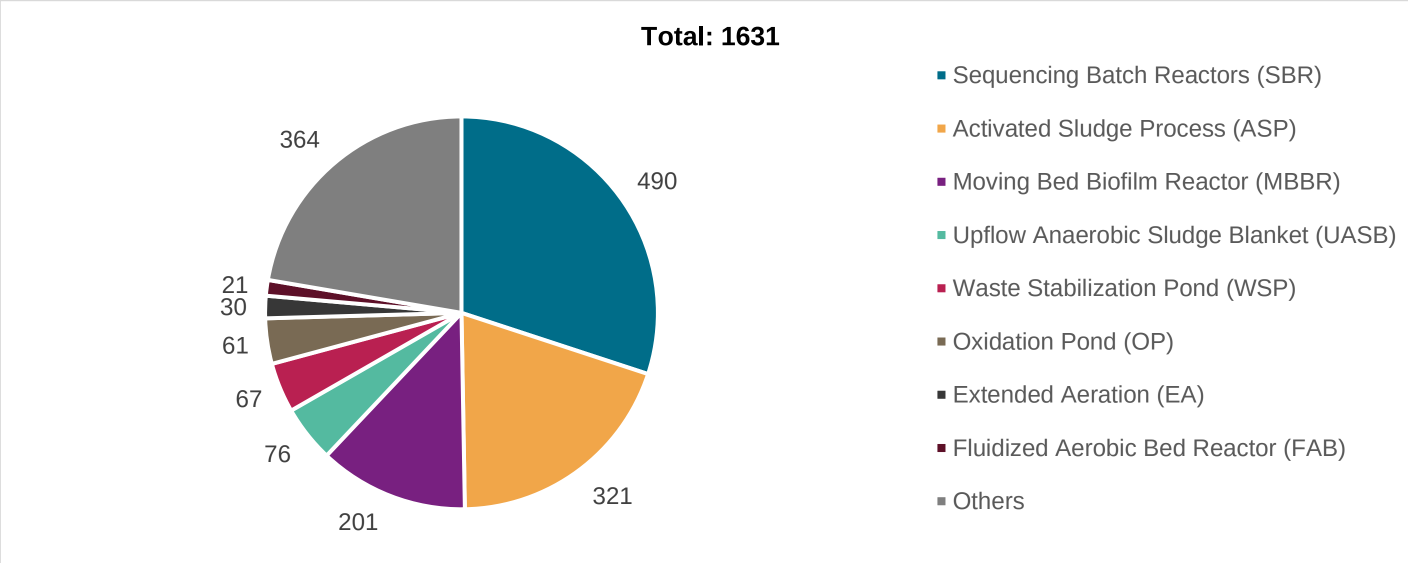
The actual sewage treated has also shown an increasing trend, from 19,919 MLD to 27,916 MLD, indicating a growth of ~30% during the period. While there is still a significant gap between installed capacity and actual treatment, it has narrowed over the years, indicating improved utilisation of existing infrastructure.

The percentage of total sewage generated that is treated has increased from 28.2% to 34.6% during this period. This suggests that while there is still a significant gap in treatment capacity, the country is making progress in treating a larger proportion of sewage generated.

The utilisation rate of STPs hovering around 60% can be attributed to several factors. One major reason is that STP capacities are often designed to cater to future demand, considering the projected population growth and urbanisation in the area. This means that the existing capacity may not be fully utilised, as the current sewage generation might lower than the designed capacity for the respective catchment area.

Another significant reason for low utilisation is the lack of proper sewage collection infrastructure in many areas. In some cases, the sewage collection network is incomplete, or the pipes are old and leaky, leading to significant losses of sewage during transmission. This results in a lower volume of sewage reaching the STP, which in turn affects the utilisation rate.

Split of STPs basis technology used (FY21)



Notes: Also includes technology of proposed STPs
Source: CPCB Status of STP report, Crisil Intelligence

Sequencing Batch Reactor (SBR) is the most widely used technology, accounting for 490 STPs with a total capacity of 10,638 MLD in 2021. Activated Sludge Process (ASP) is the second most common technology, used at 321 STPs with a capacity of 9,486 MLD. Upflow Anaerobic Sludge Blanket (UASB) and Moving Bed Biofilm Reactor (MBBR) are also popular technologies, with 76 and 201 STPs, respectively, using them.

In terms of capacity, SBR and ASP dominate the landscape, accounting for approximately 53% of the total STP capacity in 2021. UASB and the “Others” category also cover significant capacities at 3,562 MLD and 8,497 MLD, respectively. The “Others” category is notable for its diversification, encompassing a range of technologies such as Membrane Bioreactors (MBR), hybrid systems and advanced oxidation processes, among others. This diversity suggests that the Indian STP market is open to innovation and experimentation, with various technologies being explored to address specific wastewater treatment challenges.

Wastewater treatment process and technologies

The wastewater industry employs a range of technologies and treatment plants to remove contaminants and pollutants from water, ensuring the protection of public health and the environment. The wastewater treatment process typically involves a combination of physical, chemical, and biological methods to remove pollutants and contaminants from wastewater.

In the wastewater landscape, treatment processes are broadly categorized into preliminary, primary, secondary, and tertiary treatment stages.

- Preliminary treatment: consists of the removal of wastewater constituents such as grit and grease that may cause operational and maintenance problems during the treatment process.

- Primary treatment: entails the removal of suspended solids and organic matter from the wastewater, in which the Biochemical Oxygen Demand (BOD) of the wastewater is reduced by at least 20 per cent before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50 per cent. Typically achieved through physical and/or chemical processes.
- Secondary treatment: involves the removal of biodegradable organic matter, suspended solids, and, in some cases, nutrients from the wastewater in which the BOD and Chemical Oxygen Demand (COD) are reduced by at least 70 and 75 per cent respectively, typically achieved through biological treatment with a secondary settlement.
- Tertiary treatment: removal of residual dissolved and suspended materials (after secondary treatment) in which the BOD and COD are reduced by at least 95 and 85 per cent, respectively. Additionally, following a tertiary treatment, at least one of the following efficiencies should be achieved: (i) nitrogen removal of at least 70 per cent; (ii) phosphorus removal of at least 80 per cent; (iii) microbiological removal achieving a faecal coliform density of less than 1000 in 100 ml (ibid).

The various technologies and treatment plants used in the wastewater industry can be broadly classified into several categories. Some key technologies and types of treatment plants include:

- **Activated Sludge Process (ASP):** a biological treatment method that uses microorganisms to break down organic matter in wastewater, involving aeration to promote microbial growth, followed by settling and removal of the sludge.
- **Membrane Bio Reactor (MBR):** a hybrid treatment process that combines biological treatment with membrane filtration, using microorganisms to break down organic matter and then using membranes to separate the treated water from the sludge.
- **Moving Bed Bio Reactor (MBBR):** a biological treatment process that uses moving beds of biomass carriers to support microbial growth, providing a compact and efficient treatment process that can handle high organic loads.
- **Sequencing Batch Reactor (SBR):** a biological treatment process that uses a single tank to perform all treatment steps, including filling, reacting, settling, and decanting, offering a flexible and efficient treatment process that can handle variable flows and loads.
- **Other technologies:** such as trickling filter, Rotating Biological Contactor (RBC), Upflow Anaerobic Sludge Blanket (UASB) reactor, constructed wetlands, and advanced oxidation processes (AOPs), which use various methods such as fixed bed media, rotating disks, sludge blankets, plants, and oxidising agents to break down organic matter and remove contaminants from water. These technologies and treatment plants play a crucial role in ensuring the effective removal of pollutants and contaminants from wastewater, protecting public health and the environment.

Overview of key end-users and industries and their need for wastewater treatment

Industries such as smart cities, SEZs, textiles, chemicals, food processing, pharmaceuticals, oil & gas, and power all generate wastewater with highly variable compositions, requiring tailored treatment solutions to meet regulatory and sustainability goals. Each sector faces unique challenges: textile and chemical industries deal with dyes, heavy metals, and toxic organics; food processing generates high organic loads and suspended solids; pharmaceuticals produce complex, persistent contaminants; oil & gas face hydrocarbons and heavy metals; while smart cities and SEZs require modular, decentralized systems to manage diverse and fluctuating wastewater streams efficiently. The overarching need is for systems that ensure compliance, minimize environmental impact, and, where possible, enable water reuse or resource recovery.

Examples of Industry-Specific Needs:

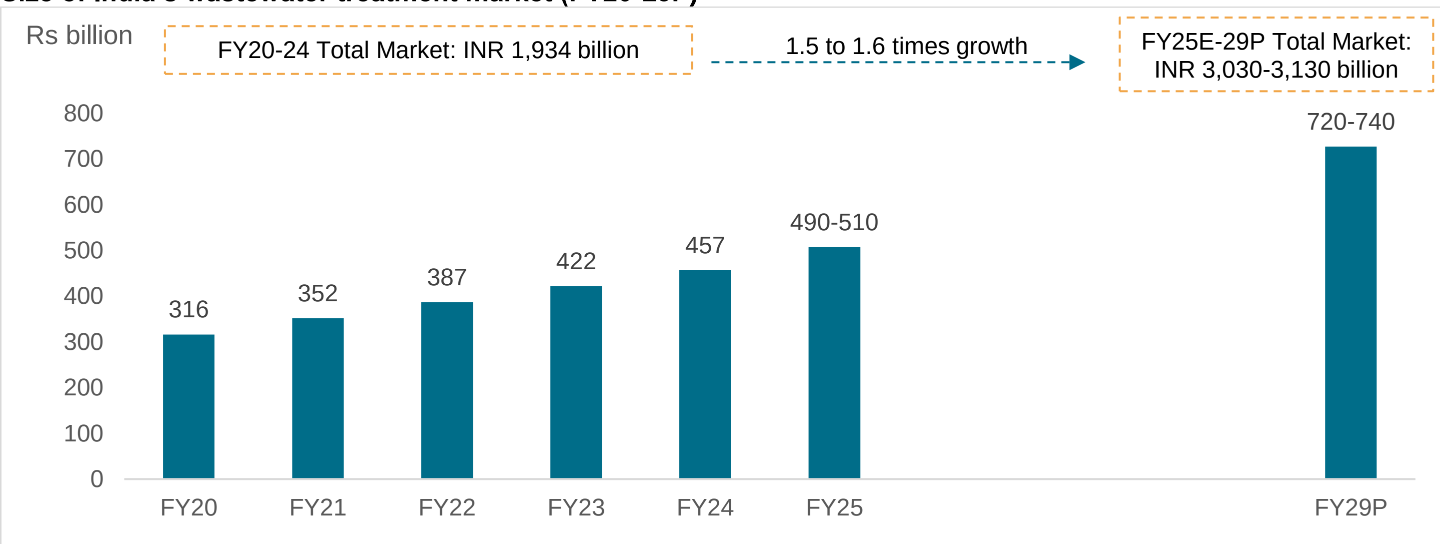
- Textile: Removal of dyes, heavy metals, and organics for water reuse.
- Chemicals: Treatment of toxic organics and inorganics, often requiring advanced oxidation.
- Food Processing: High-load organic and fat removal, enabling water recycling.
- Breweries and distilleries: Removal of high organic compounds such as sugars, starches, ethanol, and volatile fatty acids from spent grains, yeast, hops and distillation byproducts.
- Pharmaceuticals: Elimination of persistent organics and active compounds, often via membrane or advanced oxidation.
- Oil & Gas: Oil-water separation, heavy metal removal, and safe disposal, Oil recovery, Oil removal from waste water
- Power: Removal of cooling tower blowdown contaminants and ash pond effluents. Demineralisation, Remineralisation, filtration, Condensate Polishing Unit (CPU)
- Smart Cities/SEZs: Decentralized, flexible systems for varied industrial inputs.

Wastewater treatment solutions are highly customized, combining multiple technologies to address specific contaminants and operational needs. Primary steps often include screening and clarification to remove solids, followed by chemical-physical treatments (coagulation, flocculation, pH adjustment), biological processes (aerobic/anaerobic digestion), and advanced methods like membrane filtration, ion exchange, or vacuum distillation for complex or high-strength effluents. The choice and sequencing of these technologies depend on the exact wastewater profile, cost implication energy usage, recovery of organics, regulatory requirements, and reuse ambitions. Increasingly, industries seek integrated systems that adapt to variable loads, automate process control, and support circular economy goals by recovering water and valuable by-products, ensuring both compliance and operational efficiency.

Market assessment of wastewater treatment

The Indian wastewater treatment market is projected to expand a substantial 1.6 to 1.7 times from Rs 1,934 billion during fiscals 2019-2024 to Rs 3,030-3,130 billion during fiscals 2025-2029, driven by policy initiatives of CPCB and SPCBs and the government's efforts to enhance sewage infrastructure and treatment capabilities. The urgent need to mitigate water pollution, improve water management and promote water reuse is fuelling demand for advanced wastewater treatment solutions, particularly in industries such as pharmaceuticals, leather tanning, food and beverage, paper and pulp, and power plants.

Size of India's wastewater treatment market (FY20-29P)



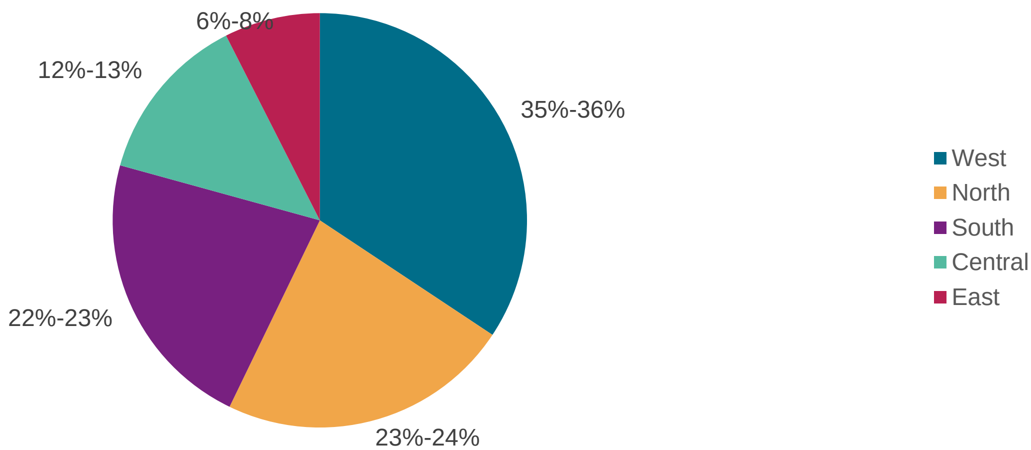
Note: P – Projected
Source: Crisil Intelligence

The regional split of India's wastewater treatment market for fiscal 2024 reveals that the west region accounts for the largest market share (35%-36%), followed by the north region (23%-24%), the south region (22%-23%), and the central and east regions (~18%-21% combined). The top five states in terms of wastewater treatment capacity are Maharashtra, Gujarat, Uttar Pradesh, Delhi and Karnataka.

The Namami Gange programme, which has completed 127 projects with 90% of them located in the north, central and east regions, has likely contributed to the growth of the wastewater treatment market in these regions. The south and west regions, which include states such as Karnataka, Tamil Nadu, Maharashtra and Gujarat, have a significant share of the wastewater treatment market, driven by presence of major industrial hubs and urban centres and stringent reuse policies in these states.

The adoption of cutting-edge technologies, including ultrafiltration, ozonation and Zero Liquid Discharge (ZLD) techniques, is also contributing to the market's growth. These advanced technologies not only enable industries to comply with stringent regulations but also enhance the quality of treated water, making it suitable for various non-potable uses. As a result, India's wastewater treatment market is expected to expand significantly, driven by the increasing focus on modernisation, sustainability and environmental stewardship. The government's initiatives and policy push, combined with the growing demand for efficient wastewater treatment solutions, are expected to drive growth in the market.

Regional split of India's wastewater treatment market (FY24)

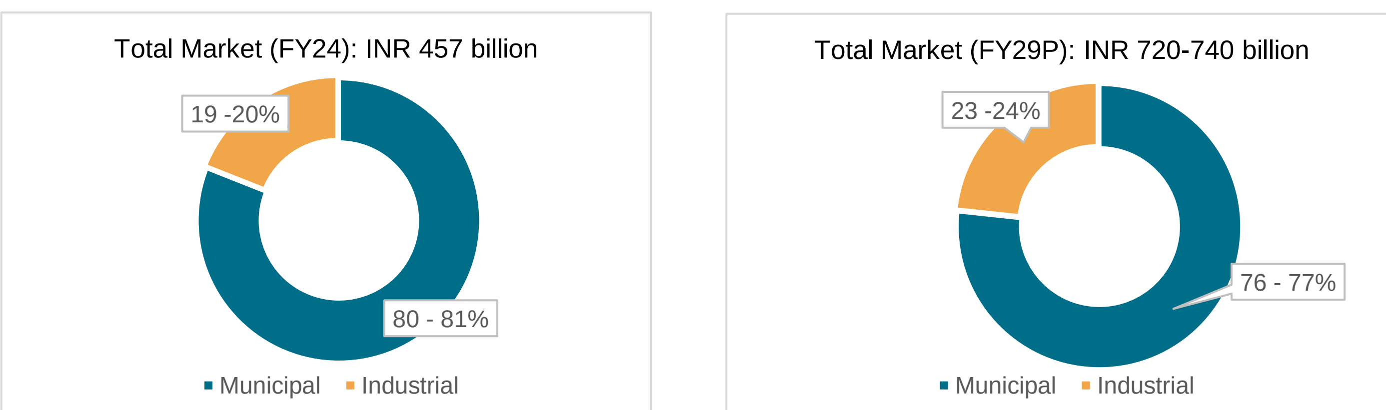


Note: North includes Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, National Capital Territory of Delhi and Union Territory of Chandigarh. Central includes Chhattisgarh, Uttarakhand, Uttar Pradesh and Madhya Pradesh. South includes Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu, Union Territory of Puducherry, Andaman and Nicobar Islands and Lakshadweep. East includes Bihar, Jharkhand, Odisha, Sikkim, West Bengal, Assam, Arunachal Pradesh, Manipur, Tripura, Mizoram, Meghalaya and Nagaland

Source: MoHA (Zonal Councils), Crisil Intelligence

The wastewater treatment sector in India's industrial landscape is witnessing robust growth, driven by rapid industrialization, stringent environmental regulations, and escalating water scarcity. The Central Pollution Control Board (CPCB) has enforced stringent guidelines, notably Zero Liquid Discharge (ZLD), under the Liquid Waste Management Rules, mandating industries to treat and recycle all wastewater, leaving no discharge into the environment. Supported by government initiatives like the National Mission for Clean Ganga and AMRUT. This growth is further propelled by innovations such as microalgae-based treatment and Per- and Polyfluoroalkyl Substances (PFAS) destruction technologies, addressing emerging contaminants and aligning with ZLD mandates. The regulatory push, combined with the projected increase in water demand, underscores the critical need for industries to adopt sustainable water management practices to ensure compliance and resource conservation.

Municipal and Industrial split of wastewater treatment market[1]



Note: P – Projected,

1: Industrial includes CETPs and ETPs

Source: Crisil Intelligence

Oil and Gas Industry: The oil and gas sector, encompassing over 23 refineries in India, generates significant volumes of wastewater laden with hydrocarbons, heavy metals, and salts, with up to 70% of produced water being potentially recyclable. CPCB's ZLD guidelines, enforced under the Liquid Waste Management Rules, require this sector to eliminate effluent discharge, compelling the adoption of advanced treatment technologies such as API oil-water separators, Dissolved Air Flotation (DAF), and reverse osmosis. These technologies ensure compliance with stringent discharge standards while enabling water reuse, reducing freshwater dependency in water-stressed regions. The regulatory framework, particularly notices issued to factories for ZLD action plans, has driven investments in treatment infrastructure, with companies facing penalties or shutdowns for non-compliance. The sector's focus on sustainability, coupled with CPCB's emphasis on ZLD, is fostering innovations like membrane filtration to treat complex effluents, aligning with national goals of environmental protection and resource efficiency.

Petrochemicals and Chemicals Industry: The petrochemicals and chemicals sector, produces complex wastewater containing aromatics, ammonia, and sulfides, necessitating sophisticated treatment solutions to meet CPCB's ZLD mandates. Under the Liquid Waste Management Rules, industries like bulk drugs and chemicals are required to implement ZLD, involving absolute recycling of permeate and conversion of solutes into solid residues through concentration and thermal evaporation. Technologies such as membrane bioreactors (MBR), electrodialysis, and bioremediation are increasingly adopted to address recalcitrant pollutants and ensure zero discharge. The CPCB's regulatory push, reinforced by initiatives like the National Mission for Clean Ganga, has led to a 10% annual increase in wastewater treatment investments, with companies deploying sequencing batch reactors (SBR) and advanced oxidation processes to comply with ZLD deadlines. The sector's growth, coupled with rising compliance costs, is driving innovation and market expansion, as firms aim to minimize environmental impact and enhance sustainability credentials.

Power Generation Industry: The power generation sector, particularly thermal plants, which account for >50% of India's electricity, produces wastewater with high Total Dissolved Solids (TDS) and heavy metals, necessitating advanced treatment to comply with CPCB's guidelines. Technologies like reverse osmosis, ion exchange, and constructed wetlands are critical for recycling water used in cooling processes, aligning with the Liquid Waste Management Rules' emphasis on zero discharge, the sector is under pressure to adopt sustainable water management practices to meet both regulatory and operational needs. CPCB has also mandated power plants to reduce freshwater intakes and reuse treated water from nearby STPs (Mandatory use of water from STP for thermal power plant, if it is in 50km radius of power plant)

The CPCB's Liquid Waste Management Rules, particularly the ZLD guidelines, are pivotal in shaping India's industrial wastewater treatment landscape. Mandated for high-polluting sectors like textiles, tanneries, bulk drugs, and distilleries, ZLD requires industries to recycle all wastewater and manage residues, with enforcement tightening along the Ganga basin and other critical water bodies. Notices issued to factories for submitting ZLD action plans, backed by the threat of penalties or shutdowns, have accelerated adoption across industries, including oil and gas, petrochemicals, and power generation. The regulatory framework is supported by government initiatives like the National Mission for Clean Ganga, which emphasizes pollution control, and the Atal Mission for Rejuvenation and Urban Transformation, promoting sustainable urban water management. These policies, combined with market trends toward sustainability, have driven the adoption of advanced technologies like membrane filtration, advanced oxidation, and PFAS destruction, addressing both traditional and emerging contaminants.

Recent initiatives across wastewater management

Initiatives	Details
Delhi Jal Board (DJB)	• In December 2024, DJB started partial operations of the Okhla STP under the Yamuna Action Plan Phase III in Delhi. Currently, the trial run is ongoing. The STP will be commissioned in phases • The project involves development of 124 million gallon per day at Okhla to treat the sewage generated in South Delhi, New Delhi Municipal Corporation (NDMC) areas and some other parts of Delhi
Greater Chennai Corporation (GCC)	• On October 30, 2024, GCC passed a resolution to raise municipal bonds worth Rs 2 billion for the construction of stormwater drains. The stormwater drain projects are expected to be implemented in Thiruvottiyur, Manali and Madhavaram localities in Northern Chennai • GCC will invest about Rs 4.7 billion under the Asian Development Bank-financed Kosasthalaiyar Basin project. Out of the 769 Kilometre (km) drain network proposed, about 100 km is yet to be constructed under the project
Bangalore Water Supply and Sewerage Board (BWSSB)	• In October 2024, BWSSB proposed to mandate having onsite STPs in upcoming independent houses in Bengaluru. This mandate is already in place for apartment complexes built after 2016 • Reportedly, a new policy requiring dual piping systems and small recycling units in upcoming residential buildings has been approved by BWSSB. It will also be submitted to the government for approval and necessary legislative amendments
BWSSB has revived Kengeri Lake	• BWSSB has revived Kengeri Lake by filling it with treated wastewater. The lake had dried up due to absence of rainfall in Bengaluru • It further plans to recharge five more lakes and has issued a public disclaimer advising against using the water for potable purposes
Treated wastewater from fish processing plants proposed to be reused by steel rolling mills in Goa	• Treated wastewater discharged by fish processing plants is expected to be utilised for water requirements of steel rolling mills at the Cuncolim Industrial Estate in Goa. This water conservation solution has been suggested by the Goa State Pollution Control Board (GSPCB) • As per a study by GSPCB, seven fish processing plants and exporters together consume about 567 kld (thousand litres per day) and generate approximately 494 kld of wastewater • The steel mills need 749 kld of water every day for cooling, slag crushing, the furnace tank, and other processes
Ghaziabad Municipal Corporation (GMC)	• GMC has a significant budget for fiscal 2025, with Rs 1.94 billion earmarked for infrastructure development, including sewer and road construction, and Rs 1.39 billion for water conservation, distribution, and strengthening of water infrastructure • The corporation also expects to generate revenue through the sale of treated water, with estimated earnings of Rs 670.10 million from the TSTP (Tertiary sewage treatment plant) and Rs 5 million sewage which will supply treated water to private, industrial and other units, promoting sustainable practices and contributing to the corporation's revenue streams

Source: Crisil Intelligence

Key challenges in India's wastewater treatment industry

The wastewater treatment market faces several challenges, including capacity gaps in Urban Local Bodies, lack of regulatory standards, and economic viability concerns of Sewage Treatment Plants. Additionally, the need for advanced treatment technologies to address changing contaminants and enable water reuse is becoming increasingly important. These challenges hinder the effective functioning and sustainability of wastewater treatment in India.

Market challenges	Details
Capacity gaps by ULBs	• ULBs are primarily responsible for the provision and maintenance of wastewater treatment facilities in their administrative area. However, in many cases, they lack the capacity to plan and implement such projects • Performance audit by CPCB in the 'human power availability in SPCBs" report (CPCB, 2020) based on category states that the shortage of staff is 37.6%, 39% and 52.3% in the Group A, B and C categories, respectively • Labs are not well equipped due to a shortage of manpower and procurement delays in instruments, equipment and consumables
Lack of regulatory standards	• No standards have been set for the ambient water quality for a surface waterbody which is probably on the receiving end of treated or untreated domestic sewage and, thus, misses the goals that need to be set (water quality criteria by CPCB are set based on the uses) • As per the CPCB notified "General Discharge Standards", a surface waterbody is regulated by 35 parameters, while wastewater for land application (or irrigation) is regulated by 10 parameters, not including heavy metals

Economic Viability of STPs	• Cost of STPs increases substantially with more advanced treatments that ensure reduced pollution
	  ○ Hence, the direct economic benefits from the STP derived from the use of treated water in agriculture or fisheries are considerably low
	• Higher capital and O&M (Operations and Maintenance) costs and costs of utilities are rarely covered by revenue from STPs (may include dried sludge and treated water) due to high uncertainty in demand
	  ○ Thus, smaller towns find it difficult to install STPs of adequate capacity, and the gap increases in cities and towns with lower revenue

Need for advanced wastewater treatment technologies	• Conventional centralised wastewater treatment plants are designed only to remove biological oxygen demand (BOD), nitrogen (N) and phosphorous. With rapid urbanisation, the nature and type of contaminants are changing, along with the emergence of new challenges. Hence, new technologies that are more efficient in treating water for reuse are required

Source: Crisil Intelligence

Growth drivers of the wastewater treatment industry

The wastewater treatment market is driven by several factors, including supportive financial models, unlocking revenue potential through reuse, and integrated water management. Additionally, the focus on rural segments, regularization of operations and maintenance works, and deployment of technological innovations and energy-efficient measures are also driving growth in the sector. These drivers are expected to promote investment, innovation, and sustainability in wastewater treatment, leading to improved efficiency and effectiveness in the industry.

Market drivers	Details
Supporting financial models for industries	• Improved risk allocation through innovative financing models, such as the hybrid annuity model (HAM), which is attracting private sector participation • Diversified funding sources, including international organisations (e.g., the World Bank, the Asian Development Bank and Japan International Cooperation Agency) and government grants and subsidies • Increased private sector participation, driven by the provision of additional funding sources and improved risk allocation
Unlocking revenue potential through reuse	• Implementing regulatory measures to enforce or incentivise the mandatory reuse of treated wastewater in industries • Creating a market for compost from digested sludge, which can provide an additional revenue stream
Integrated water management	• Sharing resources across projects, to increase the scale of operations and reduce costs • Implementing city-wide sanitation and wastewater treatment programmes, to achieve integrated water management and improve overall efficiency • Adoption of energy-efficient technologies, such as Variable Frequency Drive (VFD)-based pumps, which can reduce energy consumption and costs • Conversion of biogas to bio-CNG (compressed natural gas), which can provide a new revenue stream and reduce greenhouse gas emissions
Focus on rural segment	• Decentralised wastewater treatment systems in rural areas, where traditional centralised systems are often not feasible due to lack of infrastructure and resources, are driving innovation and investment in this sector • Including the development of low-cost, community-based treatment systems that can effectively manage wastewater and promote sustainable sanitation practices in rural communities
Regularisation of O&M works by the government	• The government is making efforts to streamline O&M works in projects by introducing specific guidelines • It is promoting the One City One Operator model and long-term concession periods (25-30 years) to increase accountability of the private sector
Deploying technological innovations and energy efficient measures	• Operational efficiency of WTPs/ STPs is being improved through application of energy-saving systems such as VFD-based and other energy efficient pumps • New technologies such as sewer cleaning machines, Programmable Logic Controller (PLC)-based SCADA systems, and sensor-based predictive maintenance are also being deployed

Digital and technological initiatives in waste water treatment industry

Digital initiatives	Details
Automatic drain cleaning machines by Bhubaneswar Municipal Corporation	• The Bhubaneswar Municipal Corporation plans to use automatic drain cleaning machines instead of excavators • They will be utilised owing to advantages such as automatic drain cover removal, silt extraction and a complete shift to mechanical cleaning of drains
Online monitoring stations by Delhi Pollution Control Committee	• The Government of Delhi has started constructing an online monitoring station along Yamuna River and different locations of drains flowing into it • It is being installed by the Delhi Pollution Control Committee. It will help access real-time data on pollutants discharged in the river. The work is expected to be completed by end-2025
Fully automated vacuum sewer network in Goa	• India's first fully automated vacuum sewer network system was inaugurated in Goa on October 15, 2024, under AMRUT. It is expected to aid sewage management for more than 200 households in areas with a high-water table, such as Mala and St Inez Creek in Panaji • The project is expected to overcome the geographical constraints of traditional gravity-based sewer systems, such as a high-water table and narrow lanes. It offers advantages such as minimal excavation requirements, fully sealed solution and prevention of groundwater infiltration
Desiltation machineries and monitoring systems	• The Hyderabad Metropolitan Water Supply and Sewerage Board has undertaken desiltation of 300,000 manholes under its 90-day initiative in Hyderabad, with the use of 220 airtech machines and 146 silt removal vehicles for sewage management • A dedicated dashboard has been established to monitor the initiative on a daily basis. It enables data uploading of details such as cleaned pipeline lengths and manhole counts, along with photographs as evidence. Also, Google Maps using CAN (Communication area network) numbers with GPS integration is being deployed to record complaints relating to sewage overflow, contaminated water and road silt

Reuse of treated wastewater

India's policy landscape on treated water reuse is evolving to address water scarcity through improved infrastructure, service enhancements, and a recent focus on circularity, reflecting shifting priorities towards sustainable water management. Initially, the emphasis on infrastructure development was primarily driven by the need to address basic water supply and sanitation challenges, with a focus on constructing sewage treatment plants and developing wastewater treatment infrastructure to ensure proper sanitation and protect public health.

