INDIA WATER AND WASTEWATER TREATMENT MARKET

FORECAST TO 2030

By Type, By Offering, By Equipment, By Application, By End-Use

7th December 2023

ABOUT US

Reports and Data is a market research and consulting company that provides syndicated research reports, customized research reports, and consulting services. Our solutions purely focus on your purpose to locate, target, analyze consumer behavior shifts across demographics, across industries, and help client's make a smarter business decision. We offer market intelligence studies ensuring relevant and fact-based research across multiple industries including Healthcare, Material, Chemicals, Power, and Energy. We consistently update our research offerings to ensure our clients are aware about the latest trends existent in the market. Reports and Data has a strong base of experienced analysts from varied areas of expertise. Our industry experience and ability to develop a concrete solution to any research problems provides our clients the ability to secure an edge over their respective competitors.

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1. MARKET SYNOPSIS

1.1. DEFINITION OF WATER AND WASTEWATER TREATMENT

Water treatment pertains to the systematic set of procedures employed to enhance the purity and safety of water by mitigating, eliminating, or diminishing the presence of impurities, pollutants, and undesired substances. The goal of water treatment is to make water safe and suitable for various purposes, including drinking, industrial processes, irrigation, and recreational activities. This process involves a series of physical, chemical, and biological processes that target specific contaminants such as suspended solids, microorganisms, dissolved chemicals, and metals. Water treatment helps ensure the protection of public health, preservation of ecosystems, and the sustainable use of water resources.