As the understanding of water management evolved, the focus shifted towards service-level improvement of the overall sanitation system, recognizing that merely building infrastructure was not enough, and it was equally important to ensure efficient operation and maintenance of the infrastructure, along with improving service delivery and access to water and sanitation services. In recent years, there has been a growing recognition of the need for circularity in water management policies, with circular economy principles emphasizing the sustainable use and reuse of resources, including water, to minimize waste and maximize resource efficiency.

The Bureau of Indian Standards (BIS) notifies various IS standards to ensure that the water quality meets the needs of industrial and agricultural sectors, while the Central Public Health and Environmental Engineering Organisation (CPHEEO) has recommended norms to ensure treated sewage quality for specified activities at the point of use, including norms for dissolved phosphorus, nitrogen, and faecal coliform, allowing treated sewage-water to be used in horticulture practices, golf courses, for irrigation of non-edible crops and some edible ones.

The governance model for the reuse of treated used water in India is multifaceted, involving various stakeholders at the national, state, and local levels, with the central government formulating extensive policies and regulatory frameworks, state governments developing region-specific regulations and incentives, and municipal authorities implementing used water treatment and reuse projects, while partnerships between government agencies, private sector entities, academic institutions, and civil society organizations are fostered to promote innovation, capacity-building, and community engagement.

Industrial wastewater reuse is a critical component of India’s water management strategy, given the country’s escalating water demand and the significant contribution of industries to wastewater generation. Industries such as thermal power, textiles, paper, chemicals, and steel consume vast amounts of water). Unlike municipal wastewater, industrial wastewater often contains complex pollutants, including heavy metals, organic compounds, and salts, requiring advanced treatment for safe reuse. Industrial wastewater is reused primarily for non-potable purposes, reducing freshwater demand and discharge into water bodies. Key applications include:

Potential reuse sectors of wastewater:

Byproducts of TWW	Sectors could use	Reuse segment
Treated sewage	Agriculture Industrial Municipal Energy	• Treated Wastewater (TWW) used in thermal power plant (TPP) for a variety of functions, including the boiler, cooling system, and coal and ash management systems, with the cooling system accounting for the majority of the volume • Non-potable requirements such as preparation of steam boilers and humidifiers, heat transfer in heating systems, pyrocondensate, cooling liquid and solids, flushing of solid particles and gas purification, baths for the surface treatment of various kinds • Can be used in Irrigation across different crops, based on treated quality
Sludge	Agriculture Transport Energy	• Treated sludge can be used as urea for irrigation • Biomethane generated can be injected into the city gas network and partly replace the gas usually used for domestic purposes (heating, cooking, etc.) or to supply vehicles equipped to use it as fuel
Bio-solids	Agriculture	• Rich sources of nitrogen, phosphorous and potassium, critical nutrients in agriculture, of which phosphorous and potassium are imported by India.

Potential industrial reuse of treated wastewater

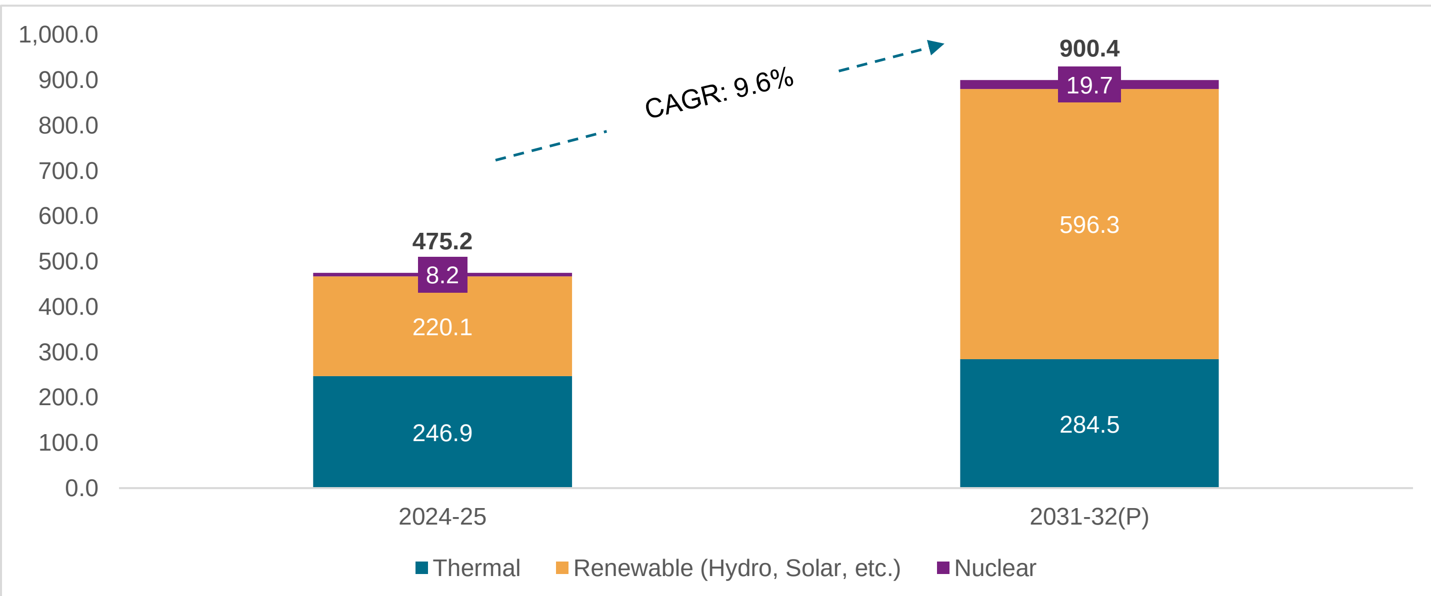
The benefits of water reuse for industries in India are multifaceted and significant. One of the primary advantages is the cost savings that can be achieved through wastewater reuse, with a study by The Energy and Resources Institute (TERI) estimating that thermal power plants can save INR 300 million annually and conserve 10 million cubic meters of water per year per plant. Additionally, water reuse plays a crucial role in environmental protection by reducing the amount of untreated discharge into rivers and groundwater, thereby mitigating pollution, seawater intrusion, and aquifer depletion, with a significant 40% of industrial wastewater being reused. Furthermore, reuse of water is a critical requirement under evolving discharging norms set by the Central Pollution Control Board (CPCB), avoiding penalties that can range from INR 1-5 crore per violation, while also enhancing their sustainability credentials. Another benefit of water reuse is the potential for energy recovery, with anaerobic digestion of sludge producing biogas that can offset 10-20% of energy costs in large sewage treatment plants.

Many large Indian companies, particularly in the refining and steel sectors, are now moving towards adopting advanced in-house effluent treatment solutions, enabling them to reuse water and become environmentally compliant. For example, Indian Oil Corporation's (IOCL) refinery in Panipat has implemented a state-of-the-art effluent treatment plant that recycles and reuses over 80 – 95% of its wastewater in refineries, reducing its freshwater intake and minimizing its environmental impact. Similarly, Reliance Industries' Jamnagar refinery has implemented a zero-liquid discharge system, which treats and reuses all its wastewater, In the steel sector, companies like Tata Steel and JSW Steel have also adopted advanced water treatment and reuse technologies, with Tata Steel's Jamshedpur plant achieving a water recycling rate of over 90%. Additionally, Hindustan Zinc's (HZL) zinc has implemented a ZLD and in FY24, it has recycled around 18 billion litres of the wastewater, making it one of the most water-efficient zinc smelters in the world. By adopting such solutions, these companies are not only reducing their environmental footprint but also enhancing their brand reputation, improving regulatory compliance, and contributing to the country's water security and sustainability goals.

Currently Thermal power plants are one of the major users of water in the country in recognition of this, the Ministry of Power's Tariff Policy (2016) mandates thermal power plants within 50 km of a sewage treatment plant to use treated sewage water, with associated costs allowed as a pass-through in the tariff. By adopting advanced treatment technologies, treated sewage water can be utilized in various stages of TPPs, such as ash pond sprinkling, cooling towers, and horticulture, making water reuse a vital strategy for ensuring sustainable operations in the thermal power sector.

As per the new environmental Regulations issued by MOEF&CC in Dec-2015, all new stations to be installed after 1st January 2017, shall be required to meet specific water consumption up to maximum of 2.5 Cubic meter/h/MW without Flue Gas Desulfurization (FGD). These norms are, however, not applicable to the Thermal Power Plants using sea water. Since, the availability of water is going to be a concern in operation of thermal power projects in the future, efforts need to be made to access the feasibility of adopting air cooled condensers, especially in areas with shortage of water.

Total power generation capacity (in GW) in India



Source: NEP, CEA, Crisil Intelligence

The treated wastewater reuse market in India is poised for significant growth, driven by the increasing adoption of treated wastewater (TWW) in thermal power plants. With the current thermal power generation capacity of 247 GW expected to reach 284.5 GW as per the National Energy Policy (NEP), the potential market for TWW reuse is substantial. As thermal power plants begin to utilize TWW, a large and lucrative market is expected to emerge, presenting opportunities for stakeholders to capitalize on the growing demand for sustainable and efficient water management solutions.

National-level Initiative in wastewater reuse landscape:

Adoption of ZLD systems in India

The Indian government, through the Ministry of Environment, Forest and Climate Change and CPCB, is promoting the adoption of ZLD systems for wastewater treatment in industries, with a focus on recycling and reusing wastewater. ZLD involves advanced treatment technologies that convert wastewater into solid or vapor form. Its adoption is being driven by regulatory initiatives such as the National Guidelines on Zero Liquid Discharge 2015. While conventional treatment processes can be expensive, membrane-based technologies, such as Reverse Osmosis (RO), and energy-efficient water pumps, such as axial piston pumps, can help reduce costs. Industries such as textiles, tanneries and distilleries are under scrutiny to comply with environmental regulations, and the adoption of technologies such as RO, membrane-based filtration, ultrafiltration and nanofiltration is on the rise.

The benefits of ZLD include resource efficiency, maximised water recycling, reduced freshwater consumption, and cost savings in the long run, despite high initial investment, making it an attractive solution for addressing water scarcity in dry regions. In line with India's National Water Policy, CPCB drafted guidelines in 2015 for the implementation of ZLD technologies in water-polluting industries, with the goal of recovering and reusing treated water to conserve freshwater resources. The guidelines, which were circulated to SPCBs and Pollution Control Committees (PCCs) for feedback, targeted industries with high-polluting potential, such as distilleries, pulp and paper, textiles, pharmaceuticals, tanneries, and sugar production, which generate wastewater with high Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), colour, metals, pesticides, toxic waste, solvents, and Total Dissolved Solids (TDS). However, while CPCB has mandated ZLD for distilleries in the Ganga basin, it has not directed other industrial sectors to adopt ZLD, despite the potential benefits of this technology in reducing wastewater pollution and conserving water resources.

Sector	Number of industries implemented ZLD	Number of industries consented of having ZLD	Compliance status of ZLD plants reported by SPCBs/PCCs (not complying)
Pulp and paper	260	226	7
Distillery	210	204	4
Sugar	9	9	0
Textile	187	149	4
Pharma	304	286	12
Tannery	9	9	0

Note: Numbers are reported as of December 2022
Source: Status report by CPCB in compliance with NGT order dated February 8, 2022, Crisil Intelligence

Liquid waste-management rules:

To address the lack of standard rules for domestic and industrial sewage treatment, the government has introduced the Liquid Waste Management Rules, 2024. Notified by the Ministry of Environment, Forest and Climate Change in October 2024, these rules aim to minimise, collect, treat, and reuse liquid waste, including wastewater and sludge. The rules will come into effect from October 2025, giving stakeholders a one-year period to comply with the key component of the initiative includes:

- Extended User Responsibility (EUR) framework, which requires industries, institutions, and large housing societies to treat and reuse a specified percentage of wastewater.
- Additionally, bulk users (those consuming more than 5,000 litres per day or generating 10 kg BOD per day) will be required to meet reuse targets of 20% by fiscal 2028, increasing to 50% by fiscal 2031.
- Urban local bodies (ULBs), wastewater treatment operators, and users will be responsible for setting up on-site sanitation systems, ensuring a comprehensive approach to liquid waste management.

This initiative has identified and provided the reuse target for new bulk users and existing bulk users along with industries, below are detailed target across each category:

Target for new bulk users:

	Minimum of the treated wastewater (percentage of water consumed)			
Category of bulk user	**FY28**	**FY29**	**FY30**	**FY31 and onwards**
Residential societies	20	30	40	50
Institutional / commercial /establishments such as government offices / private offices	20	20	40	40

Target for existing bulk users

	Minimum of the treated wastewater (percentage of water consumed)			
Category of bulk user	**FY28**	**FY29**	**FY30**	**FY31 and onwards**
Residential societies	10	15	20	25
Institutional / commercial / establishments such as government offices / private offices	10	10	20	20

Target for Industries:

	Minimum of the treated wastewater (percentage of water consumed)			
Category of bulk user	**FY28**	**FY29**	**FY30**	**FY31 and onwards**
Industrial Units	60	70	80	90

TWW reuse policies across key states:

State	Policy	Details
Tamil Nadu	Treated Wastewater Reuse Policy 2019	• To reuse treated wastewater for industrial and agriculture uses. Memoranda of Understanding (MoUs) are signed between multiple ULBs and the user agencies for reuse of secondary treated effluent water.
West Bengal	Treated Wastewater Reuse Policy of Urban West Bengal (2020)	• The policy emphasizes the need for sustainable water management in West Bengal by promoting the reuse of treated wastewater, reducing dependence on freshwater resources and introducing reforms in planning, institution, finance, technology and regulation. • It acknowledges the benefits of reusing treated wastewater in agriculture, highlighting its potential to support sustainable water practices
Gujarat	Policy for Reuse of Treated Wastewater (2018)	• Maximise the collection and treatment of sewage generated and sustainable reuse of treated water, thereby reducing the dependency on freshwater sources. • The policy puts forward an ambitious target of reuse of 70% of treated wastewater by 2025 and 100% reuse by 2030.
Maharashtra	State water policy	• The policy encourages recycling or reuse of treated wastewater and mandates penal action of the polluter of water resources. • The policy considers that at least 80% of the water used for domestic purpose will be available for reuse. • It is the obligation of local bodies to make available the entire quantity of generated sewage for reuse, after treating it to the standards prescribed by the Maharashtra Pollution Control Board (MPCB)
Punjab	Treated Wastewater Policy (2017)	• Prioritises agricultural reuse of treated effluent for unrestricted irrigation. • The policy states that crops to be irrigated with treated effluents or a blend thereof with freshwater resources shall be selected to suit the irrigation water, soil type and chemistry, and the economics of the reuse operations

Reuse projects across multiple states

Project Name	Location	STP Capacity	Reuse water capacity	Treated water used by	Project status
Bhesan Sewage Treatment Plant - Phase 1	Gujarat	100		Hazira based industries (Industrial use)	Completed
Variav-Kosad Sewage Treatment Plant	Gujarat	84		Hazira based industries (Industrial use)	Completed
Asarma Sewage Treatment Plant	Gujarat	15		Utran Gas Based Power Plant, GSECL.	Completed
Bamroli STP - Phase 1	Gujarat	57	40	Pandesara GIDC	Completed (Commissioned in 2014)

Project Name	Location	STP Capacity	Reuse water capacity	Treated water used by	Project status
Dindoli Phase 1 STP	Gujarat	57	40	Pandesara Industrial Estate (Nos. of Units :178)	Completed (Commissioned in 2020)
Bamroli STP - Phase 2	Gujarat	50	35	Sachin Textile Process Industries Welfare Association (Nos. of Units : 71)	Completed (Commissioned in 2020)
Bingawan STP, Kanpur	Uttar Pradesh	210	40	Panki thermal power plant	Completed (Commissioned in 2024)
Shahjahanpur STP	Uttar Pradesh	45	40	Rosa thermal power stations	Completed (Commissioned in 2024)
Varachha – Valak – Kamrej STP	Gujarat	140		Industries in Kadodara – Palsana (Industrial use)	Under execution
50 MLD Pathanpura 45 MLD STP & Rahmat Nagar 25MLD STP - Chandrapur	Maharashtra	120		Unit no. 8 & 9 (2 x 500MW) at Chandrapur Super Thermal Power Station (CSTPS)	Under execution
Bhesan (extention) Sewage Treatment Plant	Gujarat	70		Hazira based industries (Industrial use)	Under execution
Indirapuram sewage treatment plant	Uttar Pradesh	56	40	Sahibabad Industrial Estate, Ghaziabad	Under execution
Korba STP	Chhattisgarh	33	20.5	NTPC Jamni Pali	Under execution
Naini prayagraj sewage treatment plant	Uttar Pradesh	80	55	Bara thermal power station, Naini	Under execution (Planned to be completed in 2025)
Aligarh STP	Uttar Pradesh	45	30	Harduaganj thermal power stations	Under execution (Planned to be completed in 2025)

Project Name	Location	STP Capacity	Reuse water capacity	Treated water used by	Project status
Bulandshahar STP	Uttar Pradesh	40	20	Rosa thermal power stations	Under execution (Planned to be completed in 2025)
Nimora STP	Chhattisgarh	90		Alok ferro alloys limited and Adani thermal power plant	Proposed
Chandandih STP	Chhattisgarh	75		NTPC-SAIL Power Company limited (NSPCL)	Proposed
Jalgaon STP	Maharashtra	48		Bhusawal thermal power stations	Proposed
Maheshtala STP	West Bengal	35		Budge budge thermal power station	Proposed
Okhla STP	Delhi	564		Bus washing, gardening and other non-potable purposes	Completed

Note: Non exhaustive

Source: CPCB, SPCB websites, News reports, Crisil Intelligence

Market drivers for reuse TWW

Government Initiatives

- Emphasis on water conservation, wastewater treatment and reuse through initiatives, such as the National Water Mission, Swachh Bharat Abhiyan and the recently launched Liquid Waste Management Rules, 2024, will create a favorable policy environment

Additional economic benefits

- Revenue generation from the sales of treated water, lower wastewater treatment cost and support for the circular economy
- Sale of water to private companies in the nearby areas for non-potable use

Increasing cross-Sectoral Synergies

- Government initiatives are poised to facilitate the convergence of treated wastewater reuse opportunities across different sectors and industries
- For example, programme aimed at enhancing agricultural productivity, such as the PM Krishi Sinchayi Yojana, are exploring the potential of reusing treated municipal wastewater for irrigation in peri-urban areas

Market challenges for TWW:

Lack of prescribed standards for reuse of sludge

- Absence of clear guidelines and regulations for the reuse of sludge from wastewater treatment plants
- Uncertainty about the safe and effective use of sludge in various applications, such as agriculture or construction

Lack of infrastructure

- Limited availability of infrastructure to support the reuse of treated wastewater
- Pipelines and distribution networks to transport treated water to industries or agricultural areas
- Storage facilities to hold treated water until it is needed.

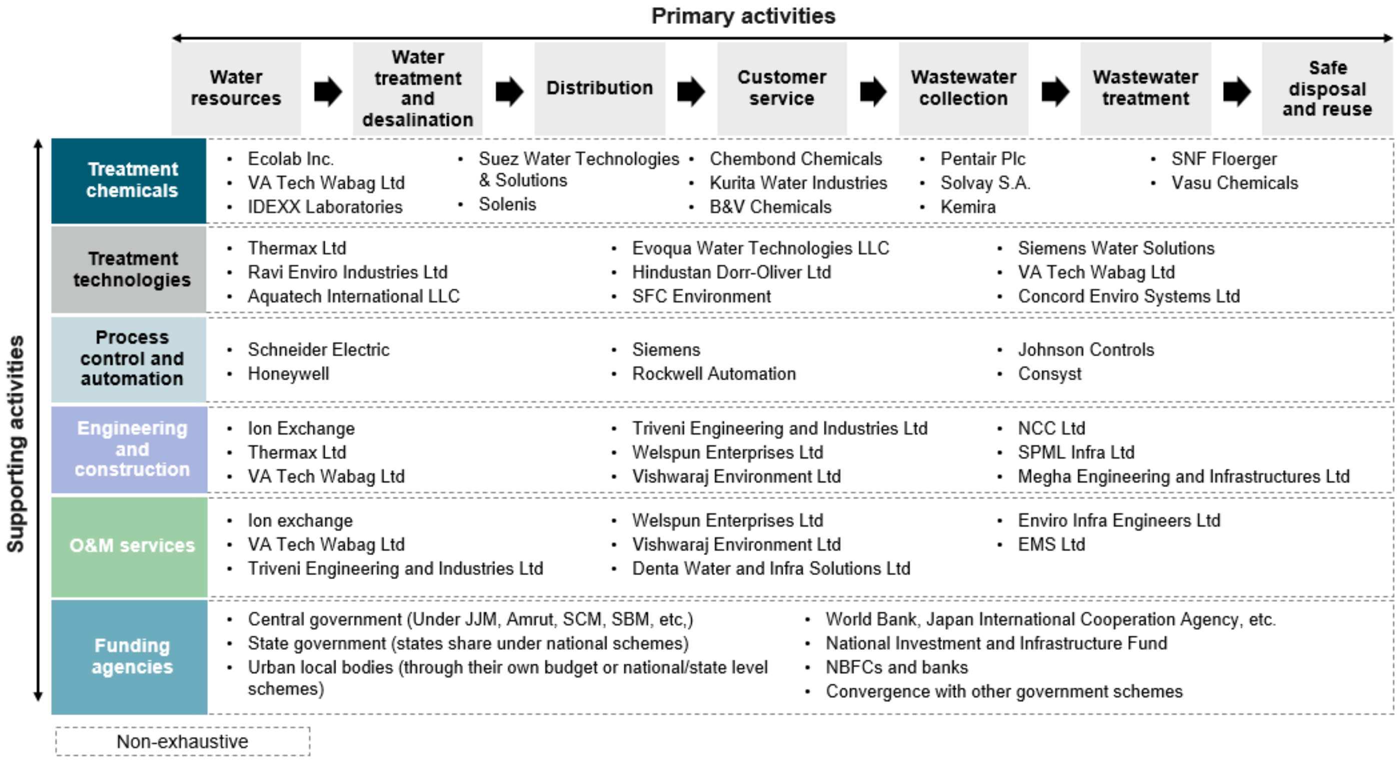
Lack of incentives to end-users

- Limited economic benefits or incentives for industries, farmers or other end-users to adopt treated wastewater reuse
- High costs associated with treating and transporting wastewater, which can make it less competitive with traditional water sources

4. An overview of the value chain, SWOT analysis and porter five forces of Indian water and wastewater treatment industry

Value-chain analysis of water and wastewater management in India

The water and wastewater market value chain are a complex network of activities that work together to provide clean water and sanitation services to communities. The primary activities of the value chain include sourcing of water resources, treatment and desalination, distribution, customer service, wastewater collection, treatment, and safe disposal and reuse. These activities are supported by a range of secondary activities, including raw material providers, engineering and construction, operations and maintenance (O&M) services and financial management.



Notes: The above infographic is only indicative in nature and not exhaustive representation of the sector
Source: Crisil Intelligence

Treatment chemicals: Treatment chemicals such as Corrosion inhibitors, Scale inhibitors, Biocides and disinfectants, Coagulants & Flocculants, and Chelating Agents are used to treat and manage water and wastewater. Companies like Ecolab, VA Tech Wabag, Ion exchange, among others, provide these specialized chemicals to help prevent corrosion, scaling, and microbial growth, while also improving water clarity and quality. These solutions are essential for ensuring the safety and efficiency of water treatment operations, and are used in a variety of applications, including industrial, municipal, and wastewater treatment

Treatment Technologies: Different technologies such as Membrane Bio Reactor and Activated Sludge Process are used across the landscape to improve water treatment operations. Companies like Aquatech, SFC environment, Evoqua water technologies, WOG Group and others provide these technologies, enabling the removal of pollutants and contaminants from water, and producing high-quality effluent that meets regulatory standards.

Process control and automation: It plays a crucial role in water and wastewater treatment plants, enabling efficient and reliable operation, as well as ensuring compliance with regulatory standards. Advanced automation systems, such as supervisory control and data acquisition (SCADA) and distributed control systems (DCS), are used to monitor and control various treatment processes, including chemical dosing, filtration, and disinfection. These systems utilize sensors, actuators, and programmable logic controllers (PLCs) to collect data, analyze trends, and make adjustments in real-time, optimizing treatment performance and minimizing energy consumption. Additionally, automation enables remote monitoring and control, allowing operators to respond quickly to changes in water quality or system conditions, and reducing the risk of human error. By leveraging process control and automation, water and wastewater treatment plants can improve treatment efficiency, reduce costs, and provide safer, more reliable services.

Engineering and construction Multiple companies like Triveni engineering and industries, NCC, SPML, Megha Engineering and infrastructures, Welspun, WOG Group and others are responsible for designing and building the infrastructure required to support the water and wastewater market. These companies provide a range of services, either through EPC model or PPP model, to help build and upgrade water and wastewater treatment plants, distribution systems, and other infrastructure. Once the infrastructure is built, trial runs are done, and detailed guidelines and regulatory checks are done then the project is transferred for maintenance in case of PPP/HAM models it is with the same company or SPV created for the project. In the case of EPC contracts, the project is typically handed over to the customer who may manage maintenance services, internally or externally as per the contractual agreement. In some instances, the contract may stipulate that the EPC contractor will provide maintenance services for an initial period of one to two years, after which the responsibility is handed over to the customer who may maintain this internally or externally.

Operations and maintenance (O&M) service providers in India, such as VA Tech Wabag, SUEZ, Enviro, WOG Group play a critical role in ensuring that water and wastewater infrastructure operates efficiently and effectively. Generally, all O&M companies in India also have significant engineering and construction capabilities and often provide integrated EPC and O&M services to their clients under PPP models such as HAM, BOT, DBOT projects. These companies provide a range of O&M services, including maintenance, supply of chemical, IOT implementation, repair and replacement of equipment, as well as operational support and management. The O&M segment presents an attractive opportunity to generate predictable, stable, and higher-margin cash flows while fostering long-term strategic relationships with clients.

Funding agencies are vital component of the water-and-wastewater market value chain in India, providing the necessary funding and financial expertise to support the development and operation of water-and-wastewater infrastructure. The financing landscape for water-and-wastewater projects in India is diverse, with a significant portion of projects being funded through various Central and state government schemes. Additionally, international funding agencies such as the World Bank, Japan International Cooperation Agency (JICA) and Asian Development Bank (ADB), have also started providing financial support for water and wastewater projects in India, further augmenting the availability of funds for the sector. Commercial Banks and selected NBFCs have also emerged as leading financers to the water-and-wastewater market value chain in India supporting the companies through fund and non-fund bank limits.

Different business models in water and wastewater treatment

The Indian water and wastewater sector has witnessed a significant trend in project implementation, with projects across water supply, wastewater and desalination segments being implemented mainly under three models EPC, PPP, PPP – HAM models. However, PPP-HAM is emerging as a popular alternative, with increasing interest from private players even though the majority of the project in WSS segment is happening through EPC mode.

Overview of EPC mode

Over the years, the infrastructure business has seen various contracting methods evolve. Traditional contracting models have been replaced by new approaches as projects have grown more complex. Gradually, the responsibility for project management has moved from the owner or developer to the contractor.

This shift is evident in the move from owner-managed projects to Engineering, Procurement, and Construction (EPC) contracts. In EPC contracts, the contractor assumes the risks of time and cost overruns, along with the responsibilities for design, material procurement, and construction. These contracts also shield the owner/developer from cost, currency and interest rate fluctuations.

Unlike other contracts where procurement and design are separate processes, EPC contracts integrate them, reducing the overall project duration. Contract which requires heavy financial and technically requirement generally divided into smaller EPC projects. A typical EPC project covers design, civil works, equipment purchase, installation, and commissioning. Most of the EPC players provide integrated and customised solutions as per the client requirements through a consultative approach.

Key factors influencing EPC player selection

Past experience	• Size of the projects handled and that are sucessfully running
Financial networth and credit rating	• Typically "x" times the cost of the project. Higher the credit rating the better
Workmanship and completion time	• Demostrated performance with respect to quality of the project
Usage of modern techniques and design innovation	• This aids in hasle free and on-time completion of projects
Bankability of EPC contractor	• Risk sharing, insurances, warrantes, guarenties etc

Further in India, in general, a single stage two-part system (referred to as the "Bidding Process") is used for selection of the EPC contractor in order to award the project. It includes technical evaluation and financial evaluation

Technical qualification: In this the eligibility and qualification criteria are evaluated based on years of experience and expertise of the contractor in the said industry in which EPC project is being executed, domicile of the executing contractor, availability of resources with the contractor and capabilities of such resources among others

Financial qualification: In this the average annual turnover of the EPC contractor over the past 3 financial years is considered which needs to be above the said criteria mentioned along with this the EPC contractor should have a minimum net worth (set forth in bid document) as per its financials. Further, in some cases a minimum amount of working capital as per its latest financials is also considered. In addition, the contractor is also asked to furnish financial statements for the necessary financial years.

Post this the EPC contractor with lowest bid value called the “L1 bidder” is selected to whom the contract is awarded. Further, in some of the bidding processes a weighted average of qualification criteria (technical and financial) and bid value is considered while awarding the contract.

Overview of entry barriers for EPC industry in India

The Engineering, Procurement, and Construction (EPC) industry in India is a vital part of the country's infrastructure development, encompassing sectors like infrastructure, and industrial projects. However, there are multiple challenges faced in EPC modes:

- **High Capital Requirements:** The EPC industry demands substantial initial investments for equipment, technology, and skilled manpower. Smaller firms may find it challenging to secure the necessary funding to compete with established players**.**
- **Regulatory and Compliance Issues:** The industry is heavily regulated, requiring companies to comply with various environmental, safety, and labour regulations. Navigating these regulations can be complex and costly affair, posing a significant barrier for new entrants.
- **Technical Expertise:** Some of the EPC projects often require specialized technical knowledge and expertise of the industry. Companies must possess a skilled workforce capable of handling complex engineering tasks and innovative construction techniques. Building such a team is a considerable challenge for newcomers.
- **Project Management Skills:** Managing large-scale EPC projects requires robust project management skills to ensure timely and cost-effective completion. New entrants might lack the experience and processes needed to manage such projects efficiently.
- **Financial Risks and Creditworthiness:** EPC projects often involve significant financial risks, including cost overruns and delays. New entrants must demonstrate strong financial stability and creditworthiness to secure contracts and financing, which can be challenging without a proven track record.
- **Competitive Landscape:** The EPC industry in India is highly competitive, with established players having strong market presence and relationships with key stakeholders. Breaking into this competitive landscape requires significant marketing efforts and the ability to differentiate from existing competitors.

Overview of PPP model

Under PPP, there are several models that have gained popularity, but HAM (Hybrid annuity model) has gained the popularity in the water and wastewater treatment industry. Below are the few different tendering models which is taken under PPP modes by the government.

- **Design-build-operate-transfer (DBOT)**: A model where the private sector partner designs, builds, and operates the project for a specified period, after which it is transferred to the government
- **Design-build-operate (DBO)**: A model where the private sector partner designs, builds, and operates the project, but the ownership remains with the government
- **Build-own-operate-transfer (BOOT)**: BOOT projects are typically structured as long-term concessions, often spanning 25 to 30 years, where the developer finances, constructs, owns, and operates the infrastructure facility, recovering its investment through user charges or government annuities. These projects offer consistent and predictable revenue over the concession lifecycle
- **Design-build-finance-operate-transfer (DBFOT)**: A model where the private sector partner designs, builds, finances, and operates the project for a specified period, after which it is transferred to the government
- **Build-operate-transfer (BOT)**: A model where the private sector partner builds and operates the project for a specified period, after which it is transferred to the government
- **Hybrid annuity model (HAM)**: A model where the government provides 40% of the project capital cost as construction support, and the remaining 60% is paid as annuity payments throughout the operations phase, plus interest.

Overview of HAM Model

HAM-based model has started picking up under the Namami Gange Programme. Now, a similar model is being picked by state governments as well as ULBs. Under HAM, the government is required to provide 40% of the project capital cost as construction support, which can be provided at the end of the construction period or during the construction phase. The remaining 60% of the project cost is paid as annuity payments throughout the course of the operations phase plus interest. This model allows the private sector partner to focus on designing, building, and operating the project, while the government provides financial support and takes care of risks.

The key parameters for bidding under the HAM model include:

- **Bid parameter**: The lifecycle cost of the project, which is calculated as the net present value (NPV) of the project cost plus the NPV of O&M cost for the 15-year concession period
- **Revenue collection and O&M payments**: The toll collection is the responsibility of the government, and O&M payments will be made to the concessionaire, which will be inflation-indexed
- **Secured cash flow**: Bi-annual annuity payments are made by the government for 15 years, including interest payments (at bank rate + x%) on a reducing-balance method, and agreed O&M

- **Risk allocation**: In the HAM, the private partner assumes the construction and maintenance risks, similar to those in BOT projects. Meanwhile, the government takes on the responsibility of managing other key risks, including revenue risk, land-acquisition risk, political risk, and inflation risk. Notably, land acquisition, which was previously a significant challenge in project completion, is now handled by the government authority in PPP mode, thereby mitigating this risk for the private partner.
- **Sharing of capital cost**: About 40% of the bid project cost shall be payable to the concessionaire by the authority in five equal instalments linked to physical progress of the project. The concessionaire has to initially bear the balance 60% of the project cost through a combination of debt and equity.

Now, let us look at the advantages and disadvantages of the HAM model:

Advantages of HAM:

- **Lower upfront finance requirement**: Government agencies are required to mobilise only 40% of the initial funding upfront, while the private player arranges for the other 60% of the project cost
- **Financing risk**: The financing risk during the O&M period is fully borne by the government, and any shortfalls in the O&M cost are met by the government
- **Shorter delays**: The responsibility of all environmental and land clearances rests with the government, shortening the delays in project commencement and the private sector risks of delayed construction phase
- **Assured annuity payments**: The assured annuity payments provide comfort to potential lenders/financing institutions to provide debt to private contractors.
- **Inflation-adjusted project cost**: The model incorporates inflation-adjusted project cost over time, especially for projects with longer than one-year implementation periods and for O&M expenditure, which helps to mitigate the inflation risks
- **Performance-linked annuity payments**: The performance-linked annuity payments create the appropriate incentives for the private sector providers to deliver high-quality services

Disadvantages of HAM

- **Higher project cost**: The private concessionaire has to mobilise 60% of the costs, which may lead to higher project costs owing to incorporation of high returns on equity and higher interest on debt
- **Entry of small bidders limited**: The HAM approach may limit the entry of small bidders, as they may not be able to mobilise adequate initial capital requirement which is 60% of the total project cost
- **Long-term commitment of government funds**: The model requires a long-term commitment of government funds — for 10-15 years — which can be challenging for local governments
- **Risk of non-payment**: The risk of non-payment of annuity payments by the government can affect the bid prices and drive up the overall project costs

Emerging business models for Industries and residentials for small scale wastewater treatment

The traditional approach to wastewater treatment for small-scale residential and industrial applications often involves significant upfront capital expenditures for the installation and maintenance of on-site treatment plants. However, new business models are emerging that offer more flexible and cost-effective solutions.

- **Treatment as a Service (TaaS):** where a third-party provider designs, installs, operates, and maintains a wastewater treatment plant for a customer, typically under a subscription-based agreement. This approach allows small-scale residential and industrial users to access advanced treatment technologies without the need for significant upfront investments, reducing the financial burden and minimizing the risk of technology obsolescence. Under the TaaS model, the service provider is responsible for ensuring the treatment plant meets regulatory requirements and operates efficiently, freeing up the customer to focus on their core business. The provider typically charges a monthly or annual fee based on the volume of wastewater treated, making it a predictable cost for the customer. This model also enables the service provider to optimize treatment plant performance, reduce energy consumption, and implement innovative technologies, such as advanced oxidation processes or membrane bioreactors, to improve treatment efficiency and reduce environmental impact. By outsourcing wastewater treatment to a specialized provider, small-scale residential and industrial users can benefit from expertise, economies of scale, and reduced liability.
- **Treatment Plant Leasing (TPL):** which allows customers to lease a pre-designed and pre-fabricated wastewater treatment plant for a fixed period. This approach offers greater flexibility and control compared to traditional ownership models, as customers can select from a range of treatment technologies and capacities to suit their specific needs. The leasing provider is responsible for maintaining and upgrading the treatment plant, ensuring compliance with regulatory requirements, and providing technical support. At the end of the lease term, the customer can choose to renew the lease, upgrade to a new treatment plant, or return the equipment to the provider. TPL enables small-scale residential and industrial users to access advanced treatment technologies with minimal upfront capital outlay, while also reducing the risk of technology obsolescence and environmental liability.

Both TaaS and TPL models offer significant benefits for small-scale residential and industrial wastewater treatment applications, including reduced capital expenditures, increased flexibility, and improved environmental performance. By leveraging these innovative business models, customers can focus on their core business while ensuring compliance with regulatory requirements and minimizing their environmental footprint. As the demand for wastewater treatment services continues to grow, these models are likely to play an increasingly important role in the development of sustainable and cost-effective solutions for small-scale residential and industrial applications. By adopting TaaS or TPL, customers can access advanced treatment technologies, reduce their environmental impact, and benefit from the expertise and economies of scale offered by specialized service providers.

SWOT analysis of water and wastewater management sector of India

Strengths	• **Government support:** The Indian government has launched initiatives such as the National Water Mission and Swachh Bharat Abhiyan to improve water treatment and supply. It has established a Jal Shakti Ministry to look after the matters related to the water sector in the country • **Technological advancements:** Advanced technologies such as membrane bioreactors, ultraviolet treatment and desalination have improved the efficiency and effectiveness of water treatment processes • **Growing private sector participation**: Private players are increasingly participating in the development of new infrastructure and services in the water sector
Weaknesses	• **Inadequate infrastructure:** Many parts of the country lack access to safe and reliable water supply and the existing infrastructure is often inadequate to meet the growing demand • **Lack of regulation:** There is a lack of effective regulation and enforcement of water and wastewater quality standards, leading to pollution and contamination of water sources • **Inefficient operations:** Many older water treatment plants, wastewater treatment plants and supply systems are inefficient, with high energy consumption and water, sewage losses, leading to increased costs and environmental impacts.
Opportunities	• **Growing water demand:** Water demand in the country is expected to increase significantly in the coming years, driven by population growth, urbanisation and economic development, presenting opportunities for investment and innovation in the water sector • **Reuse potential:** The reuse of treated wastewater can generate higher revenue streams for water utilities and private players, while also reducing the demand for water from freshwater sources • **Increasing focus on water conservation:** The increasing focus on water conservation and sustainable water management creates opportunities for promoting water-saving technologies and practices, driven by increasing regulatory scrutiny, growing stakeholder emphasis on ESG performance, and the rising number of corporates setting ambitious sustainability targets.
Threats	• **Lack of quality regulation of treated wastewater:** Lack of effective regulation and enforcement of treated wastewater quality standards pose a significant threat to environment and human health, as it can lead to the release of untreated or partially treated wastewater into water bodies

- **Economic viability of wastewater projects:** The economic viability of wastewater projects is another major issue as many projects are currently driven by government push and may not be sustainable in the long term without continued government support

- **Associated infrastructure challenges:** Lack of associated infrastructure, such as sewage and water supply line, is another problem that hinders effective management of water and wastewater in India, particularly given the high levels of non-revenue water in the country

- **Threat of Aggressive Bidding and Margin Compression:** The water/wastewater EPC/EPM sector in India, particularly in segments such as water and wastewater treatment plants ("WWTPs"), common effluent treatment plants ("CETPs"), and water supply and sewerage systems ("WSSPs"), is highly fragmented and competitive. A large number of entities, including well-established corporates, regional contractors and joint venture participants, actively bid for projects under various government-sponsored schemes and private sector requirements. This leads to aggressive bidding, which often results in prices being quoted at or below cost, thereby compressing industry-wide margins.

Source: Crisil Intelligence

Porter's five force analysis of water and wastewater treatment landscape in India

Degree of competition: Moderate to High	Suppliers' bargaining power: Moderate to High
• Numerous players, including both domestic and international companies, compete in the market. • Market fragmentation with a mix of large, medium, and small players. • Continuous need for innovation to improve efficiency and comply with regulations. • Competitive pricing strategies to gain market share • The CAPEX-intensive nature of the new HAM model may disadvantage smaller players, making it challenging for them to compete with larger players for high-value projects.	• Limited suppliers for specialized equipment and chemicals, such as reverse osmosis membranes or anaerobic digestion systems, hold stronger bargaining power due to limited alternatives and high switching costs. • Global players like DuPont, Veoila with proprietary technologies, have an edge, but local suppliers are increasing competition. • Reliance on imported high-end technologies can increase supplier power, but government initiatives to promote local manufacturing (e.g., Make in India) are fostering domestic supply chains, reducing dependency.
Customers' Bargaining Power: Moderate to High	**Threat of New Entrants: Moderate to High**
• Government and municipalities have significant bargaining power due to large contract volumes and competitive bidding processes. • Industrial clients, particularly in sectors like pharmaceuticals and textiles, demand customized solutions and can negotiate favorable terms due to multiple provider options. • Buyers are price-sensitive due to budget constraints and competitive pricing.	• Barriers to entry: High capital costs for constructing treatment plants, regulatory compliance, and the need for technical expertise deter new entrants. • Government initiatives and increasing private investment in wastewater management create opportunities for new entrants, particularly in niche areas like biogas extraction or oil-water segregation. • However, established players with economies of scale and strong client relationships dominate large projects, making it challenging for new entrants to compete.
Threat of Substitutes: Low to Moderate	
• Untreated water discharge is increasingly unfeasible due to strict regulations, and alternative water sources like desalination are gaining traction but complement rather than replace wastewater treatment. • Technologies like rainwater harvesting or greywater recycling pose a minor threat but are often integrated into treatment systems. • The push for circular economy solutions reduces the appeal of substitutes by adding value to treatment processes.	

Source: Crisil Intelligence

Key success factors for players in the water and wastewater treatment industry in India

The Indian water and wastewater treatment market is poised for significant growth, driven by rising environmental awareness, government investments, and the need for efficient and sustainable water management solutions. To succeed in this market, players are focusing on efficient and timely project completion, compliance with regulations, and securing sustainable financing, technological development, etc.

Efficient and Timely Project Completion:

Efficient and timely project completion is crucial in the water and wastewater treatment industry, as delays can escalate costs and damage credibility. To achieve this, players must integrate advanced technologies, robust supply chains, and effective project management tailored to India's unique challenges. Clients in this industry have robust internal evaluation and supplier accreditation protocols. Some of the key strategies for efficient and timely project completion include:

- **Advanced Treatment Technologies**: Adopting advanced treatment technologies such as Membrane Bioreactor (MBR), Reverse Osmosis (RO), Ultrafiltration (UF), and Zero Liquid Discharge (ZLD) can help improve treatment efficiency and reduce operational downtime.
- **Automation and IoT Integration**: Implementing automation and IoT technologies can enable real-time monitoring of treatment processes, minimize human intervention, and optimize resource use.
- **Modular and Scalable Designs**: Modular treatment plants can significantly reduce construction time and allow for phased expansions, enabling partial operation while additional capacity is built.
- **Robust Supply Chain Management**: Establishing partnerships with local manufacturers or maintaining strategic inventories can mitigate supply chain risks and ensure timely availability of equipment.
- **Skilled Workforce and Project Management**: A skilled workforce trained in water treatment technologies and project management is essential for seamless execution, and project management tools can help track milestones, allocate resources, and manage risks.

Compliance to Regulations:

Compliance with India's stringent environmental regulations is non-negotiable, and players must adopt technologies and strategies that meet regulatory requirements. Some of the key strategies for compliance include:

- **Regulatory-Compliant Technologies**: Adopting technologies that meet CPCB and SPCB standards, such as ZLD systems, can ensure compliance with discharge limits.
- **Real-Time Monitoring Systems**: Implementing real-time monitoring systems such as CEMS and CEQMS can track parameters like pH, turbidity, and heavy metal content, ensuring compliance with discharge limits.
- **Energy-Efficient Solutions**: Adopting energy-efficient technologies can reduce operational costs and align with India's sustainability goals.

- **Upgraded Treatment Facilities**: Retrofitting existing STPs and CETPs with advanced technologies can ensure compliance with updated standards.
- **Decentralized Systems**: Implementing decentralized systems such as small-scale STPs or FSTPs can ensure compliance with local SPCB norms.

Financing Capabilities

Securing adequate financing is a major challenge in India's capital-intensive water treatment sector, and players must demonstrate financial viability through cost-effective technologies and bankable project models. Some of the key strategies for financing include:

- **Cost-Effective Technologies**: Adopting cost-effective technologies such as MBBR or SBR can reduce capital and operational costs.
- **Public-Private Partnership (PPP) Models**: Adopting PPP models such as HAM and BOT can reduce financial risk for companies and attract private investment.
- **Scalable Infrastructure**: Phased infrastructure development can lower upfront capital needs, making projects more appealing to financiers.
- **Operation and Maintenance (O&M) Contracts**: Long-term O&M contracts can provide stable revenue streams, enhancing project bankability.
- **Digital Tools for Financial Planning**: Using software for cost estimation, lifecycle analysis, and financial modeling can help companies present robust business cases to investors.

5.Government policies and regulatory framework in India

Overview of regulations and policies from Central Pollution Control Board (CPCB)

The CPCB's wastewater management framework is rooted in central legislation (Prevention and Control of Pollution) Act, 1974, and the Environment (Protection) Act, 1986 (EPA). The Water Act of 1974 established to prevent and control water pollution by setting standards for wastewater discharge into water bodies. The EPA, enacted in 1986, expanded the CPCB's authority to set effluent and emission standards specific to industries, with SPCBs enforcing stricter standards where necessary.

Key regulations by CPCB and other relevant bodies

- The CPCB sets specific discharge standards for treated sewage and industrial effluents to ensure environmental safety. As per, key parameters for treated sewage and effluent discharged into inland surface waters such as pH: Must be between 6.5 and 9.0 (CPCB) or 6.5 and 8.5 (SPCBs), Total Suspended Solids (TSS): Not to exceed 100 mg/L, Oil and Grease: Not to exceed 10 mg/L, etc.

- The CPCB mandates that infrastructures like apartments, commercial projects, educational institutions, and municipalities install Sewage Treatment Plants (STPs) meeting specific criteria. Some of the key guidelines include:

    - Operational Standards: STPs must be operated by trained personnel, with regular monitoring of parameters like BOD, COD, and TSS. The CPCB notes that 39% of STPs fail to meet standards due to inadequate expertise, requiring monthly expert inspections.

    - Safety and Signage: STPs must display "Danger" and "Water Not Fit for Drinking" signs, and treated water must be used for non-potable purposes like toilet flushing via dual piping systems.

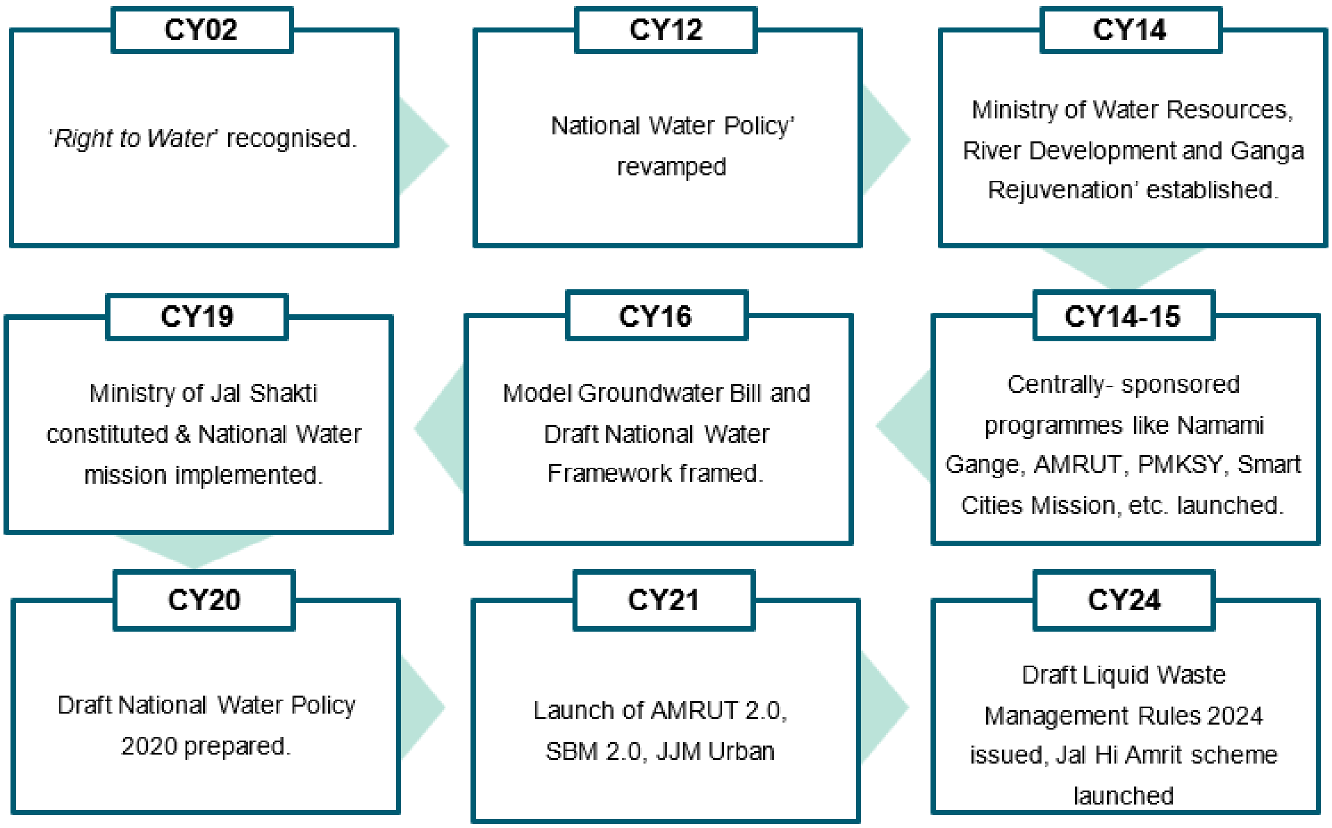
    - Modular Design: Large STPs should be built in modular units to accommodate varying loads, especially in new developments.

- The CPCB promotes wastewater reuse and ZLD to enhance sustainability. It mandates states to submit action plans for treated wastewater utilization, focusing on agriculture, industry, and non-potable uses. CPCB's ZLD mandates, particularly for industries like textiles and pharmaceuticals, require complete treatment and reuse of effluents

- The CPCB collaborates with SPCBs to monitor wastewater discharge through the National Water Quality Monitoring Programme (NWMP), analyzing pollutants in water bodies to enforce corrective measures. The CPCB's Online Continuous Effluent Monitoring Systems (OCEMS) require industries to install real-time sensors for parameters like pH, COD, and TSS, ensuring compliance, as per CPCB.

Evolution of water policies and regulations over the years

The government has various policies and frameworks that supported the growth of the water management sector in the country.

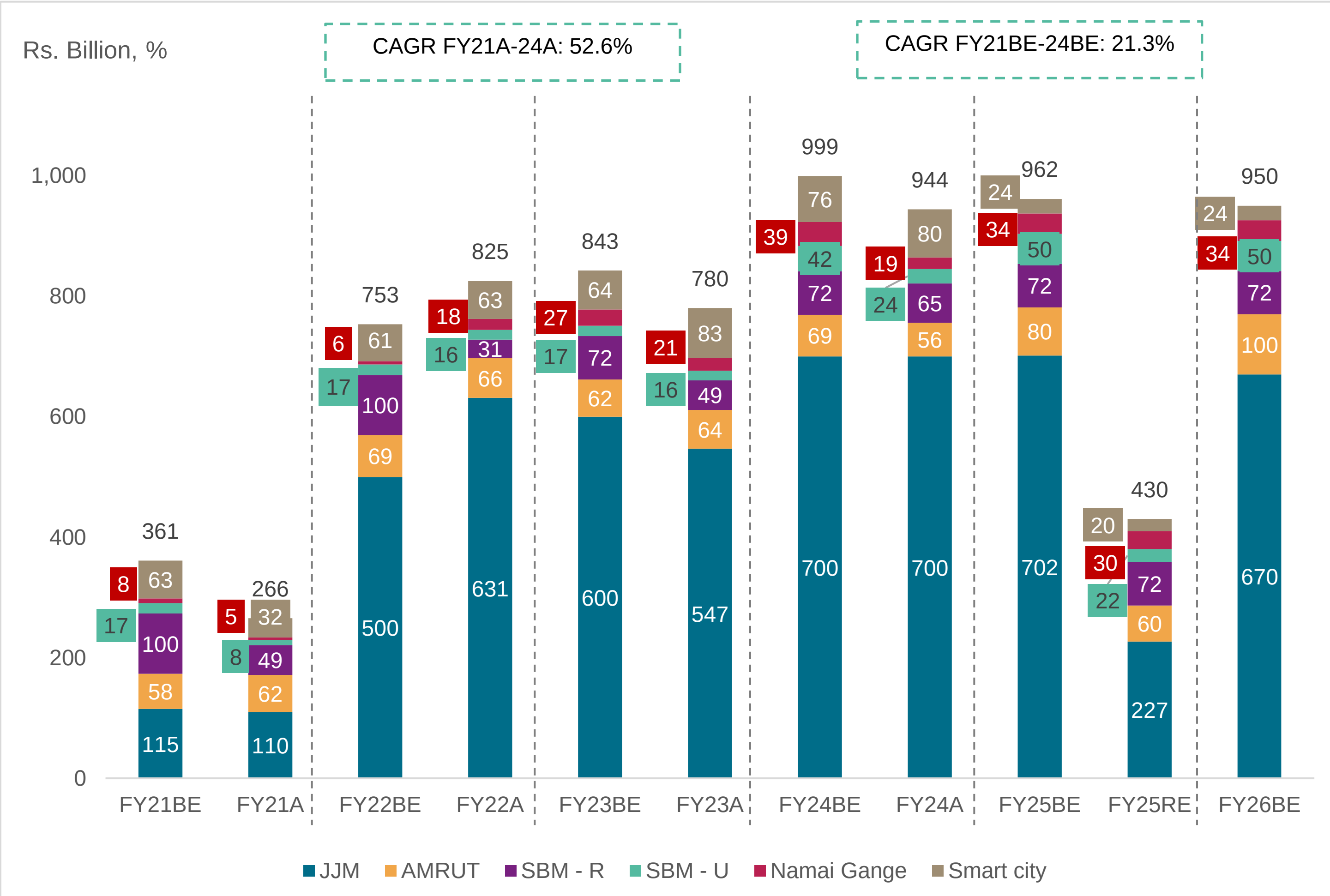


In India, water management is primarily the responsibility of state governments, with the central government providing technical and financial support. Recognising the importance of water conservation, the government has made it a top priority. Various government agencies are actively involved in managing water resources, beginning with the introduction of the National Water Policy in 1987. The policy has undergone several revisions to promote optimal water usage, reduce environmental impact and ensure water security, equitable distribution and efficient use.

The National Water Mission continues to guide the policy, prioritising water conservation, rainwater harvesting and improving efficiency to ensure long-term sustainability in water resource management. These guidelines aim to build resilient systems that ensure safe drinking water, addressing long-standing issues of competence and capacity in small water systems. By prioritising simple and affordable solutions, the WHO seeks to professionalise the sector and enhance access to clean water for vulnerable communities.

The Government of India has launched several schemes and programs focussed on water conservation, distribution and infrastructure including the Jal Jeevan Mission, Swachh Bharat Mission, Atal Mission for Rejuvenation and Urban Transformation ("AMRUT"), and Namami Gange.

Budgetary allocation across different funds



Notes: BE: Budget estimates, A: Actuals

Source: India Budget, expenditure profile, Crisil Intelligence

Launched on August 15, 2019, the Jal Jeevan Mission (JJM) is a flagship programme of the central government, with the objective of providing functional household tap connections (FHTCs) to all rural households. It aims to improve the lives of rural communities by providing them safe and adequate drinking water and promoting sustainable water management practices.

Jal Jeevan Mission

The Jal Jeevan Mission is a flagship initiative by the Government of India, launched in 2019 with the goal of providing every rural household with safe and adequate drinking water through a functional tap water connection by 2024, with an allocated budget of INR 2.8 trillion till FY26 including budget estimates and revised estimates. The mission aims to ensure that every rural household has access to 55 Liters of potable water per person per day on a long-term basis. With over 155 million households already connected to tap water, Jal Jeevan Mission plays a critical role in addressing water scarcity and ensuring the long-term sustainability of water resources through rainwater harvesting, groundwater recharge, and water conservation efforts. Particularly in rural and remote areas, this mission supports improved living standards and health outcomes.

JJM uses a multi-stakeholder approach, involving the central government, state governments and local communities. It promotes community participation in water management, with a focus on sustainable and equitable use of water resources. It also emphasises on the importance of technological innovations, such as solar-powered water supply systems, to reduce cost and improve efficiency.

Community participation in water management is being promoted, with a focus on sustainable and equitable use of water resources. A comprehensive plan has been developed to achieve the mission's objectives, build resilient water supply systems and promote community-led initiatives. It also recognises the importance of community education and awareness about water management to ensure long-term sustainability of water resources.

The mission is being implemented in a phased manner by developing in-village piped water supply infrastructure. Local communities are given help in capacity building and training to ensure their active participation in water management. Community-led total sanitation (CLTS) will help improve the overall quality of life in rural areas.

A comprehensive plan has been developed to achieve the mission's objectives. The mission will continue to work towards achieving its objectives, with a focus on community participation, education and technological innovations.

In short, the highlights of the mission are:

- Providing Functional Household Tap Connections (FHTCs) to all rural households
- Promoting community participation in water management
- Ensuring sustainable and equitable use of water resources
- Developing a comprehensive plan to achieve the mission's objectives
- Providing community education and creating awareness about water management
- Promoting technological innovations, such as solar-powered water supply systems, to reduce cost and improve efficiency

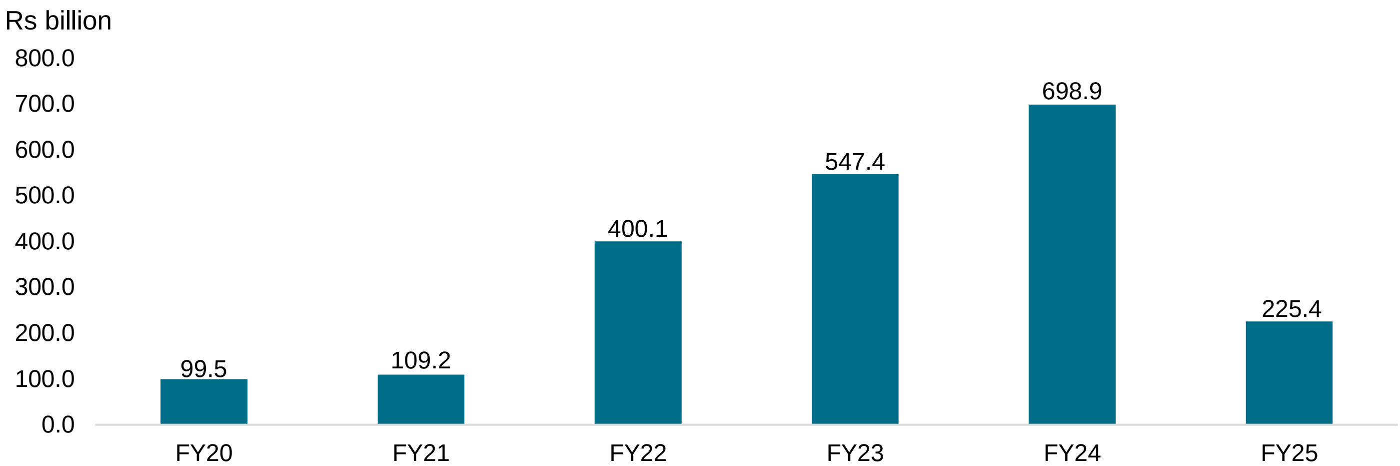
Fund distribution ratio for different states/ UTs

State/UTs	Central share (%)	State share (%)
Himalayan and northeastern sates	90	10
Other states	50	50
UT with legislature	90	10
UT without legislature	100	0

Source: JJM toolkit, Crisil Intelligence

JJM’s fund distribution ratio varies with states and Union Territories (UT), with Himalayan and northeastern states receiving 90% central funding, other states 50% and UTs without legislature receiving 100% central funding.

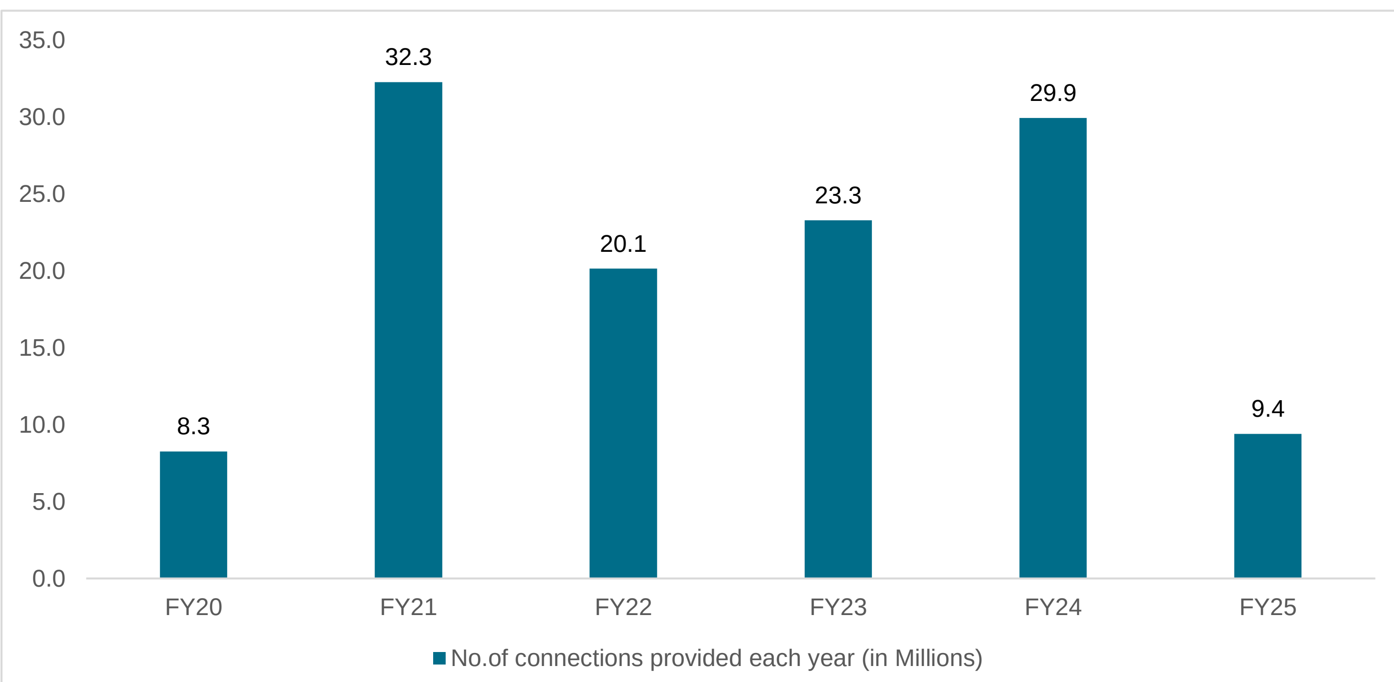
Funds drawn by states/ UTs



Source: JJM dashboard, Crisil Intelligence

The mission has made significant progress in providing tap water supply to households across the country. Funds utilized by states under JJM have shown a steady increase over the years, indicating a growing commitment to the mission. The trend suggests that the mission is gaining momentum. The increased fund offtake boosted tap water supply to households as there has been a notable increase in connections provided over the years.

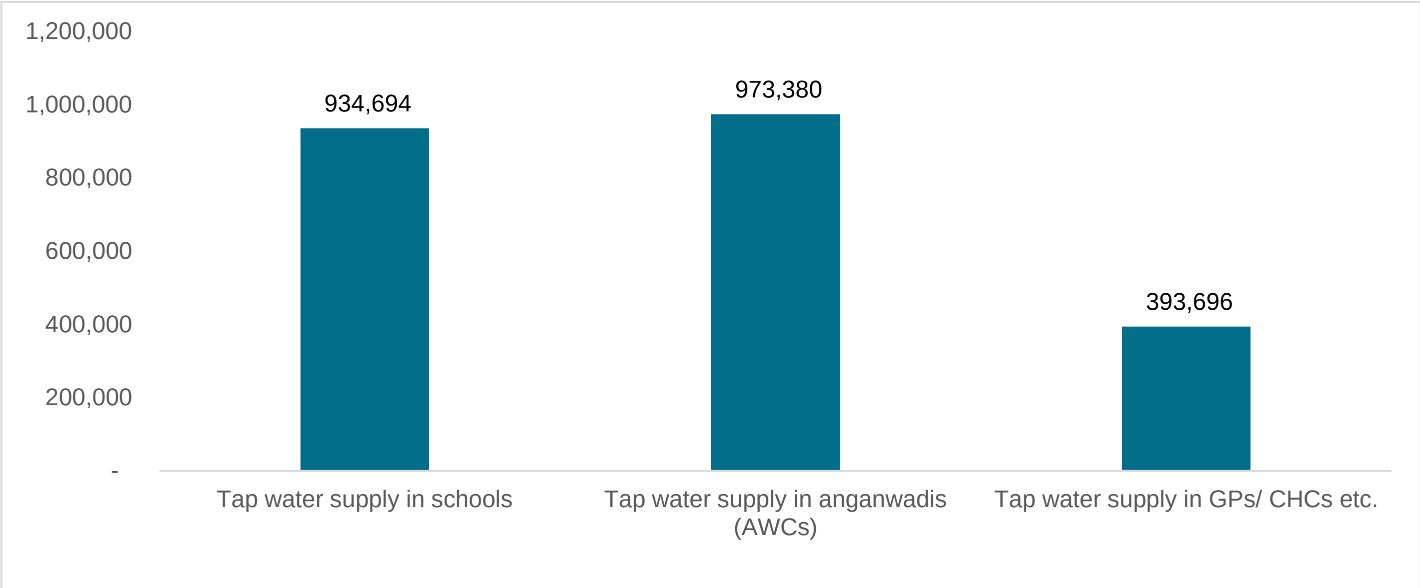
Households provided with tap water supply across each year



Note: As on May 2025

Source: JJM dashboard, Crisil Intelligence

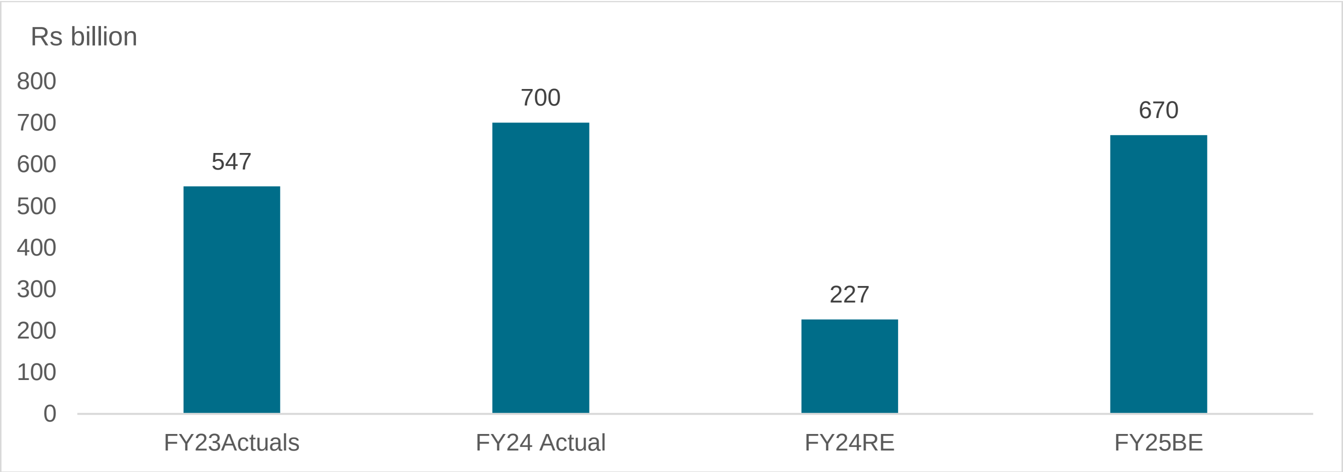
Status of Tap water connections in schools, Anganwadi centres, Gram panchayat, etc.



Note: As on May 2025

Source: JJM dashboard, Crisil Intelligence

Budgetary allocation for JJM



Source: Ministry of finance, Crisil Intelligence

The substantial budget allocation for JJM, though with some fluctuation over the years, also reflects the government's commitment to providing adequate funding to support the mission's objectives. The funds allocated to are utilised to provide tap water supply to households and to maintain and upgrade existing water supply infrastructure. The steady increase in household connections provided under the mission suggests it is on track to achieve its targets. Overall, the data suggests that JJM is making progress towards its objectives and the government is committed to supporting the mission through adequate funding.

AMRUT 2.0

The AMRUT 2.0 scheme was launched on October 1, 2021, by the Ministry of Housing and Urban Affairs (MoHUA) with the aim of making cities self-reliant and water secure. The scheme is a continuation of the previous AMRUT scheme, which was launched in 2015. It is designed to provide basic services such as water supply, sewerage and urban transport to households and build amenities in cities to improve the quality of life for all citizens, especially the poor and disadvantaged.

The AMRUT 2.0 is an urban renewal initiative launched by the Government of India in 2021. AMRUT Mission 2.0 aims to improve the quality of life in cities across India by upgrading infrastructure, enhancing basic services and promoting sustainable urban development. The primary objectives of AMRUT Mission 2.0 includes ensuring functional tap and sewerage connections to all households in towns across India, and promoting the recycling and reuse of treated sewage, rejuvenation of water bodies, and water conservation through the development of city water balance plans.

The main objectives of AMRUT 2.0 are:

- **Universal piped water supply:** Giving water tap connections to all households to ensure every household has access to clean and safe drinking water
- **Universal coverage of sewerage and septage management:** To provide universal coverage of sewerage and septage management in 500 AMRUT cities, ensuring that every household has access to proper sanitation facilities
- **Promoting circular economy of water:** Recycling and reusing treated sewage, reducing the burden on freshwater resources and minimising the environmental impact of wastewater disposal
- **Rejuvenation of water bodies:** To augment water availability, enhance amenity value and develop green spaces, which will, in turn, improve the overall aesthetic and environmental quality of urban areas
- **Making cities *atmanirbhar* and water secure:** By ensuring they have necessary infrastructure and resources to manage their water needs sustainably

The AMRUT 2.0 scheme has several key components, including:

- **Water supply:** The scheme aims to provide universal piped water supply with household water tap connections, ensuring that every household has access to clean and safe drinking water
- **Sewerage and septage management:** It aims to provide sewerage and septage management in 500 AMRUT cities, ensuring every household has access to proper sanitation facilities
- **Rejuvenation of water bodies:** It seeks to rejuvenate water bodies to augment water and enhance amenity value and develop green spaces, improving the overall aesthetic and environmental quality of urban areas
- **Technology sub-mission:** It will leverage latest technologies in the field of water to improve the efficiency and effectiveness of water supply and sewerage systems.
- **Public-private partnerships (PPPs):** The scheme encourages PPP projects in million-plus cities, with a minimum of 10% of total fund allocation at the city level committed to such project

The AMRUT 2.0 scheme has a multi-level governance structure as follows:

- **State high powered steering committees (SHPSCs):** Headed by the state chief secretaries, SHPSCs monitor and supervise the implementation of the scheme at the state/UT level
- **State level technical committee (SLTC):** Headed by the state secretary of Urban Development and Housing Department, the SLTC provides technical support to the SHPSC in monitoring and supervising the scheme at the State level
- **Apex committee:** The apex committee reviews and monitors the mission periodically

  Independent review and monitoring agencies (IRMAs): IRMAs assess and monitor the work done under AMRUT in states/UTs. Funds are released to States/UTs basis compliance reports by these monitoring agencies

Funds distribution ratio:

States/UTs	Central share (%)
Union Territories	100%
Northeastern states and Himalayan states	90%
Cities of states with less than one lakh population	50%
Cities of states with population one lakh to 10 lakh (both included)	On-third of the project cost
Cities of states with population more than 10 lakh	25% of the project funds by the Centre (except for projects taken up under PPP mode) *

Note: PPP projects amounting to at least 10% of total project allocation for all cities with population above 10 lakhs in a state will be mandatorily taken up under this scheme

Source: AMRUT 2 guidelines (MoHUA), Crisil Intelligence

The total indicative outlay for AMRUT 2.0 is Rs 2,990 billion, including the total Central assistance of Rs 767.6 billion, for five years (FY22 to FY26). As on November 15, 2024, Central assistance of Rs 639.77 billion was approved to states/UTs, of which Rs 117.56 billion has been released so far. The states/UTs have reported utilisation of Rs 65,40 billion of central share, and cumulatively, with state's share, the total expenditure reported by states/UTs is Rs 170.89 billion.

Tentative distribution of central fund allocation among project components of Mission planned during launch of AMRUT 2.0

Description	Central share (Rs. Billion)
Water supply projects	352.5
Rejuvenation of water bodies and developing green spaces & parks projects	39
Sewerage and septage management projects	276
Total tentative central allocation (CA) on projects	667.5

Source: AMRUT 2 guidelines (MoHUA), Crisil Intelligence

Budget allocation under the scheme

Mission component	Allocation (Rs billion)
Projects	667.50
Incentive for reforms (8% of CA allocation)	53.40
Administrative and other expenses (A&OE) for states/ UTs (3.25% of project CA allocation)	21.69
Administrative and Other Expenses for MoHUA (1.75% of project CA allocation)	11.68
Technology sub-mission (1% of project CA allocation)	6.67
IEC activities (1% of project CA allocation)	6.67

Source: AMRUT 2 guidelines (MoHUA), Crisil Intelligence

As reported by states/UTs on the AMRUT 2.0 portal (as on November 15, 2024), tenders have been issued for 5,886 projects worth Rs 1,158.73 billion, of which contracts have been awarded for 4,916 projects worth Rs 851.14 billion. Rest of the projects are at various stages of implementation. Works worth Rs 230.17 billion have been physically completed.

Jal Hi Amrit scheme: In October 2024, the Jal Hi Amrit (JHA) scheme was launched as an extension of AMRUT 2.0, with the aim of transforming STPs into resource recovery facilities. The JHA programme aims to incentivise states and UTs to ensure the optimal functioning of Used-water Treatment Plants (UWTPs). These plants must consistently meet environmental standards while producing recyclable treated water. As part of this initiative, UWTPs will be awarded clean water credits through a star rating system. Incentives will be provided to urban local bodies (ULBs)/ parastatal agencies based on a comprehensive evaluation process detailed in the following section. Additionally, the JHA programme focuses on enhancing the skills of UWTP operators/ULB officials. Through customised capacity-building programmes, the initiative aims to equip these personnel with the knowledge and expertise needed to manage the facilities efficiently and consistently meet discharge standards.

The AMRUT 2.0 scheme is expected to have several benefits, including:

- **Improved water supply:** The scheme will ensure that every household has access to clean and safe drinking water, improving the overall health and well-being of citizens
- **Better sanitation:** The scheme will ensure that every household has access to proper sanitation facilities, reducing the risk of water-borne diseases and improving the overall environmental quality of urban areas
- **Increased water security:** The scheme will promote the circular economy of water, reducing the burden on freshwater resources and minimising the environmental impact of wastewater disposal
- **Higher aesthetic and environmental quality:** The scheme will rejuvenate water bodies and develop green spaces, improving the overall aesthetic and environmental quality of urban areas
- **Increased economic opportunities:** The scheme will create new economic opportunities in the water sector, including the development of new technologies and industries related to water management

AMRUT 2.0 is a comprehensive scheme aimed at making cities self-reliant and water secure by providing universal piped water supply, sewerage and septage management, and promoting the circular economy of water. The scheme has made significant progress since its launch and it is expected to have a positive impact on the urban life. However, the scheme faces several challenges, including financial, technical, institutional and environmental, which need to be addressed to ensure the successful implementation of the scheme.

Namami Gange Programme

The Namami Gange Programme is an integrated conservation mission launched by the Government of India in 2014 to rejuvenate the Ganga River through initiatives such as sewerage treatment, river-front development, and biodiversity enhancement. This project is implemented by the National Mission for Clean Ganga with an estimated budget outlay of Rs 2,000 million. Key components of the mission include river-surface cleaning, afforestation, public awareness, industrial effluent monitoring, and the development of Ganga Gram. Under this mission, various programs and projects are implemented to improve water quality and enhance the ecosystem.

The programme was initially set to run until March 2021, but was subsequently extended to March 2026. The 100% centrally funded programme adopts a hybrid annuity-based PPP model. The Ganga flows more than 2,500 km through the plains of north and eastern India, with the Ganga basin comprising 26% of India's landmass, making it a key source of livelihood and water for many citizens. The NPG covers eight states, 47 towns and 12 rivers, comprising the main river and its tributaries. The second phase of the programme, which runs from fiscal 2021 to 2026, aims to build on the success of the first phase.

The key features of the NGP 2 are:

- Empanelment of agencies to support the preparation of Detailed project reports (DPR)
- Standardisation of the DPRs and instituting trainings ahead of its preparation
- Mapping and monthly monitoring of the drains by the SPCBs
- Characterisation of sludge and its monetisation
- Monthly reports and review of activities to improve monitoring
- Institutional strengthening of the Sate Project Management Group (SPMGs) by filling up of vacancies
- Stringent monitoring of the DPRs and procurement process
- Strengthening of the DGCs (District ganga committees) through capacity building
- Fixed day, mandated monthly DGCs meetings along with minutes
- Increase participation in Namami Gange programmes – Arth Ganga, etc

To be sure, the programme has made significant progress in achieving its objectives.

The first phase of the programme, which ended in 2021, saw the completion of several key projects, including the creation of sewerage infrastructure, control of industrial pollution and improvement with regard to rural sanitation.

For instance, all 4,465 villages along the bank of the Ganga have been declared open defecation-free and significant reduction in pollution from industries has been achieved. Paper and pulp facilities have installed advanced process technologies, resulting in lower freshwater consumption and wastewater discharge, and zero black liquor discharge. In fact, the industrial sector has been a key focus area, with CETPs provided to tanneries located along the riverbank to transition to cleaner processes and reduce water consumption.

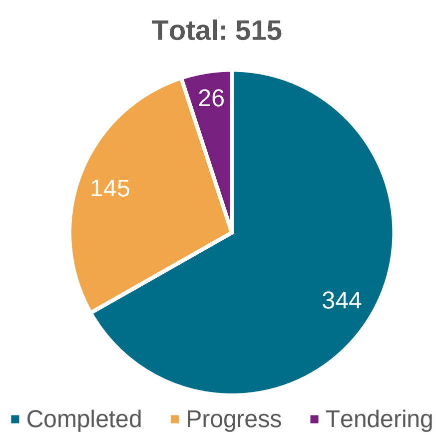
In addition to these efforts, the government has also promoted sustainable agricultural practices, such as organic farming, to reduce pollution and improve the overall health of the Ganga basin. The introduction of new technologies, such as the use of GIS and remote sensing, has helped monitor the health of the river as well. Public awareness and community participation have been crucial components, with initiatives such as Ganga Utsav, which aims to promote awareness and education about the river among the general public, successful in engaging the community. Ganga Amantran, a 34-day river rafting expedition, has also been instrumental in promoting community participation and public awareness.

The programme has also seen significant investment in infrastructure development, including the creation of sewerage, industrial pollution control and rural sanitation infrastructure, which has improved the overall quality of life for people living in proximity to the Ganga basin. Furthermore, initiatives such as Arth Ganga aim to promote sustainable agriculture and reduce pollution in the basin area – this has seen significant success, with the adoption of sustainable agricultural practices by farmers in the Ganga basin, and the reduction of pollution from industrial and agricultural sources.

As the programme moves forward, there are plans to restore the 'wholesomeness' of the river, defined in terms of ensuring continuous flow, unpolluted flow, geologic and ecological integrity, and climatic and spatial understanding. Towards this, the programme will continue to focus on creation of sewerage, industrial pollution control and rural sanitation infrastructure, and will introduce advanced technologies to monitor and further improve the health of the river.

Overall, of a total of 513 under NGP, 344 projects have been completed, which represents a completion rate of ~67%, which is a notable achievement, considering the complexity and scale of the programme. The fact that 143 projects are still in progress and 26 are at the tendering stage indicates that the programme continues to have a strong pipeline of projects. As of May, 31, 2025, 211 sewage infrastructure projects have been sanctioned under the Namami Gange Programme, with 133 projects completed and operational.

Projects under NGP segregated by status



Source: NGP dashboard, Crisil Intelligence

Uttar Pradesh has the highest number of projects, totalling 164. The state has also made significant progress, with 110 projects completed. Uttarakhand has made significant progress as well, with 67 projects of a total of 89 completed, representing a completion rate of ~69%. In contrast, Jharkhand, Delhi and Madhya Pradesh have relatively fewer projects and will need to accelerate the pace of project implementation to meet the overall objectives of the NGP.

State-wise NGP project split by status

States	Completed	Progress	Tendering	Total
Uttar Pradesh	110	45	9	164
Uttarakhand	67	22	0	89
West Bengal	56	17	7	80
Bihar	47	19	5	71
Jharkhand	14	5	0	19
Delhi	12	11	2	25
Madhya Pradesh		6	2	8
Haryana	3	1	0	4
Himachal Pradesh	1	1	0	2
Rajasthan	0	1	0	1
Telangana	0	1	0	1
Other projects[1]	34	16	1	51

Notes:
1: Other projects are R&D, study, reports, etc. projects given to institutions
2: Numbers are as of November 30, 2025
Source: NGP dashboard, Crisil Intelligence

Still, despite the variations, data suggests that NGP is making progress, in terms of project completion, and with continued efforts, it is likely to achieve the overall objective.

A look at the project status reveals that the majority of completed projects are in the categories of ghats, crematoria and River front development (84 projects), sewage infrastructure (127 projects), and interception and diversion (64 projects), indicating that the programme has made substantial progress in improving the sewage infrastructure and creating new ghats and crematoria along the river.

The completion of these projects is expected to have a positive impact on the river's water quality and the overall environment.

Data also shows that there are still significant number of projects in progress, particularly in the categories of interception and diversion (52 projects), R&D (37 projects) and industrial pollution abatement (11 projects). The tendering stage also has a notable number of sewage infrastructure (22 projects), interception and diversion (20 projects), and bioremediation (two projects) projects.

Project type split as per status

Type of projects	Completed	Progress	Tendering	Total
Sewage infrastructure	133	55	23	**211**
Interception and diversion	69	50	22	**141**
Laying of new sewerage networks	25	3		**28**
Construction of new STPs	19	1		**20**
Repair/restoration/upgradation works	17			**17**
Rehabilitation of existing STPs	3	1	1	**5**
Ghats, crematoria and RFD (River front development)	84	23	2	**109**
R&D	25	37		**62**
Afforestation	32	5		**37**
Industrial pollution abatement	9	12	1	**22**
Bioremediation	11	6	2	**19**
Biodiversity conservation	8	8		**16**
IEC activities and institutional development	3	6		**9**
Solid waste management	6	1	1	**8**
Composite ecological task force	6	1		**7**
Sanitation	1			**1**

Note: As of May 30, 2025
Source: NGP dashboard, Crisil Intelligence

Ongoing and upcoming projects will continue to build on the momentum of the completed projects, and their successful implementation will be crucial in achieving the programme's objectives of restoring the river

On the funding front, data reveals that of the total sanctioned amount of ~Rs 400.5 billion, Rs 197.3 billion has been released and Rs 194.1 billion has been expended. Majority of the sanctioned amount is allocated to sewage infrastructure (Rs 330.0 billion), interception and diversion (Rs 216.5 billion) and laying of new sewerage networks (Rs 55.8 billion).

The fact that these categories account for a significant portion of the total expenditure indicates that the programme is prioritising the development of sewage infrastructure and interception and diversion systems to improve the water quality.

Category wise project update

Type of project	Sanctioned Amount (Rs billion)	Funds released (Rs billion)	Total expenditure (Rs billion)
Sewage infrastructure	330.0	156.8	155.9
Interception and diversion	216.5	73.5	73.2
Laying of new sewerage networks	55.8	44.8	44.5
Construction of new STPs	37.6	24.7	24.7
Rehabilitation of existing STPs	14.8	7.7	7.6
Repair/restoration/upgradation works	5.4	6.1	5.9
Ghats, Crematoria and RFD	18.1	13.1	13.1
Industrial pollution abatement	17.2	5.8	5.1
Sanitation	10.2	9.9	9.9
R&D	7.3	2.0	1.9
Afforestation	5.4	4.5	3.7
Bioremediation	3.9	0.4	0.4
Composite ecological task force	3.4	2.0	2.0
Biodiversity conservation	2.5	1.3	1.1
IEC (Information, Education, and Communication) activities and institutional development	1.9	1.0	0.5
Solid waste management	0.6	0.5	0.5
Total	**400.5**	**197.3**	**194.1**

Note: As of January 30, 2025

Source: NGP dashboard, Crisil Intelligence

Smart Cities Mission

The Smart Cities Mission is an initiative of the government to promote core infrastructure and quality of life for citizens in cities by ensuring a clean and sustainable environment and the application of 'smart' solutions. The focus is on sustainable and inclusive development, which can be replicated within as well as outside the ‘smart city’, catalysing the creation of similar smart cities in various regions and parts of the country.

The core infrastructure elements in a smart city include adequate water supply, assured electricity supply, sanitation, efficient urban mobility and public transport, affordable housing, robust IT connectivity and digitalisation, good governance, sustainable environment, safety and security of citizens, and health and education.

The mission involves the strategic components of area-based development, which includes city improvement, city renewal and city extension, as well as a pan city initiative that applies smart solutions to larger parts of the city.

Government funds and matching contribution by the states/ULBs meet only part of the project cost, with the balance funding to be mobilised from various sources, including own resources of the states/ULBs, and via innovative finance mechanisms and private sector participation through PPPs.

The distribution of funds under the scheme is:

- 93% project funds
- 5% Administrative and Office Expenses (A&OE) funds for states/ULBs (towards preparation of Smart city proposals and for Project management consultants, pilot studies connected to area-based developments, and deployment and generation of smart solutions and capacity building)
- 2% A&OE funds for the Mission Directorate and connected activities/structures, research, pilot studies, capacity building, and concurrent evaluation

The Smart Cities Mission also involves convergence with other schemes, such as AMRUT, Swachh Bharat Mission, National Heritage City Development and Augmentation Yojana, Digital India, and other programmes connected to social infrastructure.

By integrating these schemes, comprehensive development can occur, achieving urban transformation and improving the quality of life for citizens.

As of February 7, 2025, the mission has undertaken 8,058 projects, which cost a cumulative Rs 1,645.14 billion. Of these, a significant 7,491 projects have been successfully completed, comprising a total investment of Rs 1,501.57 billion. Another 567 projects totalling Rs 143.57 billion are ongoing.

The Smart Cities Mission has achieved milestones across sectors, with a total of 8,058 projects initiated. Notably, the WASH (water, sanitation, and hygiene) sector has been a major focus area, with 1,440 projects completed at a total cost of Rs 467.30 billion. The projects include significant initiatives such as the 120 MLD WTP and ZLD system under 590 MLD WTPs at Sarthana Water Works in Surat, as well as 2 MLD water treatment plant, pumping station and pipeline for conveying water from Narsinghghat and Kshipra rivers to Rudrasagar. The primary objective of these projects has been to enhance the water supply, sanitation and hygiene infrastructure in urban areas, tackling pressing concerns such as sewage management, water treatment and sewage treatment.

With 106 ongoing WASH projects valued at Rs 30.05 billion, the mission continues to prioritise health and well-being of citizens.

Swachh Bharat Mission - Urban (SBM-U)

The Swachh Bharat Mission - Urban (SBM-U), was launched on 2nd October 2014 aimed at making urban India free from open defecation and achieving 100% scientific management of municipal solid waste in 4,041 statutory towns in the country. The Swachh Bharat Mission Urban 2.0 was launched in October 2021 with the aim to achieve garbage free cities by 2026. The primary objectives of the mission include ensuring that all sewage is safely managed and treated, promoting the collection, treatment, recycling and reuse of used water to prevent environmental pollution. In order to achieve these objectives, the mission aims to establish and upgrade STPs to ensure scientific processing of sewage and septage Rs.1588.3 million has been allocated to States/UTs for wastewater/used water management, including setting up of STPs and FSTPs (fecal sludge treatment plants. The mission also implements systems for the collection, transportation and treatment of used water and promotes the reuse of treated sewage to support a circular economy

Below are the key components under SBM (Urban) – 2.0:

Key focus segments	Objective	Key components
Used water management	To ensure that no untreated fecal sludge or used water is discharged into the environment, and all used water (including sewerage and septage, grey water and black water) is safely contained, transported and treated, along with maximum reuse of treated used water, in all cities with less than 1 lakh population.	• Setting up of waste processing facilities such as MRFs, transfer stations, composting plants, bio methanation plants, RDF processing facilities, plastic waste processing facilities, waste to electricity, sanitary landfill, etc. • Procuring mechanized sweeping equipment and setting up processing facilities for effective management of Construction and Demolition (C&D) waste (in 154 cities) • Bioremediation/ capping of all legacy dumpsites in all ULBs
Sustainable solid waste management	To make all cities clean and garbage free, with 100% scientific processing of Municipal Solid Waste	• Setting up of waste processing facilities such as MRF's, transfer stations, composting plants, bio methanation plants, RDF processing facilities, Plastic waste processing facilities, waste to electricity, sanitary landfill, etc • Procuring mechanized sweeping equipment and setting up processing facilities for effective management of Construction and Demolition (C&D) waste (in 154 cities)

Key focus segments	Objective	Key components
		• Bio-remediation / capping of all legacy dumpsites in all ULB's
Sustainable Sanitation	To sustain Open Defecation Free status in all Statutory towns.	• Construction of Individual Household toilets • Construction of Community and Public Toilet (CT and PT) seats • Construction of urinals, along with retrofitting of unsanitary toilets • Aspirational toilets ULBs will have to provide additional pts in all tourist destinations/ places with high footfall/ iconic cities/ religious destinations
IEC / BCC	To ensure awareness creation along with large scale citizen outreach to intensify 'Jan Andolan' and institutionalize swachh behavior and related set of actions, towards achieving the vision of "Garbage Free" cities.	• National level support for agencies, campaign management, promotion of national level initiatives, and advocacy • State/ ULB level support for campaign management, onboarding of grassroots organisations, promotion of good practices, and events
Capacity Building (CB)	To create institutional capacity to effectively implement programmatic interventions to achieve mission objectives.	• National level support for centres of Excellence, academic funding, capacity building and training, knowledge management, e-learning, various training and innovation related initiatives, and digital outreach programmes • State level support for program management units, ICT initiatives, human resources and grassroots capacity building, and training

6.Overview of production of compressed biogas from organic waste in India

Review and outlook for consumption of compressed biogas in India, in volume terms

India's energy transition is also driven by its ambitious targets and commitments, including achieving energy independence by 2047 and becoming a net-zero economy by 2070. The country has also made significant commitments at the global level, including achieving 500 GW of renewable energy capacity and reducing carbon emissions by ~1 billion tons by 2030, as announced at COP26. Furthermore, at COP27, India committed to rationalizing its natural resources to achieve these goals. Bioenergy is expected to play a crucial role in enabling India to deliver on its Nationally Determined Contributions, with a suite of biomass-based energy sources, including biofuels, biogas, CBG (also referred as bioCNG), bioLNG, biodiesel, biohydrogen, and briquettes/pellets, all contributing to the country's energy mix.

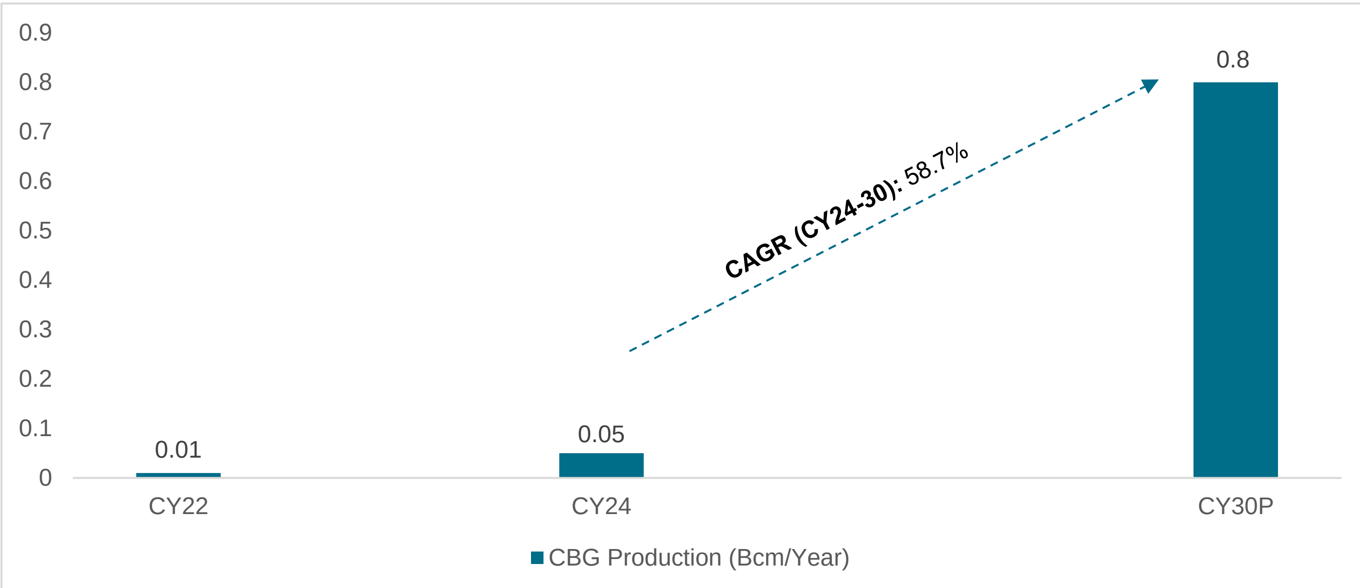
India's biogas sector, with a history spanning over a century, is gaining momentum, driven by the country's large agricultural sector, which provides a solid foundation for biogas production. The government has renewed its focus on the biogas sector, introducing policies aimed at accelerating investments in compressed biogas (CBG) production. Notably, the first standard on biogas (IS 16087:2013) was introduced in 2013, followed by a revision in the biogas standard in 2016 (IS 16087:2016), and the National Policy on Biofuels in 2018. With an estimated potential of approximately 87 billion cubic meters per year, India's CBG sector is ripe for growth, although the installed capacity as of CY24 stands at less than 1% of this potential, indicating a significant opportunity for expansion and development in the sector.

India's agricultural and waste management sectors present a significant opportunity for the production of renewable energy. The country generates a substantial amount of waste, including around 500 million tonnes of agricultural residue annually, as well as large quantities of food waste and livestock manure. Additionally, the country's rapid urbanization has led to a steady increase in sewage generation, from 70,517 million liters per day (MLD) in fiscal 2020 to 79,908 MLD in fiscal 2024. However, the good news is that sewage treatment capacity has also increased, from 29,738 MLD to 42,012 MLD during the same period, with the actual sewage treated showing an upward trend, from 19,919 MLD to 27,916 MLD. Biogas plants can convert these waste streams, including agricultural residue, food waste, livestock manure, and sewage sludge, into methane-rich biogas through anaerobic digestion, providing a renewable source of energy.

The government's Sustainable Alternative Towards Affordable Transportation (SATAT) initiative has also given a boost to the CBG sector, with 50 operational plants and over 450 under development. As of September 2024, around 90 CBG plants were operational in India, with many more in various stages of development. However, despite this growth potential, CBG production remains relatively low, reaching only 0.05 billion cubic meters in 2024, as per IEA report. Challenges such as commercial viability, land availability, and offtake agreements are hindering the growth of the sector.

To overcome these challenges, strategic opportunities and policy interventions are necessary to boost gas consumption beyond the forecasted trajectory by 2030. With the right support. As per IEA, India's CBG production is projected to reach 0.8 billion cubic meters per year by 2030, at a capacity utilization rate of 50%. The states of Uttar Pradesh, Gujarat, Haryana, Maharashtra are expected to play a significant role in driving this growth, accounting for around 56% of the operational CBG plants as of July 2025

Annual CBG production in India, (CY 22-30)



Notes: P: Projected

Source: IEA-India Gas market report, Crisil Intelligence

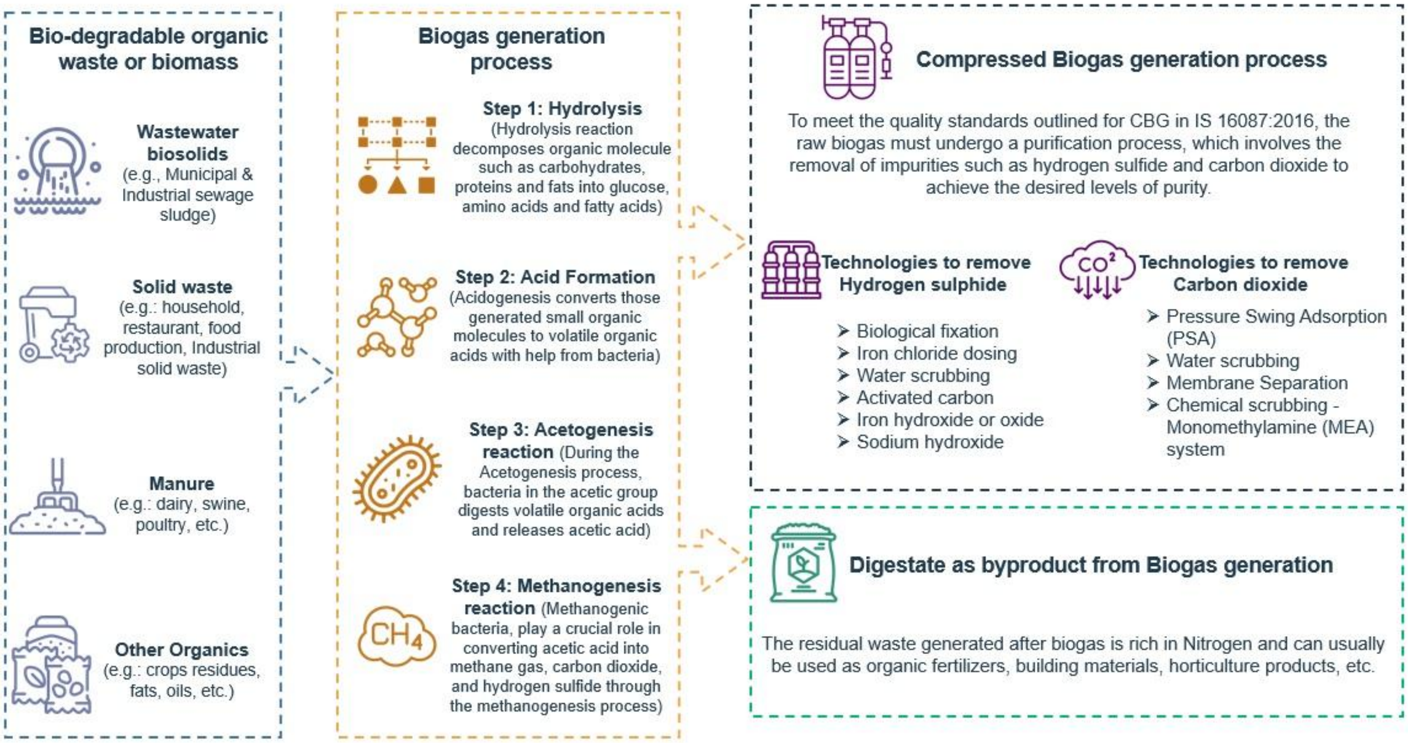
Process and technologies involved in extraction of CBG:

Bio-degradable organic waste, such as agricultural residue, cattle dung, and municipal solid waste, undergoes anaerobic decomposition to produce biogas. This biogas is then purified to remove impurities like hydrogen sulfide, carbon dioxide, and moisture, resulting in Compressed Bio Gas (CBG) with a methane content of over 90%. CBG is a clean and combustible fuel that can be produced from various waste streams, including rotten potatoes, vegetables, dairy waste, and industrial effluent. The biogas produced from these waste streams typically contains 55-60% methane, 40-45% carbon dioxide, and small amounts of hydrogen sulfide. To produce CBG, the biogas is purified to remove carbon dioxide and hydrogen sulfide, compressed to 250 and most of then transported to retail outlets through cylinder cascades or pipelines. To meet the standards outlined in IS 16087:2016, the CBG must meet certain specifications, including a methane content of over 90%, which ensures its quality and suitability as a clean and efficient fuel., including:

- Being free from liquids across all temperature and pressure ranges
- Being free from particulate matter like dirt and dust
- Being odorized to a level similar to that found in local distribution systems

Sl.No	Characteristic	Requirement
1	Methane (CH4), minimum	0.9%
2	Only Carbon Dioxide (CO2), maximum	0.04%
3	Carbon Dioxide (CO2) + Nitrogen (N2) + Oxygen (O2) maximum	0.1%
4	Oxygen (O2) percentage maximum	0.005%
5	Total sulphur (including H2S) mg/m3, maximum	20 mg/m3
6	Moisture mg/m3, maximum	5 mg/m3

CBG generation process and technologies used at each stage



Source: Crisil Intelligence

These technologies are emerging globally and are still evolving in terms of commercial deployment in India. Further, risks remain in execution, market maturity and other factors.

Overview of captive industrial applications of CBG

The use of CBG in captive industrial applications offers a range of benefits, including reduced energy costs, increased energy independence, and minimized environmental impact. A power company, for instance, can use CBG to generate electricity and heat, reducing its reliance on grid power and lowering its energy costs. Similarly, a distillery can use CBG to power its operations, reducing its energy costs and minimizing its environmental footprint. The production of CBG from organic effluents, such as spent wash or sewage sludge, involves anaerobic digestion, followed by purification and compression. This process yields a high-quality fuel that can be used to power boilers, generators, or Combined Heat and Power (CHP) units.

Some of the key benefits of using CBG in captive industrial applications include:

- Reduced energy costs: CBG can be produced at a lower cost than traditional fossil fuels, reducing energy costs for industries.
- Increased energy independence: CBG production can be done on-site, reducing reliance on grid power and enhancing energy security.
- Minimized environmental impact: CBG production from organic effluents reduces greenhouse gas emissions and minimizes waste disposal costs.

- Improved energy efficiency: CBG can be used to power CHP systems, achieving high efficiency and reducing energy losses.

A sugar mill, for example, can use CBG to power its operations, reducing its energy costs and minimizing its environmental footprint. The CBG production process involves the anaerobic digestion of press mud, followed by purification and compression. The resulting CBG can be used to power boilers, generators, or CHP units, reducing the sugar mill's reliance on fossil fuels and lowering its energy costs. Additionally, the digestate produced during the CBG production process can be used as a nutrient-rich fertilizer, reducing the sugar mill's waste disposal costs and providing an additional revenue stream.

The use of CBG in captive industrial applications also offers a range of environmental benefits, including:

- Reduced greenhouse gas emissions: CBG production from organic effluents reduces methane emissions, which have a global warming potential 21 times higher than carbon dioxide.
- Minimized air pollution: CBG combustion produces fewer air pollutants, such as particulate matter and nitrogen oxides, than traditional fossil fuels.
- Improved water quality: CBG production from sewage sludge reduces the amount of organic matter in wastewater, improving water quality and reducing the environmental impact of industrial operations.
- Reduced waste disposal costs: CBG production from organic effluents reduces waste disposal costs and minimizes the environmental impact of industrial operations.

In terms of cost reduction benefits, the use of CBG in captive industrial applications can offer significant savings, including:

- Reduced energy costs: CBG can be produced at a lower cost than traditional fossil fuels, reducing energy costs for industries.
- Reduced waste disposal costs: CBG production from organic effluents reduces waste disposal costs and minimizes the environmental impact of industrial operations.
- Revenue generation: The digestate produced during the CBG production process can be sold as a nutrient-rich fertilizer, providing an additional revenue stream for industries.
- Government incentives: The use of CBG in captive industrial applications may be eligible for government incentives, such as tax credits or subsidies, which can help to reduce the cost of CBG production and increase its adoption.

Growth drivers of CBG in India:

Growth drivers	Details
Push towards greener fuel to reduce imports and renewable targets / green targets	• India is committed to increasing the share of renewable energy in its overall energy consumption to reduce its dependence on imported natural gas, which currently accounts for approximately 50% of its total consumption. • The government aims to mitigate the risks associated with volatile import prices and strive for self-reliance in the energy sector. In this context, CBG is poised to play a vital role in achieving this objective • The government has introduced a phase-wise plan to promote CBG production and utilization. The CBG Obligation will become mandatory from FY 2025-26, starting at 1% of total CNG/PNG consumption, and will increase to 5% by 2028-29, replacing the current voluntary system
Strong policy push and regulatory compliance for the industries	• The growth of CBG in India is driven by a combination of factors, including government support through favorable policies and schemes like SATAT and Gobardhan, as well as the country's existing and expanding natural gas pipeline infrastructure. • Stringent regulations on effluent discharge, such as those enforced by the Central Pollution Control Board (CPCB), drive industries to adopt CBG production, reducing greenhouse gas emissions and aligning with India's net-zero targets.
Abundant feedstock availability	• India's vast supply of agricultural waste, industrial effluents, and organic residues (e.g., sugarcane press mud, distillery spent wash) provides a low-cost, reliable feedstock for CBG production, particularly for effluent-heavy industries. • As per IEA, India has tapped less than 1% of its total potential for (CBG), indicating a vast and largely untapped opportunity for growth and development in the CBG sector
Effluent treatment and Waste valorization	• Effluent-heavy industries adopting CBG can generate carbon credits by reducing methane emissions from untreated waste and replacing fossil fuels. These credits provide additional revenue streams, particularly for oil and gas companies and distilleries aiming to offset emissions. This creates a new income source while promoting sustainability. • CBG production from effluents turns waste management liabilities into revenue streams for industries like oil and gas, distilleries, and food processing. Converting effluents into CBG reduces disposal costs and generates energy or fuel for on-site use or sale, creating a win-win situation. This approach also helps minimize environmental impact.

Source: Crisil Intelligence

Key challenges of CBG in India:

Key challenges	Details
Limited offtake	• The current procurement model for Compressed Biogas (CBG) by oil marketing companies is on a "best endeavour" basis, which lacks a guaranteed offtake, leaving plant owners vulnerable to unsold inventory risks. • Despite initiatives like SATAT and the CBG-CGD synchronisation scheme, the implementation remains limited, with companies mostly selling biogas through their own retail outlets to capture maximum value. This creates uncertainty for CBG producers.
Unregulated biomass supply chain	• The profitability and effectiveness of a CBG facility rely heavily on the consistent availability of high-quality raw materials. However, the limited window of 30-40 days to gather agricultural feedstock and the volatility of feedstock prices pose significant challenges to maintaining the plant's financial sustainability.
Limited procurement of CBG byproduct	• The production CBG also yields Fermented Organic Manure (FOM), a valuable byproduct that can be sold as organic fertilizer, providing a supplementary revenue stream. However, CBG producers face challenges in meeting government quality standards for FOM, such as moisture content and pH levels. • Furthermore, demand for FOM is hindered by the availability of subsidized chemical fertilizers and limited farmer awareness, making it difficult for producers to capitalize on this additional revenue stream.
Lack of CNG consumers near to source, specifically rural areas	• The adoption of CBG in rural areas, near the source of generation, is hindered by a key challenge: limited demand. Unlike urban areas, rural areas have lower population density and fewer CNG vehicles, resulting in insufficient demand for CNG as a transportation fuel. • This limited demand can make CBG plants in rural areas economically unviable, as production and distribution costs may not be covered by revenue from sales, posing a significant barrier to their sustainability.

Source: Crisil Intelligence

Overview of government policies for biofuels, Waste to energy programs and CBG

National Biofuel Policy 2018

National Biofuel Policy was implemented in 2018 by the Government of India. The Policy aims to increase biofuel usage in different sectors of the economy and make a transition towards a cleaner fuel during the coming decade. Further, the Government of India aims to utilize, develop and promote domestic feedstock for the production of biofuels to increasingly substitute fossil fuels while contributing to national energy security, climate change mitigation, strengthening of foreign exchange reserves, and creating new employment opportunities in a sustainable way, particularly through building a circular economy in the most rural parts of India.

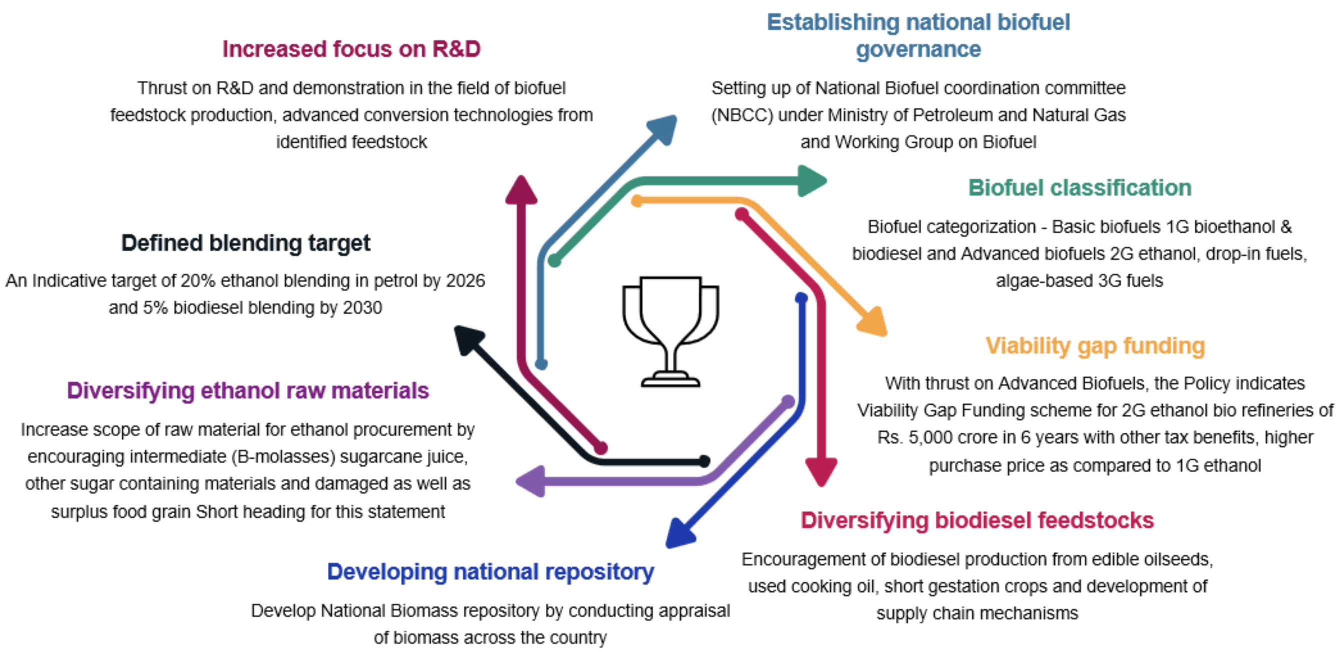
The Goal of the Policy is to increase availability of biofuels in the market and increasing their blending percentage. An indicative target of 20% blending of ethanol in petrol and 5% blending of biodiesel in diesel is proposed by 2030, which was amended and preponed to 2025 under the 2022 amendments. The National Policy on Biofuels 2018 was notified by the Ministry of Petroleum and Natural Gas on June 4, 2018, superseding the National Policy on Biofuels, promulgated via the Ministry of New & Renewable Energy in 2009.

The amended policy allows for more feedstock to be considered for biofuel production and promotes the production of biofuels in the country under the Make in India initiative by units located in special economic zones and export oriented units and also reduced Goods & Service Tax (GST) on ethanol meant for EBP Programme from 18% to 5%

The policy categorized biofuels as:

- Basic biofuels, i.e., first generation bioethanol and biodiesel
- Advanced biofuels, i.e., second generation (2G) ethanol, municipal solid waste, drop-in fuels, third generation biofuels, bio-CNG, etc., to enable extension of appropriate financial and fiscal incentives under each category.

Key salient features of National Biofuel policy



Source: Crisil Intelligence, Ministry of Petroleum and Natural Gas (MoPNG)

The following are the main amendments approved to the National Policy on Biofuels:

- to allow more feedstocks for production of biofuels,
- to advance the ethanol blending target of 20% blending of ethanol in petrol to ESY 2025-26 from 2030,
- to promote the production of biofuels in the country, under the Make in India program, by units located in
- Special Economic Zones (SEZ)/ Export Oriented Units (EoUs),
- to add new members to the NBCC.
- to grant permission for export of biofuels in specific cases, and
- to delete/amend certain phrases in the Policy in line with decisions taken during the meetings of National

- Biofuel Coordination Committee.

Government hopes that with this amendment the industry will pave the way for Make in India drive thereby leading to reduction in import of petroleum products by generation of more and more biofuels. Since many more feedstocks are being allowed for production of biofuels, this will promote the Atmanirbhar Bharat and give an impetus to the government's vision of India becoming 'energy independent' by 2047. The amended policy expands the scope of raw material for ethanol production by allowing use of sugarcane juice, sugar containing materials like sugar beet, sweet sorghum, starch containing materials like corn, cassava, damaged food grains like wheat, broken rice, rotten potatoes, unfit for human consumption for ethanol production.

The Policy allows use of surplus food grains for production of ethanol for blending with petrol with the approval of National Biofuel Coordination Committee. With a thrust on Advanced Biofuels, the Policy indicates a viability gap funding scheme for 2G ethanol Bio refineries of Rs. 50 billion in 6 years in addition to additional tax incentives, higher purchase price as compared to 1G biofuels. The pricing mechanism for ethanol from different feedstocks has also been reworked. (Indian Renewable Energy Development Agency) IREDA is also joining in the effort and will provide support through financing initiatives. The main objective of the scheme is to provide financial assistance for setting up of new Distillery or expansion of existing Distillery for manufacturing of Ethanol, which in turn promote blending of biofuel in petroleum for reduction in pollution levels and addressing the issues of sugar demand.

Sustainable Alternative Towards Affordable Transportation (SATAT) scheme

The SATAT initiative, launched in 2018, aims to promote the production of Compressed Biogas (CBG) from biomass waste, enhancing energy security and sustainability. The program focuses on extracting value from various waste streams, including municipal solid waste, agricultural residue, and sugar industry byproducts, by encouraging entrepreneurs to set up CBG production plants.

The multi-pronged objectives of the scheme as detailed by the Ministry of Petroleum and Natural Gas are as follows:

- Provide economical alternatives to crude oil and aid the development of vehicle-users, farmers, and entrepreneurs.
- Consequently, enhance farmer's income, entrepreneurial spirit, and employment.
- Reduce urban air pollution caused by stubble burning and vehicular carbon emission.
- Repurpose the 'Fermented Organic Manure' produced in biogas plants for organic farming.
- Transform municipal waste management
- Reduce India's dependence on crude oil imports, uplift domestic production, and move towards energy self-sufficiency.
- Make advancements in achieving India's energy goals by prioritising renewable and clean fuel.

These plants convert biomass into CBG, which is then sold to fuel stations. To ensure the viability of these plants, oil and gas companies have committed to purchasing CBG at a minimum price for the first 10 years, providing a stable market and revenue stream. The initiative aims to reduce greenhouse gas emissions, decrease fossil fuel dependency, and create rural jobs. As of July 2025, 1,094 Letters of Intent have been issued, 108 CBG plants are operational, and 13,379 tons of CBG were sold in FY25-26. The SATAT scheme invites individuals and corporations to set up CBG plants, produce, and supply CBG to Oil Marketing Companies.

Under SATAT scheme various new initiatives have been launched in FY25

- The Ministry has issued guidelines for synchronization of CBG with CNG in CGD Network
    - Since 2021, the MoPNG has issued a series of policy guidelines for the synchronisation of CBG with CGD network requirements. GAIL has been mandated to implement this scheme, ensuring the supply of CBG mixed with domestic gas at a Uniform Base Price (UBP) to CGD entities for use in the CNG and residential PNG segments of CGD networks.
    - CBG, compressed to 200-250 bars, can be supplied via cascades for sale at retail outlets or injected into distribution pipelines at pressures specified by the respective CGD entities. To participate in the scheme, CBG producers must sign an agreement with GAIL to sell their CBG and enter a tripartite agreement with GAIL and the local CGD entity for the supply of CBG.
    - GAIL's model has offtakes through both retail outlets and pipeline injection, but CBG-CGD synchronisation has been achieved in only a few cities. On-ground implementation remains limited, with companies primarily selling biogas through their own retail outlets to maximise value generation.
- A scheme for the development of pipeline infrastructure (DPI) for injection of CBG into the City Gas Distribution (CGD) network has been launched to provide financial support for extending pipeline connectivity from CBG plant to the city gas distribution grid.
- Online portal for receiving application under DPI Scheme has been activated w.e.f. 1st September, 2024.
- Ministry has also issued detailed guidelines for procurement of Biomass Aggregation Machinery (BAM) on 2nd February 2024. The Scheme envisages financial support to the CBG producers for procuring Biomass Aggregation Machineries.
- In a significant step to promote the adoption of CBG in India, the National Biofuels Coordination Committee (NBCC) approved the phase-wise mandatory selling of CBG with CNG and PNG in the city gas distribution sector in November 2023
    - Government has announced phase wise mandatory selling of CBG in CNG (T) and PNG (D) segment of CGD network to promote the production and utilization of CBG.CBG Obligation (CBO) is presently voluntary till FY 2024-2025 and mandatory selling obligation would start from FY 2025-26.

Target year	Blending % in CNG/PNG
2025-26	1%
2026-27	3%
2027-28	4%
2028-29 onwards	5%

Waste to energy Programme

The Waste to Energy Programme, launched on November 2, 2022, under the National Bioenergy Programme, aims to promote the development of projects that convert waste into bio-CNG. The program provides Central Financial Assistance (CFA) to project developers who successfully establish waste-to-energy plants, while implementing agencies are eligible for service charges. The primary objective is to support the setup of waste-to-energy projects that generate biogas, bio-CNG, power, or syngas from urban, industrial, and agricultural waste, thereby promoting a sustainable and environmentally friendly solution for waste management.

Salient features of bio-CNG:

- The programme provides CFA to project developers and service charges to implementing/inspection agencies in respect of successful commissioning of Waste to Energy plants for generation of Biogas, Bio-CNG/enriched Biogas/Compressed Biogas, Power/ generation of producer or syngas.
- Financial assistance available under the Programme for setting up Waste to Energy plant is as follows:
    - Rs 4.0 Cr per 4800 kg/day (for BioCNG generation from new biogas plant), Rs 3.0 Cr per 4800 kg/day (for BioCNG generation from existing Biogas plant*) and Maximum CFA of Rs. 10.0 Cr/project for both cases
    - Power (based on Biogas): Rs 0.75 Cr/MW (for power generation from new biogas plant), Rs 0.5 Cr /MW (for power generation from existing Biogas plant) and Maximum CFA of Rs. 5.0 Cr/project for both cases
    - Power based on bio & agro-industrial waste (other than MSW through incineration process): Rs 0.4 Cr/MW (maximum CFA of Rs. 5.0 Cr/project)
    - Biomass Gasifier for electricity/thermal applications: Rs. 2,500 per kWe with dual fuel engines for electrical application, Rs. 15,000 per kWe with 100% gas engines for electrical application and Rs. 2 lakh per 300 kWth for thermal applications.
- The eligible CFA would be 20% higher for plants set up in Special Category States/UTs (NE Region, Sikkim, Himachal Pradesh, Uttarakhand, Jammu & Kashmir, Ladakh, Lakshadweep and Andaman & Nicobar Islands), and Biomethanation plants set up in registered Gaushala/Shelter.
- SCADA System/remote monitoring system has been mandated for WTE projects except in the case of Biomass Gasifiers.
- The amount of CFA to be disbursed for the WTE projects will be calculated based on the performance the projects.

- Provision of providing advance CFA for bank financed BioCNG projects under SATAT Initiative has been included.
- IREDA has been designated as the Implementing Agency.

The Ministry of New and Renewable Energy (MNRE) has issued revised guidelines for the Waste-to-Energy (WtE) Programme under the National Bioenergy Programme. These revisions aim to foster a more efficient, transparent, and performance-oriented ecosystem for Bio Waste to Energy deployment in India. By simplifying procedures, expediting financial assistance, and aligning support with plant performance, the updated guidelines are designed to significantly enhance the ease of doing business for private as well as public sector.

A key highlight of the revised guidelines is the improved system for releasing CFA. Considering the challenges faced by the developers to achieve 80% generation, flexible provisions have been made in the Scheme for release of CFA based on plant performance. Previously, companies had to wait until the entire Waste-to-Energy project attains 80% generation to receive support. Moreover, as per the revised guidelines, there is a provision to release the CFA in two stages. Based on performance of the projects, 50% of total CFA will be released after obtaining the Consent to Operate certificate from State Pollution Control Board, against the bank guarantee, while the balance CFA would be released after achieving the 80% of the rated capacity or the maximum CFA eligible capacity, whichever is lesser.

In notably, even if a plant does not achieve 80% generation for above both conditions during performance inspection, provision is made for pro-rata-based disbursement based on the percentage output. However, no CFA will be given if the PLF is <50%.

Details of BioCNG projects supported under Waste to Energy Programme

Status	No. of projects	Capacity (in TPD)
Commissioned	66	387194
Under Installation	29	236793
Total	**95**	**623987**

Source: Ministry of new and renewable energy (MNRE), Crisil Intelligence

Select case studies of bio gas extraction plant operating in India

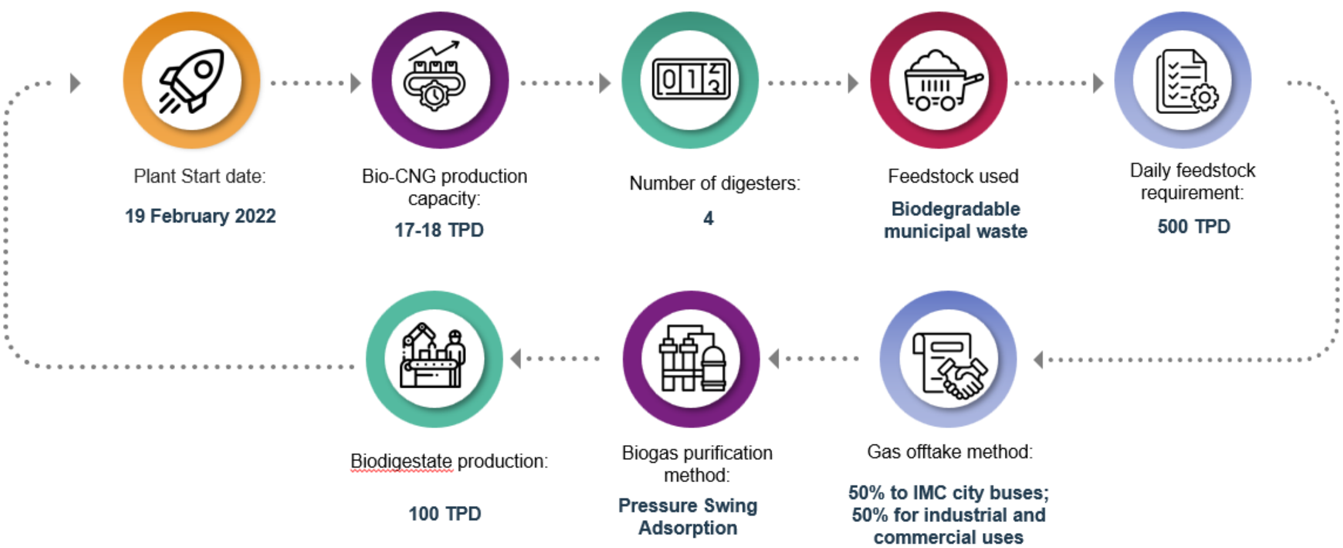
Indore Bio CNG plant, EverEnviro Resource Management Private Limited

The Indore plant is a notable public-private partnership (PPP) between the Indore Municipal Corporation (IMC) and EverEnviro, which is successfully converting municipal waste into bio-CNG. With a project cost of Rs 1500 million, fully funded by the empanelled agency, the IMC provides 90% segregated waste to the plant, and in return, receives an annual royalty of Rs 25 million from EverEnviro, making it a mutually beneficial collaboration

As per the agreement between the IMC and EverEnviro, 50% of the bio-CNG produced is reserved for powering Indore's city buses at a discounted rate of Rs 5 per kilo less than the market rate of CNG. This arrangement supports approximately 430 buses, covering 77,400 Km per day. The remaining bio-CNG is sold to Avantika Gas Ltd, the local CNG and PNG supplier. Additionally, the IMC has earned around Rs 90 million in the first two years through carbon credit trading, generating significant revenue for the municipality

The plant's success is attributed to Indore's impressive waste segregation at source, with the IMC employing 600 vehicles for waste collection. The cost of production of bio-CNG is as low as Rs 35-40 per kilogram. The plant generates 20 per cent of its 13,000 units of power requirement from rooftop solar, while the rest is taken from the power grid. Additionally, the company sells their manure at a net rate of Rs 1,800/tonne. The Indore plant's innovative approach to waste management has shown that turning trash into treasure is possible, and it's a model that could inspire other cities to follow suit.

Key information of the project



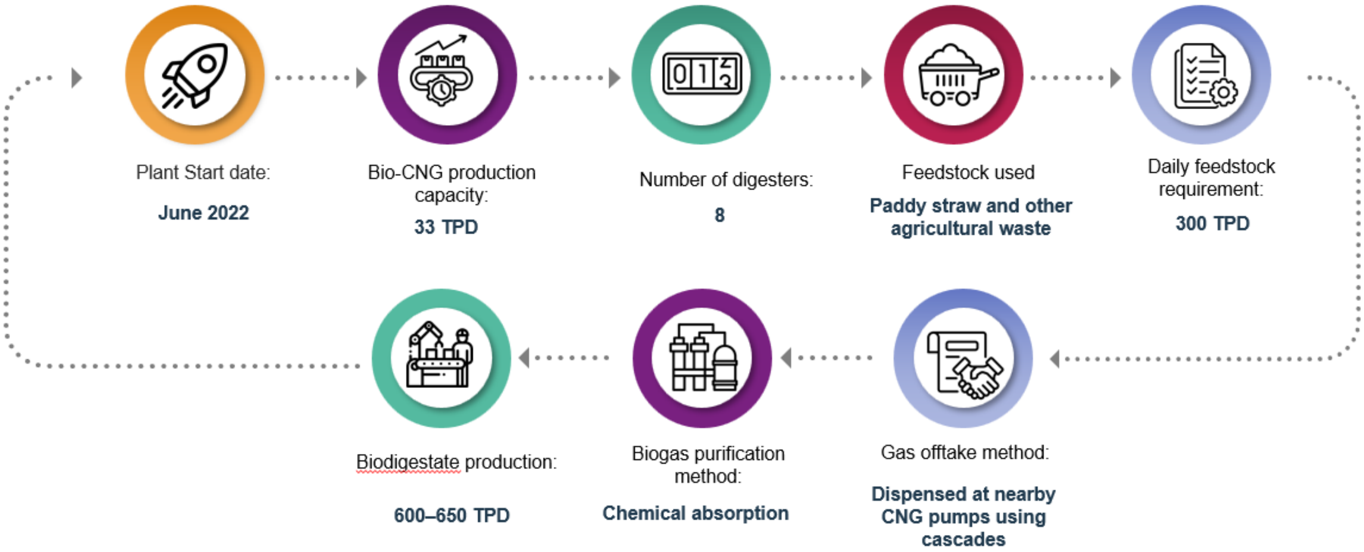
Source: CSE India, Crisil Intelligence

Sangrur Bio-CNG Plant, Punjab by Verbio AG

Located in Sangrur, Punjab, India, the Verbio CBG Plant has commenced operations in 2022. With a production capacity of 33 tons per day of biomethane, this plant is playing a significant role in harnessing the potential of agricultural waste to produce clean energy. Utilizing paddy straw and other agricultural residues as feedstock, the plant requires approximately 300 tons of feedstock daily to operate at full capacity. The gas produced is used as a vehicular fuel, distributed through cascades.

The project has brought significant benefits, including reducing air pollution by consuming 100,000 tonnes of agricultural residues per year, thereby mitigating air pollution caused by stubble burning in a radius of at least 10-15 km. The entire stubble collection process is conducted at no cost to farmers, resulting in considerable cost savings for them. The project has created a self-owned and operated agro-residue supply chain, which has generated jobs and spurred economic development in rural communities. Additionally, the introduction of bio-manure in nearby farms has offered a prospect of improving soil health, further benefiting farmers. The project has also led to the development of a climate-friendly and cost-effective fuel, which is now dispensed at all nearby CNG pumps for automotive consumers. Overall, the project has created a positive impact on the environment, farmers, and the community.

Key information of the project



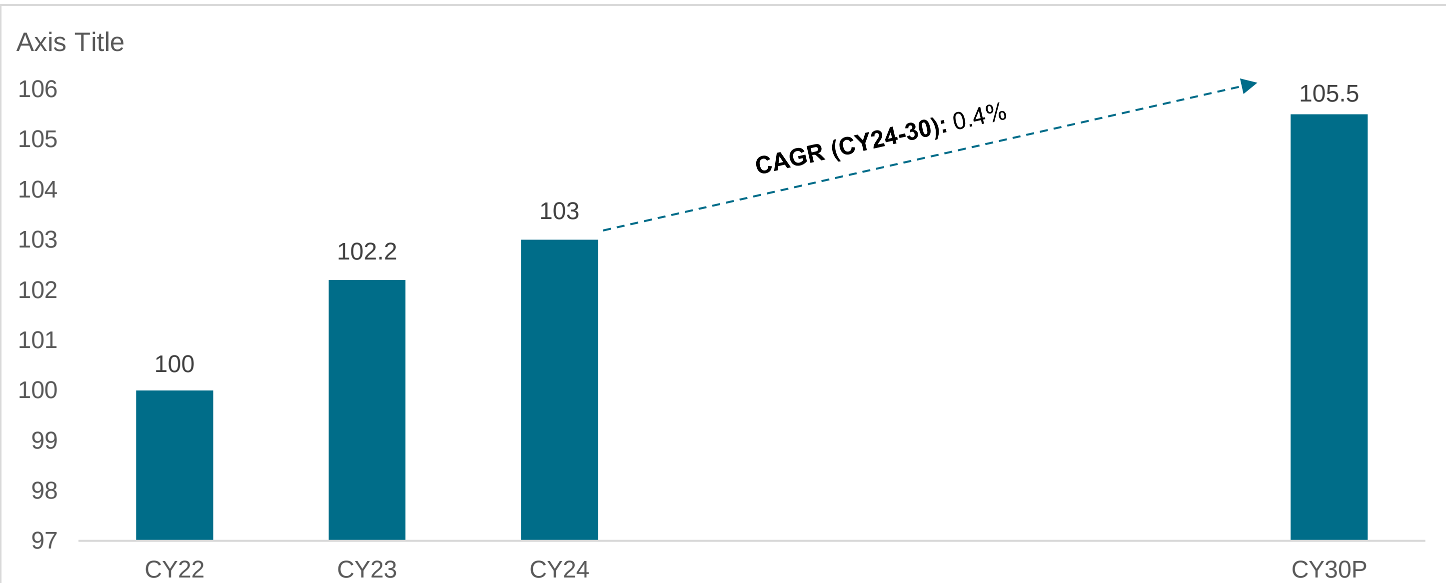
Source: CSE India, Crisil Intelligence

7.Overview of the landscape of Oil & Gas industry and importance of Wastewater treatment solution in the industry

Global Oil Demand and Supply trends:

Global oil demand is expected to increase by 2.5 million barrels per day (mb/d) between 2024 and 2030, reaching 105.5 mb/d by the end of the decade. However, this growth is expected to slow down, the main reasons for this slowdown are sluggish economic growth and the increasing substitution of oil with alternative energy sources in the transport and power generation sectors. From 2026 onwards, the majority of oil demand growth will come from petrochemicals, driven by the rising supply of Natural Gas Liquids (NGLs). As a result, demand for oil from combustible fossil fuels is expected to plateau at around 84 mb/d, leading to a peak in CO2 emissions from oil use by 2027.

Global Oil demand:



Note: P: Projected

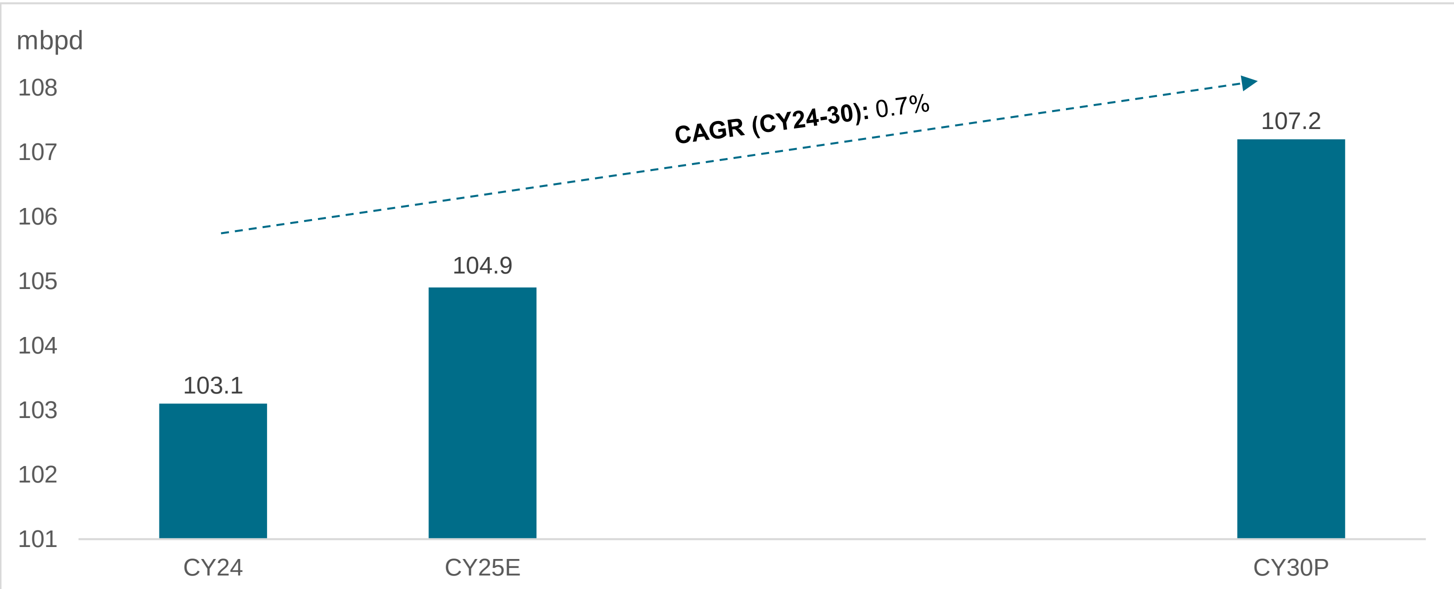
Source: IEA Oil report 2025, Crisil Intelligence

IEA forecasts a gradual and moderate increase in global crude oil supply, with an expected rise of 4-5 million barrels per day (mbpd) between 2025 and 2030. In 2025, crude oil supply is expected to increase by 1-2% driven by higher output from non-OPEC (Organization of the Petroleum Exporting Countries) nations. The OPEC+ decision to reverse voluntary cuts, starting from the second quarter of 2025, is also expected to contribute marginally to supply growth. This follows a modest increase in global oil supply of 0-1 mbpd in 2024, led by higher output from non-OPEC members, particularly North American countries such as the US and Mexico, as well as a slight easing of supply by OPEC+ members who are expected to ease voluntary cuts.

In the long term, production is expected to increase in countries such as Libya and Nigeria once their geopolitical situations stabilize, with Libya having already increased production to 1.3 mbpd in 2023 from 0.4 mbpd in 2016. Other countries like Angola, Kuwait, and the UAE are expected to add 0.3-0.4 mbpd in the next 4-5 years, while Brazil's production is set to increase by 0.2-0.4 mbpd between 2025 and 2029 due to the ramp-up of existing and new pre-salt FPSOs (Floating Production, Storage and Offloading Units)

The US, which accounted for 21% of global supply with a production of 20.1 mbpd in 2024, is expected to see a slowdown in production growth due to lower crude oil prices, adding only 1-2 mbpd in the next 4-5 years. Despite lower prices and waning demand, producers have continued to maintain or increase production to capture market share, with most pumping output above breakeven cost. This trend is expected to continue, with production growth becoming slower during the forecast period.

Global oil supply outlook



Note: P: Projected

Source: IEA Oil report 2025, Crisil Intelligence

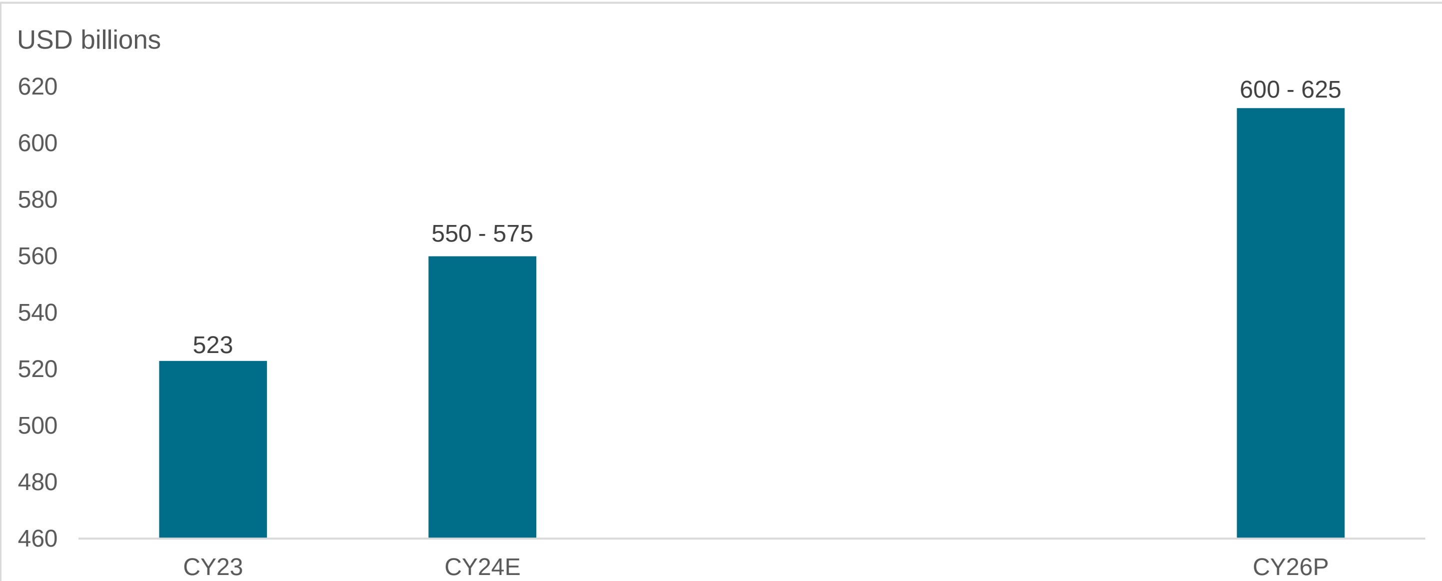
Capital investment in global upstream oil and gas sector

The Exploration and Production (E&P) industry is expected to witness an increase in investments, with overall upstream investments projected to rise to ~USD 550-575 billion in 2024, up from USD 523 billion in 2023. This growth is expected to be driven by a transition from new field exploration to maintenance of existing fields, as well as the impact of the overall energy transition theme and crude oil prices. The E&P industry is heavily dependent on the energy security requirements of countries, and any fluctuation in demand for crude oil can have a significant impact on the industry.

In recent years, the growth in crude oil demand and subsequent increase in oil prices have provided momentum to drilling operations. However, with stable crude oil prices and improvement in spending by oil and gas exploration companies, the profitability of oilfield equipment companies has also seen an increase. Oilfield equipment and services form the core of the drilling industry, and investments in these areas account for the largest capital expenditure by E&P players. As upstream players try to curtail their operating costs by optimizing usage of oilfield services and re-negotiating contract prices, oilfield equipment providers may see an erosion in their profitability.

Crude oil prices are a key factor driving near-term investments in E&P. Crisil Research expects crude oil prices to remain steady in the USD 80-85 per barrel range in 2024, with the decision of the OPEC+ to scale back voluntary production cuts leading to companies re-examining their overall investment strategy and affecting rig utilization levels. In 2023, crude oil prices witnessed a steady decline of 18% on-year, supported by easing of geopolitical tensions and recessionary pressures globally. However, the decision of the OPEC+ in April 2023 to cut 1.16 mbpd of output, coupled with summer demand from the US, resulted in overall prices surging in H2 2023.

Global upstream investments



Source: Crisil Intelligence

Looking ahead, moderating demand coupled with steady global supply are expected to keep crude oil prices range-bound in 2024. Crisil Intelligence expects overall crude oil prices to average around USD 83-88 per barrel in 2024, although the recent issues pertaining to shipping and the OPEC+ production strategy will be key monitorables driving prices in the current year.

Global E&P investment has been on a downward trend since 2015, owing to supply abundance and a cautious approach adopted by players. However, the trend witnessed a reversal in 2022, with elevated oil prices supporting growth in investments. This situation is expected to continue in 2024 and 2025, with steady investment in drilling activities, although players may remain cautious about their capex and postpone any significant and long-term investment until demand is clearly visible. As a result, Crisil Intelligence expects global E&P spending to increase 5-10% on-year in 2024, with overall upstream investments projected to rise to ~USD 600-625 billion over the next couple of years.

Water resource management in the upstream oil and gas industry

Water usage across upstream Oil and Gas industry

Water is a critical resource in the upstream oil and gas industry, used across various stages of exploration, drilling, and production. Its usage varies depending on the extraction method, geological conditions, and whether operations are onshore or offshore. Below are the primary uses of water in O&G extraction:

Uses case of water	Details
Drilling	• Water is used to create drilling mud, a mixture of water, clay, and chemicals that lubricates the drill bit, stabilizes the wellbore, and carries rock cuttings to the surface. • Approximately 1,000–10,000 Cubic meters of water may be required per well, depending on depth and complexity (e.g., vertical vs. horizontal wells). • In offshore drilling, seawater is often used, while onshore operations may rely on freshwater, brackish water, or treated produced water.
Hydraulic Fracturing (Fracking)	• Fracking involves injecting large volumes of water mixed with sand and chemicals at high pressure to fracture shale formations and release hydrocarbons. • A single unconventional well can require 8,000–100,000 Cubic meters of water, with shale plays like the Permian Basin consuming significant volumes. • Freshwater is preferred, but due to scarcity, operators increasingly use brackish or recycled water.
Enhanced Oil Recovery (EOR)	• Waterflooding is a common EOR technique where water is injected into reservoirs to maintain pressure and displace oil toward production wells. • In offshore operations, seawater is typically used, while onshore operations may use treated produced water or other sources like rivers or groundwater. • This process can account for a significant portion of water use, especially in mature fields where water cuts (the proportion of water in produced fluids) increase.
Other Uses	• Water is used for cooling equipment, dust control on access roads, and other operational needs. • Chemical additives (e.g., corrosion inhibitors, biocides) are often mixed with water to optimize extraction processes.

Type of wastewater generated in Oil and Gas extraction process

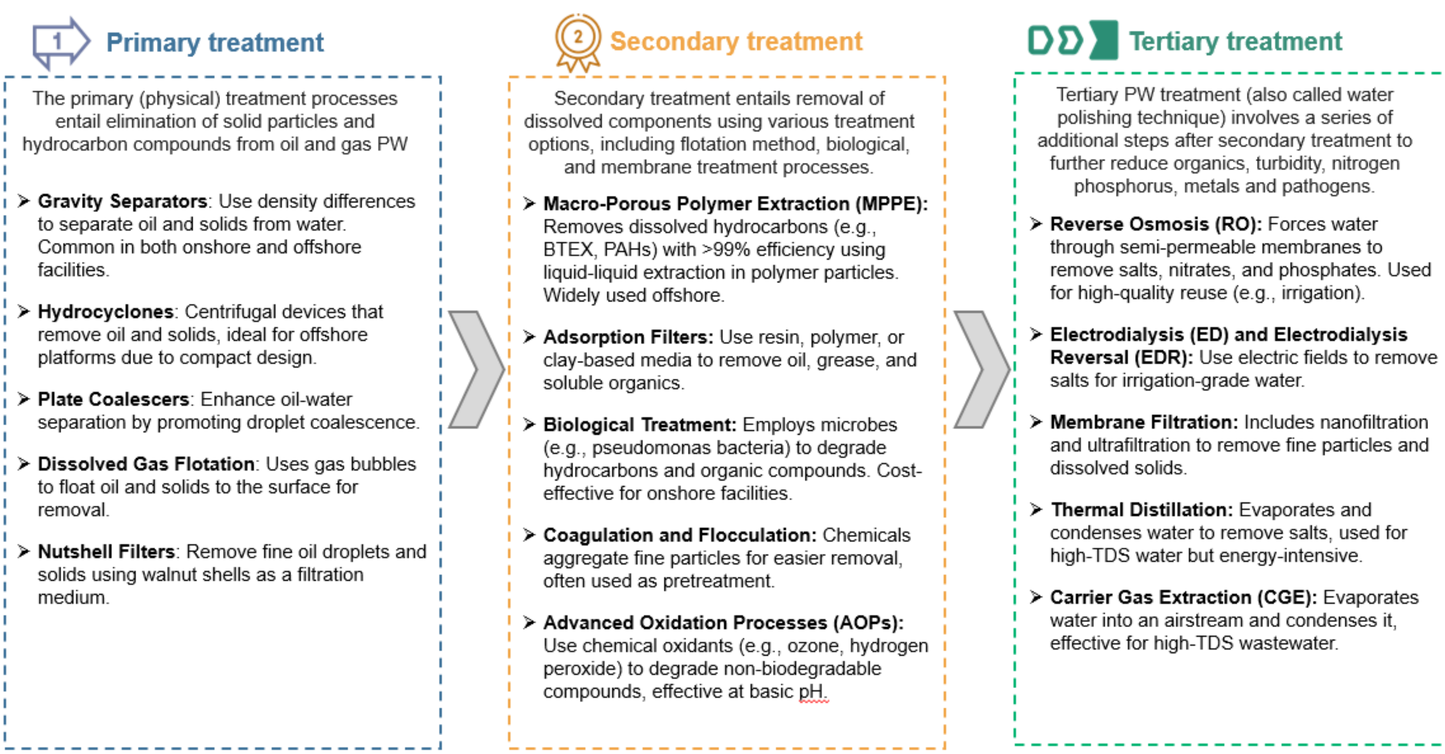
The oil and gas industry generates a substantial amount of wastewater, with Produced Water (PW) being the largest and most complex stream. This wastewater is a multifaceted blend of various components, comprising formation water, injection water, condensed water, and residual treatment chemicals.

- **Produced water:** the fluid (brine) brought up from the hydrocarbon-bearing strata during the extraction of crude oil and natural gas, and includes, where present, formation water, injection water, and any chemicals added downhole or during the oil/water separation process. Notably, it has a high concentration of Total Dissolved Solids (TDS), often ranging from 2 to 6 times that of seawater, with levels reaching up to 200,000 mg/L. Additionally, produced water contains a cocktail of contaminants, including hydrocarbons, heavy metals such as zinc, lead, manganese, iron, and barium, as well as Naturally Occurring Radioactive Materials (NORM) and chemical additives like surfactants and biocides. The composition of produced water can vary greatly depending on factors such as well age, location, and geology, with older wells tend to produce higher water cuts, sometimes as high as 8 barrels of water per barrel of oil, further complicating its management and treatment. Based on the type of oil and gas extraction method, produced water can be further broken down into the following components:

  - **Flowback:** the produced water generated in the initial period after hydraulic fracturing prior to production (i.e., fracturing fluid, injection water, any chemicals added downhole, and varying amounts of formation water). After the hydraulic fracturing procedure is completed and pressure is released, the direction of fluid flow reverses, and the fluid flows up through the wellbore to the surface. The water that returns to the surface is commonly referred to as “flowback.”
  - **Long-term produced water:** Produced water generated during the production phase of the well after the initial flowback process which can include increasing amounts of formation water. Long-term produced water continues to be produced throughout the lifetime of the well.

- **Drilling wastewater:** The liquid waste stream separated from recovered drilling mud (fluid) and drill cuttings during the drilling process.
- **Produced sand:** The slurried particles used in hydraulic fracturing, the accumulated formation sands and scales particles generated during production. Produced sand also includes desander discharge from the produced water waste stream, as well as blowdown of the water phase from the produced water treatment system.

Wastewater treatment process and technologies used in Upstream oil and gas industry



Note: PW: Produced water, The list of technologies mentioned above is not an exhaustive list, but rather a selection of the most commonly used technologies for wastewater treatment
Source: Crisil Intelligence

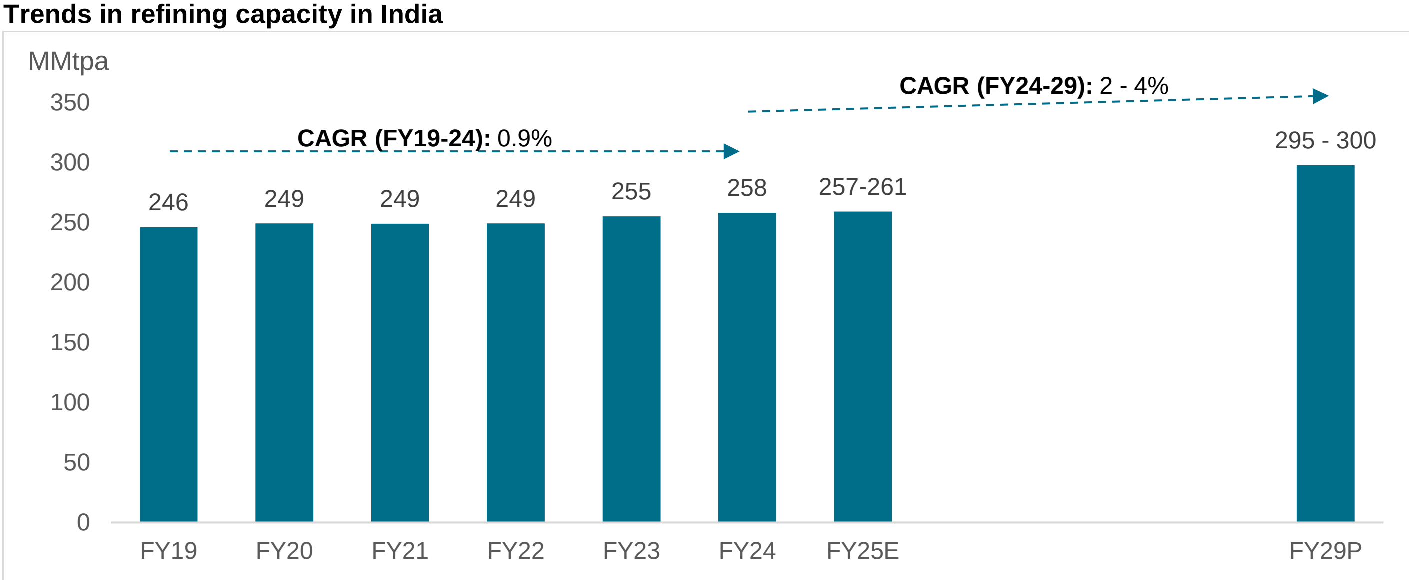
The treatment of wastewater generated during extraction involves various additional processes and technologies, which vary depending on the operations, locations, type of water, and regulatory standards. Chemical additives such as antiscalants and coagulants are used to prevent membrane fouling and enhance treatment efficiency, while energy recovery devices reduce energy costs in reverse osmosis and thermal processes by recovering pressure or heat. Mobile treatment units combine multiple technologies for flexible, on-site treatment, particularly in onshore fields, and must meet strict environmental compliance standards, such as the U.S. EPA's 40 CFR Part 435 for offshore discharge and state mandates for onshore reuse. Furthermore, advanced technologies like bioremediation, which uses proprietary bacteria to degrade hydrocarbons and pollutants, photoelectrocatalysis, which combines light and electricity to degrade organic pollutants, and digital twin technology, which optimizes treatment system design for sustainability and efficiency, are also being utilized to improve wastewater treatment and meet regulatory requirements.

Review of refining capacity in India

India's refining industry has built an enviable reputation as a key source of light and middle distillate supplies to global markets, in addition to meeting robust domestic demand growth. This assessment of oil demand and refining dynamics points to India being well placed to cement its position as a reliable international product supplier. Despite increased competition from Middle East Gulf export refineries, Crisil Intelligence expects domestic refinery capacity addition to a 2-4% CAGR versus ~0.9% CAGR during FY 2019 to 2024.

Indian refining capacity is currently assessed at close to 257 – 261 MM MMtpa (Million metric tonner per annum) and is projected to expand by 37-39 MMtpa by FY29 . Growth will be dominated by public sector undertaking (PSU) refineries, as they prepare for continued rising domestic demand and an increased share of petrochemical production. By contrast, we see little prospect for private refineries to substantially expand their refining operations over this time frame. However, public and private refinery operators will both continue to expand existing crude processing capacity through the debottlenecking of existing facilities – likely in tandem with the addition of new, or increased hydrotreating capacity, petrochemical unit additions or residue upgrading.

Trends in refining capacity in India



Notes: P: Projected, E: Estimated
Source: Crisil Intelligence

Water resource management in oil refineries

Oil refineries transform crude oil into valuable products such as gasoline, diesel, jet fuel, and petrochemical feedstocks, relying heavily on water for various processes. These operations generate significant volumes of wastewater containing complex contaminants, including hydrocarbons, salts, and chemical additives. Effective wastewater treatment is essential to comply with stringent environmental regulations, protect ecosystems, enable water reuse, and maintain operational efficiency.

Water is a critical resource in oil refineries, with consumption ranging from 0.5 to 1.5 barrels of water per barrel of crude oil processed, depending on the refinery's complexity (e.g., hydro skimming vs. deep conversion). Key uses include:

- **Cooling Water:** The largest consumer of water, accounting for 60-80% of total usage, is used in cooling towers to dissipate heat from process units, operating in closed-loop systems to minimize freshwater consumption, but still generating wastewater through evaporation and blowdown.
- **Steam Generation:** High-purity water is required for boiler feedwater to produce steam for various processes, including distillation, steam stripping, and catalytic cracking, necessitating demineralized water to prevent scaling and corrosion.
- **Process Water:** A significant amount of water is used in desalting to remove impurities from crude oil, with a consumption rate of 0.1-0.2 barrels per barrel of crude, and is also employed in hydrotreating, alkylation, and caustic washing to remove sulfur and acidic compounds.
- **Other Uses:** Water is utilized for various auxiliary purposes, including firefighting systems, equipment cleaning, laboratory operations, sanitation, and diluting chemicals such as caustic soda for process units, highlighting the diverse range of water applications in the industry.

The treatment of wastewater in the oil refining industry is a critical process that requires careful consideration of several factors, including the variability of wastewater composition, high Total Dissolved Solids (TDS) and salt content, energy intensity, and secondary waste generation. Refineries must integrate reuse systems to treat wastewater for reuse in cooling towers, steam generation, or process water, reducing freshwater demand and minimizing the environmental impact of their operations. However, this process is complicated by the high variability of wastewater composition, which varies with crude oil type and refinery processes, requiring flexible treatment systems.

The importance of wastewater treatment in the oil refining industry cannot be overstated. Untreated wastewater can contaminate water bodies, harm aquatic life, and disrupt ecosystems, violating regulations such as the U.S. EPA's 40 CFR Part 419 (Petroleum Refining Point Source Category) or the EU Water Framework Directive. Refineries must meet strict discharge standards, including oil and grease <10 mg/L, COD <100-200 mg/L, and neutral pH (6-9), to avoid fines, legal action, and reputational damage. Furthermore, proper treatment of wastewater enables reuse of water for cooling, steam generation, or process water, reducing freshwater demand, especially in water-scarce regions, and minimizing disposal costs and environmental impact.

Effective wastewater management is essential for refineries to achieve operational efficiency, improve profitability, and boost their sustainability credentials. Treated water prevents equipment corrosion and scaling, reducing maintenance costs and downtime, while also mitigating risks of operational shutdowns due to regulatory violations. Moreover, proper treatment of wastewater protects public health and safety by preventing the release of contaminants like heavy metals and polycyclic aromatic hydrocarbons (PAHs) into the environment. Players in the wastewater treatment segment, such as Veolia, SUEZ, and Xylem, play a critical role in helping refineries achieve their internal sustainability targets, comply with regulations, and improve their environmental performance.

The treatment of wastewater is a critical component of the circular economy, enabling refineries to reduce their water footprint, minimize waste, and promote sustainable development. By adopting advanced wastewater treatment technologies and practices, refineries can reduce their environmental impact, improve their reputation, and contribute to a more sustainable future. As the oil refining industry continues to evolve, the importance of wastewater treatment will only continue to grow, driven by increasingly stringent regulations, growing public awareness of environmental issues, and the need for refineries to improve their sustainability performance and reduce their environmental footprint. As such, refineries prioritize wastewater treatment and work with specialized players in the segment to ensure that their operations are environmentally responsible, sustainable, and compliant with regulatory requirements.

Treatment technologies used in oil refineries

1 Primary treatment

Refinery wastewater treatment involves an oil/water separator where oil and water are separated, followed by a secondary separation step using a DAF or IAF unit.

- **Gravity Separators**: Large basins separate oil and solids by density, with wastewater flowing slowly to allow oil to rise and solids to settle. API separator is the most widely used gravity separator, Removes 90–95% of free oil and large solids.
- **Dissolved Air Flotation (DAF)**: Introduces air bubbles to float oil and solids, effectively removing 80-90% of emulsified oils and fine solids, often with the aid of coagulants like alum.
- **Nutshell Filters**: Nutshell Filters use walnut shells to remove fine oil droplets and solids, polishing effluent to <5 mg/L, often applied after API or DAF for desalting and process wastewater.

2 Secondary treatment

In secondary treatment, the goal is to remove dissolved organic compounds (e.g., phenols, BTEX), residual oil, and biodegradable pollutants to reduce COD and BOD

- **Biological treatment:** It uses technologies such as ASP and MBRs to break down organic compounds, including phenols and hydrocarbons, particularly effective for treating high-COD wastewater streams, like sour water and desalting wastewater.
- **Chemical Oxidation:** It uses Advanced Oxidation Processes (AOPs) with ozone, hydrogen peroxide, or UV light to degrade non-biodegradable compounds like PAHs and phenols, commonly used for spent caustic treatment
- **Coagulation and Flocculation:** Chemicals are used to aggregate fine particles, typically as a pretreatment step to improve the efficiency of biological or filtration processes.
- **Adsorption Filters:** Use resin, polymer, or clay-based media to remove oil, grease, and soluble organics.

Tertiary treatment

Polish wastewater to remove salts, heavy metals, ammonia, and trace contaminants for discharge or reuse (e.g., cooling tower makeup, boiler feedwater)

- **Membrane Filtration:** Uses technologies like Reverse Osmosis (RO), Nanofiltration (NF), and Ultrafiltration (UF) to remove contaminants, producing high-quality water for reuse. RO is effective for high-TDS streams, removing 95-99% of TDS and contaminants.
- **Ion Exchange:** Uses resin beds to remove specific ions like ammonia and heavy metals, achieving >95% removal. It's used for boiler feedwater preparation, meeting discharge standards, and polishing filtration and on and wastewater for reuse in steam generation.
- **Activated Carbon Adsorption:** uses granular or powdered carbon to remove residual organics, odors, and pollutants, typically as a final polishing step. It's often used after membrane filtration and is suitable for all wastewater streams for discharge or reuse..

Notes: The list of technologies mentioned above is not an exhaustive list, but rather a selection of the most commonly used technologies for wastewater treatment
Source: Crisil Intelligence

Sustainable and technological innovation in the industry

Current trends	Details
Water reuse for operations	• In upstream oil extraction, reusing produced and flowback water for hydraulic fracturing and enhanced oil recovery (EOR) can reduce freshwater demand by 20-40%, and also aids in injection during later stages when oil and gas pressure decreases. • In refineries, reusing treated wastewater, such as sour water and desalting wastewater, in cooling towers and boiler feedwater can decrease freshwater usage by 30-50%.
Carbon Capture, Utilization, and Storage (CCUS):	• In upstream Exploration and Production (E&P), Carbon Capture, Utilization, and Storage (CCUS) technology can capture CO_2 from gas processing, which can then be used for Enhanced Oil Recovery (EOR) or sequestration, resulting in a reduction of emissions by up to 30%. • In refineries, CCUS technology can capture CO_2 from flue gases, which can be utilized to produce synthetic fuels or stored, leading to a decrease in emissions by 10-25%. • CCS (carbon capture storage) is a proven technology for reducing greenhouse gas emissions. CCS takes naturally occurring carbon dioxide from industrial processes and permanently stores it in geological formations deep underground to reduce emissions.
Forward Osmosis for wastewater:	• Forward Osmosis (FO) is a membrane-based water treatment technology that uses a semi-permeable membrane to separate water from contaminants, without the need for high pressure or energy-intensive processes. • In FO, a draw solution (a highly concentrated solution) is used to extract water from the wastewater, creating a concentration gradient that drives the water molecules through the membrane, leaving the contaminants behind. • One of the promising technology for wastewater management in the oil and gas sector, offering a low-energy, high-recovery, and robust solution for treating complex wastewater streams of O&G sector
Biogas from sludge:	• Companies in the Oil & Gas sector are utilizing anaerobic digestion technology to convert wastewater sludge into biogas, which is then used to generate power onsite, reducing landfill waste and powering their operations, resulting in a significant reduction in greenhouse gas emissions and energy costs. • Companies selling bio-digestible sludge to nearby CBG plants which generates additional revenue, and also helps reduce carbon footprint and supports the achievement of SDG, ultimately promoting a more sustainable and circular economy.
Transforming waste into resources	• In Upstream E&P, drilling cuttings are being repurposed as construction materials, significantly minimizing waste and reducing environmental impact. • In Refineries, a closed-loop system is being implemented to recover sulfur from spent caustic, which is then reused in chemical production, promoting resource efficiency and reducing the need for virgin materials.
Sustainable aviation fuels (SAF)	• SAF is a biofuel used to power aircraft that has similar properties to conventional jet fuel but with a smaller carbon footprint. Depending on the feedstock and technologies used to produce it, SAF can reduce emissions dramatically compared to conventional jet fuel. • SAF biofuel uses resource like wastewater treatment sludge, Municipal solid waste streams, Manures, Corn grain, Oil seeds, etc.
Digital Twins	• Digital Twins for Oil and Gas Assets enhance climate action by optimizing operations, reducing emissions, and improving efficiency through real-time monitoring and predictive analytics. • This innovation fosters smarter resource management, leading to lower carbon footprints, accelerated transition to renewable energy, and heightened environmental stewardship in the oil and gas sector.

Source: Crisil Intelligence

Select R&D initiatives in Oil and Gas industry

R&D Initiatives	Details
SWAP, a Platform to Decarbonize Water Recycling	• SWAP pilot plant is a modular platform that can accommodate and test different water treatment and recycling techniques, for different input water qualities, all powered by different renewable energy sources (solar, wind, solar thermal, hybridization) • This pilot also aims to study and develop the synergies that can exist between energy production and water treatment, as well as dynamic optimization models for production systems using intermittent resources
Reducing diesel consumption: the innovative approach of hybrid drilling rigs by Total energies	• To limit diesel consumption, the drilling rigs at Exploration & Production in Uganda have been fitted with storage batteries. Based on the same principle as hybrid cars, the batteries store energy when demand is low and release it when demand peaks. • This has reduced diesel consumption by 20%, equivalent to a reduction of 1 kt CO_2e/year per drilling site.
AUSEA: The Innovative Technology for Reducing Methane and CO2 Emissions by TotalEnergies	• Since 2017, TotalEnergies have been working with the French National Centre for Scientific Research (CNRS) and the University of Reims Champagne-Ardenne to develop the AUSEA technology (Airborne Ultralight Spectrometer for Environmental Applications) to detect and quantify methane and carbon dioxide emissions. • TotalEnergies is signing a cooperation agreement with multiple O&G companies to deploy AUSEA to detect and reduce methane emissions
Floating Wind Farm to power offshore plant	• TotalEnergies has launched a floating wind farm pilot project to supply renewable electricity to an offshore oil and gas platform in the North Sea. • The 3 MW floating wind turbine will be located two kilometres west of the Culzean platform, 220 km off the Scottish coast.
indSelectG by Indian Oil	• Production of gasoline meeting stringent specifications of BS-VI/Euro-VI at low cost is a challenge for refineries. indSelectG is selective hydrotreating technology developed by Indian Oil R&D with catalyst developed in-house for cracked gasoline desulphurisation keeping Octane loss minimum.
Ceramic Membrane Filtration	• The ceramic membrane filtration process is a robust and highly effective technology used in the Oil and Gas Industry, particularly for treating produced water. Produced water is a complex wastewater stream generated during oil and gas extraction that contains contaminants like dispersed oil, emulsified oil, suspended solids, heavy metals, and high salinity. • Ceramic membranes offer a key advantage over conventional polymer membranes due to their superior resistance to high temperatures, harsh chemicals (acids and bases), high pressure, and fouling agents like oil and grease. This durability makes them ideal for the challenging conditions often found in produced water treatment.

Notes: Not exhaustive
Source: Crisil Intelligence

Select case studies of wastewater treatment in oil and gas upstream and downstream operation in India

1. Effluent treatment plant at Mangalore Refinery & Petrochemical Limited

Project information

- Effluent treatment plant at Mangalore Refinery & Petrochemicals Limited (MRPL - subsidiary of ONGC)
- MRPL has a designed capacity to process 15 million metric tons per annum and have 2 hydrocrackers producing premium diesel (High Cetane). It also has 2 CCRs producing unleaded petrol of high octane.
- Overall project packages consisting of all three treatments (primary, secondary and tertiary):
  - Oily effluent treatment package
  - Contaminated rainwater treatment package
  - Cooling tower blow down treatment package
  - Sanitary sewer treatment package
  - Bioremediation of oily and chemical sludge
  - Volatile organic compound treatment (VOC

Technologies used

- Combination of technologies used:
  - PT-SBR-MBR-RO for oily water treatment
  - PT - DMF - ACF - UF - RO for Cooling Tower Blow down Treatment (CTBD)
  - eco friendly "VOC control technology and "Bioremediation" oily sludge treatment technology
  - Wet Air Oxidation (WAO) technology used in plant for high sulphide removal.
  - Fully DCS controlled plant

Inlet parameters

- Feed capacity of plant is 24MLD which includes all the waste streams (oily water, cooling tower blow down& CRWS) generated in typical refinery and petrochemicals plant.
- Average inlet feed parameters are:
  - Total Oil: 10000mg/l (free oil -9500mg/l & emulsified oil 500 mg/l)
  - TSS: 300 mg/l
  - COD: 1200 mg/l
  - BOD: 600mg/l

Outlet parameters

- Average achieved recovery of UF system is 88%. MBR and UF permeate are further passed through RO system. Overall achieved recovery of RO system is 75%
- Outlet feed parameters after tertiary treatment
  - TSS: <2 mg/l
  - COD: BDL
  - BOD: BDL
  - TDS: 80 mg/l
  - Total Hardness: <5mg/l

Sludge treatment

- Sludge from oily effluent treatment package and Cooling Tower blow down package is collected thickened
- The oily and chemical sludge from the API, TPI and DAF units after thickening are treated in batch reactors for microbial action on the hydrocarbon attached to the oily sludge
- The unit is designed to Bioremediate 1000 cubic meter/year of oily and chemical sludge in a bioreactor having a batch time of 14 days.

Notes: TOC: Total organic carbon, TSS: Total suspended solids, BOD: (Biochemical Oxygen Demand) COD: Chemical oxygen demand, O&G: Oil and grease
Source: Crisil Intelligence

2. Shutdown/ Turnaround wastewater management for a Petrochemical Project located in the Middle East.

Project information

- WOG Group provided EPC and O&M services for a mobile wastewater treatment plant to manage approximately 30,000 cubic meters of turnaround wastewater generated from the Ethylene and Aromatic plants of a Middle East-based refinery.
- The scope of work also included the installation and removal of a floating cover for a wastewater storage facility with a capacity of 17,500 cubic meters, for safe storage of wastewater during the turnaround period.
- Shutdown/turnaround wastewater skids provided a solution for managing wastewater treatment loads during shutdown and turnaround periods, with the added benefit of being able to handle additional loads during normal operational periods

Key aspects of the project

- Treatment solutions used for various types of wastewater, including Ethylene waste, Aromatic waste, Spill diversion waste, OL2k runoff waste, and mixed effluents from diverse sources.
- treatment process is designed to manage high COD and high TOC effluents
- Treatment process involved optimizing operating conditions, such as chemical dosing rates and hydraulic flow rates, based on the TOC/COD ratio.
- Reduction of up to 98% in both TOC and COD, achieved using advanced shutdown wastewater treatment skids

Inlet parameters

- Inlet feed parameters are:
  - pH: 4.0 -10.0
  - TOC: 1000 – 10000 mg/l
  - TSS: 1000 – 10000 mg/l
  - COD: 1000 - 20000 mg/l
  - O&G: 1000 – 10000 ppm
  - Phenol: 55 ppm

Outlet parameters

- Outlet feed parameters are:
  - pH: 7.2
  - TOC: 37 mg/l
  - TSS: 8 mg/l
  - COD: 79 mg/l
  - O&G: 4 ppm
  - Phenol: 0.4 ppm

Advantages of shutdown/turnaround treatment skids

- Easy to transport and operate
- Equipped with latest technological features such as Oil & Sludge removal mechanisms, Electro Oxidation and Resin based treatment
- Additional capacity to handle shock loads
- Can be an add on to the existing wastewater treatment facilities
- Support system for Sustainable Development
- Environment friendly approach

Notes: TOC: Total organic carbon, TSS: Total suspended solids, BOD: (Biochemical Oxygen Demand) COD: Chemical oxygen demand, O&G: Oil and grease
Source: Crisil Intelligence

Industry is shifting towards sustainable practices to reduce carbon footprint and promote circular economy

Industrial activity has been a cornerstone of global economic development, contributing significantly to GDP and employment. However, it is also responsible for substantial greenhouse gas (GHG) emissions, resource depletion, and environmental degradation. According to the IEA, the industrial sector is one of the largest sources of global GHG emissions, with heavy industries like oil, steel, and cement being particularly emissions intensive. The adoption of the Paris Agreement in 2015 and the 17 SDGs has created a new context for industrial operations, emphasizing the need for sustainable practices to achieve carbon neutrality

This report examines the interplay between rising industrial activity and the global push for sustainability, focusing on key mechanisms such as carbon credits, carbon neutrality commitments, circular economy strategies, and BRSR guidelines. It highlights how these frameworks are driving the adoption of water and wastewater treatment systems, biogas extraction plants, and enhanced compliance in the oil sector and other industries. By integrating recent data and case studies, the report aims to provide a holistic understanding of these trends and their implications for sustainable industrial development.

Rising industrial activity and environmental challenges:

Global industrialization has accelerated in recent decades, driven by population growth, urbanization, and increasing demand for goods and services. The industrial sector, particularly in developing economies like India, China, and Brazil, has seen significant growth. For instance, China's manufacturing sector is largest participant of global industrial output, while India's industrial growth is also rising at constant pace. However, this expansion has come at a cost, with industries contributing to global CO_2 emissions, water pollution, and solid waste generation.

Heavy industries, such as oil and gas, steel, cement, and chemicals, are particularly challenging due to their high energy demands and process-related emissions. The oil sector, for example, relies heavily on fossil fuels for extraction, refining, and transportation, making it one of the most emissions-intensive industries. Additionally, industrial processes generate significant volumes of wastewater and solid waste, exacerbating water scarcity and environmental pollution. The United Nations estimates that by 2030, global freshwater demand predicted to exceed supply by 40%, partly due to industrial water use and untreated wastewater discharge.

Sustainable Development Goals (SDGs) and Industrial Transformation

The SDGs, adopted in 2015, provide a roadmap for sustainable development, with specific targets relevant to industrial activity. Goal 9 emphasizes sustainable industrialization through resource-efficient technologies and clean industrial processes, while Goal 12 promotes sustainable consumption and production patterns, including waste reduction and recycling. These goals have spurred industries to adopt innovative solutions to align with global sustainability targets.

For example, SDG 9.4 calls for retrofitting industries to make them sustainable by 2030, with a focus on reducing CO_2 emissions per unit of value added. According to UNCTAD's SDG Pulse 2024, global carbon intensity decreased by 2.6% in 2022, with developing regions like the Americas achieving a 10.4% reduction. This progress reflects the adoption of energy-efficient technologies, renewable energy integration, and waste management systems. Similarly, SDG 12.5 aims to substantially reduce waste generation through prevention, reduction, recycling, and reuse, driving industries to invest in circular economy practices and advanced waste treatment technologies.

The SDGs have also encouraged public-private partnerships and international cooperation. Developed nations are supporting developing countries with financial and technological assistance to meet SDG targets, as stipulated in the Paris Agreement. This has led to increased investments in water treatment, biogas extraction, and other sustainable technologies in industrial sectors worldwide.

Carbon Credits and Carbon Neutrality

Carbon credits have emerged as a critical tool for incentivizing emissions reductions. A carbon credit represents one ton of CO_2 or equivalent GHG emissions reduced, avoided, or sequestered. Companies can purchase credits to offset their emissions, investing in projects such as renewable energy, afforestation, or carbon capture and storage (CCS). In China, the China Certified Emission Reductions (CCER) scheme, relaunched in 2023, supports projects like forestry and biogas production, enabling industries to offset emissions through verified projects. Similarly, the UN's Article 6 agreement at COP26 in 2021 established a framework for international carbon markets, allowing countries and companies to invest in emissions-reducing projects globally.

Carbon neutrality, or achieving net-zero CO_2 emissions, is a central pillar of global climate strategies. Over 130 countries, including major emitters like China (2060 target) and the EU (2050 target), have committed to carbon neutrality. Industries are under increasing pressure to align with these targets, particularly in hard-to-abate sectors like oil and gas. Strategies include electrification, hydrogen adoption, and CCS.

The oil sector, for instance, is exploring low-carbon technologies such as green hydrogen and biofuels. Companies like BP and Shell have committed to net-zero emissions by 2050, investing in renewable energy and carbon capture projects. The IEA's Sustainable Development Scenario projects that by 2070, CCS will account for 15% of cumulative emissions reductions, with 40% of captured CO2 linked to the power sector and 25% to heavy industries.

However, achieving carbon neutrality in the oil sector is challenging due to its reliance on fossil fuels and long asset lifecycles. Innovations like electric propulsion for shipping and green ammonia for chemical production are being explored, but their scalability remains limited. The high cost of carbon removal technologies and the need for robust policy frameworks further complicate the transition.

Business Responsibility and Sustainability Reporting (BRSR) Guidelines

In India, the BRSR guidelines, introduced by the Securities and Exchange Board of India (SEBI) in 2021, mandate the top 1,000 listed companies to report on their environmental, social, and governance (ESG) performance. The BRSR framework aligns with global standards like the Global Reporting Initiative (GRI) and the SDGs, requiring companies to disclose metrics such as energy consumption, water usage, waste management, and GHG emissions.
The BRSR guidelines have driven increased adoption of sustainable practices in India's industrial sector. Companies are investing in water and wastewater treatment systems, renewable energy, and waste-to-energy solutions to comply with reporting requirements. For example, Tata Steel has implemented water recycling systems and biogas plants to reduce its environmental footprint, aligning with BRSR mandates and SDG targets.

Globally, sustainability reporting is on the rise, with UNCTAD reporting a tripling of published sustainability reports over a few years. This trend reflects growing corporate accountability and stakeholder demand for transparency. However, challenges include inconsistent reporting standards and the need for capacity building in developing countries to implement robust ESG frameworks.

Wastewater treatment and Bio gas extraction

Industrial activity, particularly in water-intensive sectors like oil, chemicals, and manufacturing, generates significant volumes of wastewater. Untreated wastewater poses risks to ecosystems and public health, necessitating advanced treatment technologies. The adoption of water and wastewater treatment systems is driven by regulatory compliance, SDG targets (e.g., Goal 6: Clean Water and Sanitation), and corporate sustainability commitments.

Modern wastewater treatment technologies, such as reverse osmosis, ultrafiltration, and advanced oxidation processes, are being deployed to treat industrial wastewater. These systems remove contaminants, enabling water reuse and reducing freshwater demand. For example, in the oil sector, produced water (a byproduct of oil extraction) is treated using membrane filtration and reinjected into reservoirs or reused in operations.

Wastewater treatment plants are increasingly adopting circular economy principles by recovering resources from wastewater. Anaerobic digestion (AD) processes, for instance, convert organic waste into biogas, which can be used for energy generation.

Some examples demonstrating the impact of these technologies. A large-scale anaerobic dynamic membrane bioreactor (AnMBR) in Japan's Sen-En wastewater treatment plant generates 1.82–2.27 kWh of net electrical energy per day, showcasing the potential for energy-neutral or energy-positive wastewater treatment. Similarly, companies like LanzaTech use CCS to transform industrial waste gases into ethanol, which is further processed into sustainable products like PET bottles.

Biogas extraction plants are gaining prominence as a sustainable solution for managing organic waste and generating renewable energy. These plants use anaerobic digestion to produce biogas (comprising methane and CO2) from industrial and municipal waste, which can be used for electricity, heat, or as a transport fuel. The adoption of biogas plants aligns with SDG 7 (Affordable and Clean Energy) and SDG 12, contributing to carbon neutrality and circular economy goals. In the oil sector, biogas plants are being integrated into refineries to process organic waste and reduce reliance on fossil fuels.

For example, BP has invested in biogas projects to produce renewable natural gas, offsetting emissions from its operations. Challenges include high initial costs and the need for skilled labor to operate and maintain biogas plants. However, advancements in technology, such as high-efficiency digesters and CO2 capture systems, are improving the economic viability of biogas extraction. In India, the BRSR guidelines are encouraging companies to report on renewable energy adoption, further driving investments in biogas infrastructure.

8. Assessment of competitive landscape of water and wastewater treatment in India

In this section, Crisil has analysed some key players operating in the water and wastewater treatment, in India, List of key players has been selected based on the alignment with primary and secondary business objectives, considering their operational focus and the sectors they serve. Data has been sourced from publicly available information, including annual reports and investor presentations of listed players, regulatory filings, rating rationales, and/or company websites. The financials in the competitive section have been re-classified by Crisil Intelligence, based on annual reports and filings by the players. Financial ratios used in this report may not match with the reported financial ratios by the players on account of standardization and re-classification done by Crisil

Note: The list of competitive landscape peers considered in this section is not exhaustive but an indicative list

Overview of select Indian players

Operational overview

Overview of key players in water and wastewater treatment industry in India

Company Name	Established	Geographical presence	Overview
Arvind Envisol	2011	India, Africa, North America, South America, Asia Pacific, Middle east, Europe	Arvind Envisol Pvt. Ltd. (Envisol), a subsidiary of the Lalbhai group and operating under the Arvind Ltd. brand, is a water management company that offers comprehensive solutions for water treatment, industrial wastewater treatment, sewage treatment, and zero liquid discharge. The company provides a range of services, including projects, spares, and components. Envisol holds the rights to a patented Polymeric Film Evaporation Technology along with 22 other registered patents across the world and has pan-India distribution rights for Hydranautics membranes.
Denta Water and Infra Solutions Limited	2016	**India (**Core operation is in Karnataka)	Denta Water and Infra Solutions Ltd operates in the EPC sector, focusing on projects related to groundwater recharge, lift irrigation, and drinking water supply infrastructure, including those under the Jal Jeevan Mission. The company's services encompass design, engineering, procurement, and installation, as well as on-site execution and project management, culminating in project commissioning. Additionally, it offers operations and maintenance services for a specified period, typically ranging from three to five years, post-commissioning. The company's portfolio also includes construction projects in the railway and highway sectors, with

Company Name	Established	Geographical presence	Overview
			experience in water management infrastructure, including groundwater recharge projects.
Driplex Water Engineering Limited	1974	NA	DWEPL, set up in 1974 by Mr K Lall, provides turnkey solutions in water and wastewater management. It offers a range of process plants (including raw water-treatment plants, reverse osmosis and ultra-filtration plants, effluent-treatment plants, full-cycle water-treatment solutions, and ash-handling plants) mainly for power utilities, refineries, steel plants, large industrial sectors, and public health departments. DWEPL is majority held by Veolia group (earlier Suez group)
EMS Limited	1998	India: Uttar Pradesh, Uttarakhand, Rajasthan, Bihar, Haryana, Madhya Pradesh, and Maharashtra	EMS Limited a multi-disciplinary EPC company with a presence across multiple business segments. The company's expertise spans Integrated Water and Wastewater Solutions, Electrical Transmission and Distribution, and Building and Road Construction. With a comprehensive range of services, EMS Limited offers turnkey solutions that cater to the needs of various industries, from design and engineering to construction and installation to operation and maintenance. The company's capabilities extend to undertaking EPC and HAM contracts, making it a complete solution provider for the projects
Enviro Infra Engineers Ltd	2009	**India:** Uttar Pradesh, Rajasthan, Haryana, Madhya Pradesh, Chhattisgarh, Delhi, Gujarat, Karnataka, Punjab, Jharkhand	Enviro Infra Engineers provides services related to environmental infrastructure. The company's offerings include Sewage Treatment Plants (STP) and Sewage Systems (SS), Common Effluent Treatment Plants (CETP), and Water Supply Scheme Projects (WSSP). Enviro Infra Engineers delivers its projects through various models, including Engineering, Procurement, and Construction (EPC), Hybrid Annuity Model (HAM), and Operation and Maintenance (O&M) contracts.
GA Infra Private Limited	1994	India: Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Delhi	GA Infra Private Limited (GAIPL) was founded by Mr. Gajendra Agarwal and was initially a proprietorship firm. It was later reconstituted as a private limited company in March 2012. The company takes on turnkey projects that involve setting up water distribution systems, water purification plants, and solar pumps. GAIPL primarily operated in Rajasthan, but it has also expanded its presence to other states.

Company Name	Established	Geographical presence	Overview
Ion Exchange (India) Ltd	1964	India, APAC, Africa, Europe, Middle east and North America	Ion Exchange (India) Ltd was established in 1964 and provides water, wastewater treatment, and environmental solutions. The company is headquartered in Mumbai and has multiple manufacturing and assembly facilities in India and abroad, including Portugal, UAE, Indonesia, Bangladesh, and Saudi Arabia, with a presence in other key geographies as well. The company provides comprehensive and integrated services and solutions in water and wastewater treatment, including sea water desalination, recycle, and zero liquid discharge plants to diverse industries. Additionally, it offers a comprehensive range of resins, specialty chemicals, and customized chemical treatment programs for water, non-water, and specialty applications
Paramount Limited	1962	India, South east Asia, Middle east	Paramount Limited is a company that offers a range of services, including design, engineering, manufacturing, and construction, to provide comprehensive solutions for projects in various sectors. These sectors include chemical and hydrocarbon processing, water treatment, wastewater treatment, air pollution control, and hazardous waste incineration. Additionally, the company provides consultancy services, such as air quality monitoring, environmental impact assessments, and treatability and feasibility studies
Suez India Pvt. Limited	1986	Pan India	The Group is active in the Indian water and wastewater market since 1978 and established an Indian subsidiary in 1986. Suez India Pvt Ltd operates in the water management sector, offering a comprehensive range of services including water services, design and operation of water and wastewater treatment plants, and sewage maintenance. Additionally, the company operates in recovery and waste management solutions, utilizing innovative technologies such as anaerobic digestion, incineration, and smart cells to convert waste into energy. It has delivered over 250 water and wastewater treatment infrastructure projects for both municipal and industrial clients
Toshiba Water Solutions Private Limited	1984 (as UEM India)	India, Middle east, South East Asia, USA	Toshiba Water Solutions Private Limited provides a range of water treatment solutions, including Aerobic Biological Treatment, Anaerobic Biological Treatment, Wastewater Reclamation/Reuse, and Water Treatment. The company offers various services across these solutions, such as design-build, design engineering, engineering and

Company Name	Established	Geographical presence	Overview
			procurement, feasibility studies, and operations and maintenance. These services cater to both municipal and industrial sectors.
VA Tech Wabag Limited	1995	India, Middle east, Europe, North America, South America, South east Asia, Africa	VA Tech Wabag Limited is a leading provider of water treatment solutions, offering a range of services including desalination, wastewater treatment, recycle and reuse, effluent treatment, drinking water, zero liquid discharge, sludge treatment, and energy recovery. The company's expertise spans various aspects of water management, making it a comprehensive solution provider for industries and communities. VA Tech Wabag Limited pursues partnerships across various project models, including EPC, EP, DBO, BOOT, HAM and O&M. The company is deepening its focus on key regions, including the Middle East, GCC, CIS, and South East Asia, as it continues to expand its global presence and deliver innovative water treatment solutions
Vishvaraj Environment Limited	2008	**India:** Maharashtra, West Bengal, Karnataka, Chhattisgarh, Uttar Pradesh, Jharkhand, Punjab **Global:** Maldives	VEPL offers a range of services in the water management sector, including water treatment and supply, wastewater treatment and reuse, automation, and urban and rural water management. The company executes projects through various models, such as PPP, HAM, and EPC contracting, for government entities. Vishvaraj Environment Pvt. Ltd. (VEPL) has developed India's first and largest wastewater reuse plant (as of FY25) with a capacity of 190 MLD in Nagpur under the PPP model.
Welspun Enterprises Ltd	1994	**India:** Uttar Pradesh, Maharashtra, Uttarakhand, Bihar, Tamil Nadu, Punjab, etc.	Welspun Enterprise Limited operates in the infrastructure sector, with a focus on the development and operation of roads, highways, water, and wastewater projects across India. The company is involved in various PPP models in rural and urban areas. In addition to its infrastructure business, Welspun Enterprise Limited has investments in oil and gas exploration assets through a joint venture with the Adani Group, called Adani Welspun Exploration Limited (AWEL). The company has also expanded its water infrastructure business through the acquisition of Welspun Michigan Engineers Limited, a trenchless technology-based EPC company, which enables it to provide services in tunnelling, sewer rehabilitation, and allied areas.

Company Name	Established	Geographical presence	Overview
WOG Group	2010	India, Central Asia, Middle east, South East Asia	Incorporated 13 years ago and led by a team of qualified personnel with experience in environmental engineering and water and waste water industry, WOG is an integrated environmental engineering and technology company, building sustainable infrastructure globally, for their industrial and municipal clients, offering specialized services in water treatment, oil separation, wastewater recycling, and supplementary biogas generation. The Company's initiatives include the adoption of bio methane as a replacement for coal and diesel in select projects, incorporation of water recycling systems aligned with circular economy principles, and solutions supporting clients' compliance with tightening regulatory discharge norms, sustainability frameworks and Board level ESG commitments. The Company's expertise encompasses a wide range of advanced technologies, including anaerobic treatment systems, fine bubble diffuser aeration, jet aeration systems, MBR technology, AnMBR technology, physico-chemical treatment systems, systems for the treatment of free and emulsified oils, and advanced tertiary treatment solutions. WOG serves a range of industries, such as Oil & Gas, Textiles, Food and Beverages, Sugar and chemicals, and pharmaceuticals.
Xylem Water Solutions India Private Limited	2011	Karnataka, Maharashtra, Gujarat, Delhi	Xylem Water Solutions India Private Limited was formed in 2011 because of the spin-off of the water-related business of ITT Corporation India Pvt. Ltd. The company has a Technology Centre and manufacturing facility in Vadodara, with additional sales offices in Bangalore, Delhi, Mumbai, and Pune. Xylem India's operations involve manufacturing, support services, and trading activities. At its Savli Plant location, the company manufactures a range of products including pumps and accessories, water and wastewater treatment solutions, and flow control equipment. The company also provides after-sales and marketing support as part of its service activities.

Source: Crisil Intelligence, company websites, and company annual reports

Order book trend for the selected Indian players

Orderbook (Rs billion)

Company name	FY22	FY23	FY24	FY25	Q1FY26
Arvind Envisol	N.A.	N.A.	N.A.	N.A.	N.A.
Denta Water and Infra Solutions Limited	2.8	9.6	9.7	6.2	5.9
Driplex Water Engineering Limited	N.A.	N.A.	N.A.	N.A.	N.A.
EMS Limited	8.6	13.9	18.0+	22.4	N.A
Enviro Infra Engineers Ltd	1.7	14.9	23.4	19.9	30.0
GA Infra Private Limited	N.A.	N.A.	N.A.	N.A.	N.A.
Ion Exchange (India) Ltd	26.7	34.3	35.5	27.6	26.6
Paramount Limited	N.A.	N.A.	N.A.	N.A.	N.A.
Suez India Pvt. Limited	N.A.	N.A.	N.A.	N.A.	N.A.
Toshiba Water Solutions Private Limited	N.A.	N.A.	N.A.	N.A.	N.A.
VA Tech Wabag Limited	101.1	132.2	114.5	136.7	145.4
Vishvaraj Environment Limited	N.A.	42.7	34.5	160.1	N.A.
Welspun Enterprises Ltd	84.0	101.0	122.0	143.0	136.7
WOG Group	0.84	0.74	1.16	3.0	8.2
Xylem Water Solutions India Private Limited	N.A.	N.A.	N.A.	N.A.	N.A.

*Note: N.A. – Not Available; N.Ap. – Not Applicable, *approximate figures given by the company*

Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Financial parameters

Revenue from operations (Rs million)

Company Name	FY23	FY24	FY25	Q1FY26	CAGR (FY23-25)
Arvind Envisol	2,713.0	2,626.8	2,677.1	N.A.	-0.7%
Denta Water and Infra Solutions Limited	1,743.2	2,386.0	2,032.9	672.8	8.0%
Driplex Water Engineering Limited	1,313.8	521.3	N.A.	N.A.	N.Ap
EMS Limited	5,381.6	7,933.1	9,658.3	2,388.9	34.0%
Enviro Infra Engineers Ltd	3,381.0	7,289.2	10,660.6	2,409.2	77.6%
GA Infra Private Limited	11,994.4	18,293.2	N.A.	N.A.	N.Ap
Ion Exchange (India) Ltd	19,896.1	23,478.5	27,371.1	5,831.9	17.3%
Paramount Limited	1,419.5	2,425.0	N.A.	N.A.	N.Ap
Suez India Pvt. Limited	7,437.7	9,288.4	N.A.	N.A.	N.Ap
Toshiba Water Solutions Private Limited	6,159.7	5,136.9	N.A.	N.A.	N.Ap
VA Tech Wabag Limited	29,604.8	28,564.0	32,940.0	7,340.0	5.5%
Vishvaraj Environment Limited	6,699.9	12,554.4	17,587.1	N.A.	62.0%
Welspun Enterprises Ltd	27,581.9	28,742.1	35,841.0	8,450.5	14.0%
WOG Group	617.2	821.8	1,654.3	413.1	63.7%
Xylem Water Solutions India Private Limited	4,927.9	5,924.3	8,762.7	N.A.	33.3%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Growth in revenue from operations (%)

Company Name	FY24	FY25
Arvind Envisol	-3.2%	1.9%.
Denta Water and Infra Solutions Limited	36.9%	-14.8%
Driplex Water Engineering Limited	-60.3%	N.Ap.
EMS Limited	47.4%	21.7%
Enviro Infra Engineers Ltd	115.6%	46.3%
GA Infra Private Limited	52.5%	N.Ap.
Ion Exchange (India) Ltd	18.0%	16.6%
Paramount Limited	70.8%	N.Ap.
Suez India Pvt. Limited	24.9%	N.Ap.
Toshiba Water Solutions Private Limited	-16.6%	N.Ap.
VA Tech Wabag Limited	-3.5%	15.3%
Vishvaraj Environment Limited	87.4%	40.1%
Welspun Enterprises Ltd	4.2%	24.7%
WOG Group	33.2%	101.3%
Xylem Water Solutions India Private Limited	20.2%	47.9%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Operating profit before depreciation, interest and taxes – OPBDIT (Rs million)

Company Name	FY23	FY24	FY25	Q1FY26	CAGR (FY23-25)
Arvind Envisol	84.4	84.4	138.9	N.A.	28.3%
Denta Water and Infra Solutions Limited	669.6	791.4	676.9	224.6	0.5%
Driplex Water Engineering Limited	(343.1)	(454.3)	N.A.	N.A.	N.Ap
EMS Limited	1,500.0	2,038.5	2,511.7	541.1	29.4%
Enviro Infra Engineers Ltd	845.1	1,665.0	2,677.6	642.1	78.0%
GA Infra Private Limited	1,296.0	2,339.5	N.A.	N.A.	N.Ap
Ion Exchange (India) Ltd	2,549.9	2,719.4	2,938.1	625.4	7.3%
Paramount Limited	203.7	477.2	N.A.	N.A.	N.Ap
Suez India Pvt. Limited	142.3	267.7	N.A.	N.A.	N.Ap
Toshiba Water Solutions Private Limited	198.1	(190.8)	N.A.	N.A.	N.Ap
VA Tech Wabag Limited	3,178.0	3,757.0	4,223.0	956.0	15.3%
Vishvaraj Environment Limited	1,618.3	2,686.1	4,239.6	N.A.	61.9%
Welspun Enterprises Ltd	2,476.4	4,273.7	5,216.9	1,821.8	45.1%
WOG Group	39.8	77.2	679.9	141.0	313.2%
Xylem Water Solutions India Private Limited	262.0	489.3	950.5	N.A.	90.5%

Note: N.A. – Not Available; N.Ap. – Not Applicable

OPBDIT = Revenue from operations- total expenses + depreciation and amortization expenses+ finance cost

Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Operating profit before depreciation, interest and taxes – OPBDIT margins (%)

Company Name	FY23	FY24	FY25	Q1FY26
Arvind Envisol	3.1%	3.2%	5.2%	N.A
Denta Water and Infra Solutions Limited	38.4%	33.2%	33.3%	33.4%
Driplex Water Engineering Limited	-26.1%	-87.2%	N.A	N.A
EMS Limited	27.9%	25.7%	26.0%	22.7%
Enviro Infra Engineers Ltd	25.0%	22.8%	25.1%	26.7%
GA Infra Private Limited	10.8%	12.8%	N.A	N.A
Ion Exchange (India) Ltd	12.8%	11.6%	10.7%	10.7%
Paramount Limited	14.3%	19.7%	N.A	N.A
Suez India Pvt. Limited	1.9%	2.9%	N.A	N.A
Toshiba Water Solutions Private Limited	3.2%	-3.7%	N.A	N.A
VA Tech Wabag Limited	10.7%	13.2%	12.8%	13.0%
Vishvaraj Environment Limited	24.2%	21.4%	24.1%	N.A
Welspun Enterprises Ltd	9.0%	14.9%	14.6%	21.6%
WOG Group	6.5%	9.4%	41.1%	34.1%
Xylem Water Solutions India Private Limited	5.3%	8.3%	10.8%	N.A

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Crisil Intelligence

Profit after tax (Rs million)

Company Name	FY23	FY24	FY25	Q1FY26	CAGR (FY23-25)
Arvind Envisol	(315.5)	73.6	118.4	N.A.	N.Ap.
Denta Water and Infra Solutions Limited	498.6	604.7	528.9	185.5	3.0%
Driplex Water Engineering Limited	(314.4)	(502.9)	N.A.	N.A.	N.Ap.
EMS Limited	1,088.5	1,526.6	1,837.8	380.6	29.9%
Enviro Infra Engineers Ltd	574.5	1,064.6	1,771.5	424.8	75.6%
GA Infra Private Limited	786.5	1,408.9	N.A.	N.A.	N.Ap.
Ion Exchange (India) Ltd	1,949.7	1,953.5	2,082.6	484.4	3.4%
Paramount Limited	123.4	319.6	N.A.	N.A.	N.Ap.
Suez India Pvt. Limited	31.9	128.3	N.A.	N.A.	N.Ap.
Toshiba Water Solutions Private Limited	181.6	96.1	N.A.	N.A.	N.Ap.
VA Tech Wabag Limited	110.0	2,504.0	2,948.0	658.0	417.7%
Vishvaraj Environment Limited	960.6	1,657.9	2,662.7	N.A.	66.5%
Welspun Enterprises Ltd	7,260.6	3,194.0	3,538.3	1,011.6	-30.2%
WOG Group	12.3	27.9	442.4	96.8	499.9%
Xylem Water Solutions India Private Limited	105.4	213.2	463.0	N.A.	109.6%

Note: N.A. – Not Available; N.Ap. – Not Applicable

Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Profit after tax margins (%)

Company Name	FY23	FY24	FY25	Q1FY26
Arvind Envisol	-11.6%	2.8%	4.4%	N.A.
Denta Water and Infra Solutions Limited	28.6%	25.3%	26.0%	27.6%
Driplex Water Engineering Limited	-23.9%	-96.5%	N.A.	N.A.
EMS Limited	20.2%	19.2%	19.0%	15.9%
Enviro Infra Engineers Ltd	17.0%	14.6%	16.6%	17.6%
GA Infra Private Limited	6.6%	7.7%	N.A.	N.A.
Ion Exchange (India) Ltd	9.8%	8.3%	7.6%	8.3%
Paramount Limited	8.7%	13.2%	N.A.	N.A.
Suez India Pvt. Limited	0.4%	1.4%	N.A.	N.A.
Toshiba Water Solutions Private Limited	2.9%	1.9%	N.A.	N.A.
VA Tech Wabag Limited	0.4%	8.8%	8.9%	9.0%
Vishvaraj Environment Limited	14.3%	13.2%	15.1%	N.A.
Welspun Enterprises Ltd	26.3%	11.1%	9.9%	12.0%
WOG Group	2.0%	3.4%	26.7%	23.4%
Xylem Water Solutions India Private Limited	2.1%	3.6%	5.3%	N.A.

Note: N.A. – Not Available; N.Ap. – Not Applicable
PAT % = PAT / Total Operating Income
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Other Financial Ratios (FY24)

Company Name	ROE	ROCE	Gearing ratio	Current Ratio	Interest coverage ratio
Arvind Envisol	9.62%	10.85%	0.08	1.61	11.59
Denta Water and Infra Solutions Limited	45.01%	49.58%	0.01	3.20	162.48
Driplex Water Engineering Limited	-99.13%	-173.62%	0.00	1.10	(7.53)
EMS Limited	23.61%	24.46%	0.09	6.65	34.95
Enviro Infra Engineers Ltd	50.74%	32.29%	0.81	1.54	7.80
GA Infra Private Limited	49.06%	27.33%	1.35	1.64	5.70
Ion Exchange (India) Ltd	21.06%	23.84%	0.13	1.55	26.31
Paramount Limited	31.56%	34.52%	0.23	3.59	10.82
Suez India Pvt. Limited	4.57%	7.34%	0.59	1.68	2.00
Toshiba Water Solutions Private Limited	16.22%	15.23%	1.51	0.96	2.44
VA Tech Wabag Limited	14.74%	19.44%	0.15	1.68	5.76
Vishvaraj Environment Limited	33.63%	28.54%	0.88	1.49	4.00
Welspun Enterprises Ltd	13.17%	18.11%	0.30	1.88	5.61
WOG Group	25.11%	22.80%	1.18	1.32	3.08
Xylem Water Solutions India Private Limited	9.62%	10.85%	0.08	1.61	11.59

Note: N.A. – Not Available; N.Ap. – Not Applicable
Return on Capital Employed (RoCE) = EBIT divided by capital employed. Capital employed is calculated as net worth and total debt.
Return on Equity (RoE) = PAT / Average total equity
Current ratio: Current assets/ Current liabilities
Gearing ratio= Total debt/ Tangible equity
Interest coverage ratio= PBDIT/ Finance cost
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Other Financial Ratios (FY25)

Company Name	ROE	ROCE	Gearing ratio	Current Ratio	Interest coverage ratio
Arvind Envisol	13.71%	16.12%	0.02	1.72	49.99
Denta Water and Infra Solutions Limited	18.46%	17.57%	0.00	20.28	201.76
Driplex Water Engineering Limited	N.A	N.A	N.A	N.A	N.A
EMS Limited	20.66%	24.19%	0.09	8.15	31.66
Enviro Infra Engineers Ltd	27.58%	22.62%	0.24	3.07	7.72
GA Infra Private Limited	N.A	N.A	N.A	N.A	N.A
Ion Exchange (India) Ltd	18.68%	19.45%	0.25	1.49	25.52
Paramount Limited	N.A	N.A	N.A	N.A	N.A
Suez India Pvt. Limited	N.A	N.A	N.A	N.A	N.A
Toshiba Water Solutions Private Limited	N.A	N.A	N.A	N.A	N.A
VA Tech Wabag Limited	14.86%	18.39%	0.17	1.70	5.95
Vishvaraj Environment Limited	39.80%	24.62%	1.28	1.13	5.36
Welspun Enterprises Ltd	13.61%	16.14%	0.55	1.76	4.61
WOG Group	71.79%	51.32%	0.12	2.69	16.34
Xylem Water Solutions India Private Limited	14.62%	15.36%	0.07	1.37	9.66

Note: N.A. – Not Available; N.Ap. – Not Applicable
Return on Capital Employed (RoCE) = EBIT divided by capital employed. Capital employed is calculated as net worth and total debt.
Return on Equity (RoE) = PAT / Average total equity
Current ratio: Current assets/ Current liabilities
Gearing ratio= Total debt/ Tangible equity
Interest coverage ratio= PBDIT/ Finance cost
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Overview of select global players

Operational overview

Overview of select global players in water and wastewater treatment industry

Company Name	Established	Geographical presence	Overview
Ecolab Inc	1923	Africa-Middle East, Asia, Australia and New Zealand, Europe, Latin America, North America	Ecolab's history dates back to 1923, when it developed a chemistry formulation for cleaning carpets. Nalco Water, an Ecolab company, provides solutions for managing and treating water resources, improving processes, and controlling pollutants. With a portfolio of over 11,300 patents, Ecolab works with more than 40 industries. The company's key areas of focus include water management in industrial, institutional, and energy sectors. Ecolab offers a range of solutions and services related to water, hygiene, and infection prevention, serving a diverse range of industries and applications.
Veolia Environment	1853 (as Compagnie Générale des Eaux)	Africa-Middle East, Asia, Australia and New Zealand, Europe, Latin America, North America	Veolia group offers solutions for managing water, waste, and energy. Its three main business activities are water management, waste management and energy. In the water segment, the group's key activities include producing and distributing drinking water, collecting, treating, and reusing wastewater, managing industrial water, and providing integrated water solutions for energy and waste management In the waste management sector, the group handles all types of waste, including liquid, solid, ordinary, and special waste. It covers the entire waste life cycle, from collection to recycling. The key activities in waste management include collecting and sorting waste, recovering materials and energy from waste, managing industrial waste, treating and recovering hazardous and special waste, and providing waste solutions that are integrated with energy and water management.

Source: Crisil Intelligence, company websites, and company annual reports

Crisil Intelligence

Financial parameters

Revenue from operations (USD million)

Company Name	CY22	CY23	CY24	CAGR (CY22-24)
Ecolab Inc	11,446.2	12,316.8	12,473.6	10.1%
Veolia Environment	42,885.0	45,351.0	44,692.0	26.1%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Growth in revenue from operations (%)

Company Name	CY23	CY24
Ecolab Inc	7.6%	1.3%
Veolia Environment	5.8%	-1.5%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Profit after tax (USD million)

Company Name	CY22	CY23	CY24	CAGR (CY22-24)
Ecolab Inc	1,091.7	1,372.3	2,112.4	10.2%
Veolia Environment	998.0	1,334.0	1,444.0	55.0%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Profit after tax margins – PAT margins (%)

Company Name	CY22	CY23	CY24
Ecolab Inc	7.7%	9.0%	13.4%
Veolia Environment	2.3%	2.9%	3.2%

Note: N.A. – Not Available; N.Ap. – Not Applicable
Source: Company annual reports, quarterly financials and investor presentation available in the public domain, Crisil Intelligence

Key Observations:

- As of September 2025, WOG Group has competed over 150 projects worldwide, across the industrial and municipal sectors.
- WOG Group has experience executing projects in 17 countries, including India, Singapore, Malaysia, Thailand, Indonesia, Vietnam, Nepal, Bangladesh, Saudi Arabia, Syria, United Arab Emirates, Kuwait, Uzbekistan, Guyana, Trinidad and Tobago, Jamaica, and Venezuela.
- WOG Group has done multiple projects for clients like
    - India - Reliance Industries, Indian Oil Corporation, Hindustan Petroleum Corporation Limited, ITC Limited, Indian Ordnance Factories (Nagpur), DJB, United Breweries, Punjab Water Supply and Sewerage Board
    - Thailand - Indorama Ventures, Hyundai Engineering and IRPC Public Company Limited and PTT Public Company Limited
    - Kuwait - Equate Petrochemical Company
    - Saudi Arabia - Saudi Aramco and SABIC
    - Singapore - Shell, Kimberley Clark and Public Utility Board (PUB).
    - Trinidad and Tobago - Coca Cola
- WOG operates in three segments
    - WATER Treatment across Industries
    - Recovery of OIL from waste water
    - Generating Bio GAS through treatment of waste water
- WOG offers customised solutions to clients recycle, recover, optimize, conserve and reuse their resources (water, oil, Bio-methane, Bio-CNG, waste heat, carbon emission). WOG support clients on a project basis to help them comply with environmental protection norms, meet SDG goals, achieve carbon neutrality, become water positive, and reduce or reuse resources such as water and energy.
- WOG offers end to end project execution capabilities including know-how, preliminary design, detailed design, process engineering, procurement, fabrication, erection, commissioning and operation & maintenance.
- WOG has commissioned municipal waste to 25 MLD RO water plant in Thailand in phuket province for patong municipality using a combination of technologies in 2014 which is Coagulation - flocculation- high-rate Lamella clarifier - rapid sand gravity filters - modular Track ultrafiltration and low fouling reverse osmosis
- WOG has implemented technologies like Anaerobic Membrane Bioreactor, High End Tertiary Treatment Systems, Aerobic Membrane Bioreactor, Ultrafiltration, Reverse Osmosis, Waste to Energy, Improved version of Activated Sludge Process and Media Filtration of Metal removal across multiple projects

Glossary

Acronym	Expansion	Acronym	Expansion
ADB	Asian Development Bank	CPHEEO	Central Public Health and Environmental Engineering Organisation
AIIB	Asian Infrastructure Investment Bank	cum	Cubic metre
AMC	Ahmedabad Municipal Corporation	CWDL	Chennai Water Desalination Ltd
AMR	Automated meter reading	DDA	Delhi Development Authority
AMRUT	Atal Mission for Rejuvenation and Urban Transformation	DEWATS	Decentralised wastewater treatment system
BARC	Bhabha Atomic Research Centre	DJB	Delhi Jal Board
BBMP	Bruhat Bengaluru Mahanagara Palike	DMA	District metering area
bcm	Billion cubic metres	DPR	Detailed project report
BMC	Bhopal Municipal Corporation	EPA	Environmental protection agency
BOD	Biochemical oxygen demand	EPC	Engineering, procurement, construction
BOOT	Build, own, operate, transfer	ETP	Effluent treatment plant
BOT	Build, operate, transfer	FBAS	Fixed bed bio film activated sludge process
BPCL	Bharat Petroleum Corporation Ltd	GHMC	Greater Hyderabad Municipal Corporation
BWSSB	Bangalore Water Supply and Sewerage Board	GIDC	Gujarat Industrial Development Corporation
CA	Central assistance	GIS	Geographic information system
CAGR	Compound annual growth rate	GoI	Government of India
CETP	Common effluent treatment plant	GWSSB	Gujarat Water Supply and Sewerage Board
COD	Chemical oxygen demand	HAM	Hybrid annuity model
CPCB	Central Pollution Control Board	HMWSSB	Hyderabad Metropolitan Water Supply and Sewerage Board
I&D	Interception and diversion	mtpa	Metric tonne per annum
IHHL	Individual household toilets	NDMC	New Delhi Municipal Corporation
IITR	Indian Institute of Technology, Roorkee	NGP	Namami Gange Programme
IOCL	Indian Oil Corporation Ltd	NGT	National Green Tribunal
IoT	Internet of things	NIOT	National Institute of Ocean Technology
JICA	Japan International Cooperation Agency	NMCG	National Mission for Clean Ganga
JnNURM	Jawaharlal Nehru National Urban Renewal Mission	NRCP	National River Conservation Plan
KMDA	Kolkata Metropolitan Development Authority	NRW	Non-revenue water

Crisil Intelligence

Acronym	Expansion	Acronym	Expansion
KWA	Kerala Water Authority	NTPC	National Thermal Power Corporation
KWh	Kilo watt hours	O&M	Operations and maintenance
L&T	Larsen & Toubro	ODF	Open defecation free
lpcd	Litres per capita per day	ONGC	Oil and Natural Gas Corporation Ltd
LTTD	Low temperature thermal desalination	PCMC	Pimpri Chinchwad Municipal Corporation
MAHAGENCO	Maharashtra Generation Company	PHED	Public Health Engineering Department
MBBR	Moving bed bio-film reactor	PPP	Public-private partnership
MBR	Membrane bioreactor	PWD	Public works department
MED	Multi-effect distillation	RCC	Reinforced cement concrete
mgd	Million gallons per day	RIL	Reliance Industries Ltd
mld	Million litres per day	RO	Reverse osmosis
MoEFCC	Ministry of Environment, Forest and Climate Change	SBM	Swachh Bharat Mission
MoHUA	Ministry of Housing and Urban Affairs	SBM-G	Swachh Bharat Mission (Gramin)
SBM-U	Swachh Bharat Mission (Urban)	TWAD	Tamil Nadu Water Supply and Drainage Board
SBR	Sequencing batch reactor	TWW	Tertiary wastewater
SCADA	Supervisory control and data acquisition	UASB	Upflow anaerobic sludge blanket
SCM	Smart Cities Mission	UF	Ultra filtration
SIPCOT	State Industries Promotion Corporation of Tamil Nadu	UfW	Unaccounted-for-water
SLIP	Service Level Improvement Plans	UGD	Underground drainage
SMC	Surat Municipal Corporation	ULBs	Urban local bodies
SPCB	State pollution control board	UNICEF	United Nations Children's Fund
SPS	Sewage pumping station	UPJN	Uttar Pradesh Jal Nigam
SPV	Special purpose vehicle	WCF	Water conservation fee
STP	Sewage treatment plants	WHO	World Health Organisation
TANGEDCO	Tamil Nadu Generation and Distribution Corporation	WRI	World Resources Institute
TF	Trickling filter	WSP	Waste stabilisation pond
TIF	Tax increment financing	WtE	Waste-to-energy
TMC	Thane Municipal Corporation	WTP	Water treatment plant
TN	Total nitrogen	WWTP	Wastewater treatment plant
TPDDL	Tata Power Delhi Distribution Ltd	YAP	Yamuna Action Plan
TPP	Thermal power plant	ZLD	Zero liquid discharge
TSS	Total suspended solids	UfW	Unaccounted-for-water
TTP	Tertiary treatment plant	UGD	Underground drainage
TTRO	Tertiary treatment reverse osmosis	ULB	Urban local body

About Crisil Intelligence (formerly Market Intelligence & Analytics)

Crisil Intelligence is a leading provider of research, consulting, risk solutions and advanced data analytics, serving clients across government, private and public enterprises. We leverage our expertise in data-driven insights and strong benchmarking capabilities to help clients navigate complex external ecosystems, identify opportunities and mitigate risks. By combining cutting-edge analytics, machine learning and AI capabilities with deep industry knowledge, we empower our clients to make informed decisions, drive business growth and build resilient capacities.

For more information, visit Intelligence.Crisil.com

About Crisil

Crisil is a global, insights-driven analytics company. Our extraordinary domain expertise and analytical rigour help clients make mission-critical decisions with confidence.

Large and highly respected firms partner with us for the most reliable opinions on risk in India, and for uncovering powerful insights and turning risks into opportunities globally. We are integral to multiplying their opportunities and success.

Headquartered in India, Crisil is majority owned by S&P Global.

Founded in 1987 as India's first credit rating agency, our expertise today extends across businesses: Crisil Ratings, Crisil Intelligence, Crisil Coalition Greenwich and Crisil Integral IQ.

Our globally diverse workforce operates in the Americas, Asia-Pacific, Europe, Australia and the Middle East, setting the standards by which industries are measured.

For more information, visit www.Crisil.com

Connect with us: LinkedIn | Twitter

Crisil Privacy

Crisil respects your privacy. We may use your personal information, such as your name, location, contact number and email id to fulfil your request, service your account and to provide you with additional information from Crisil. For further information on Crisil's privacy policy please visit https://www.crisil.com/content/crisilcom/en/home/crisil-privacy-notice.html.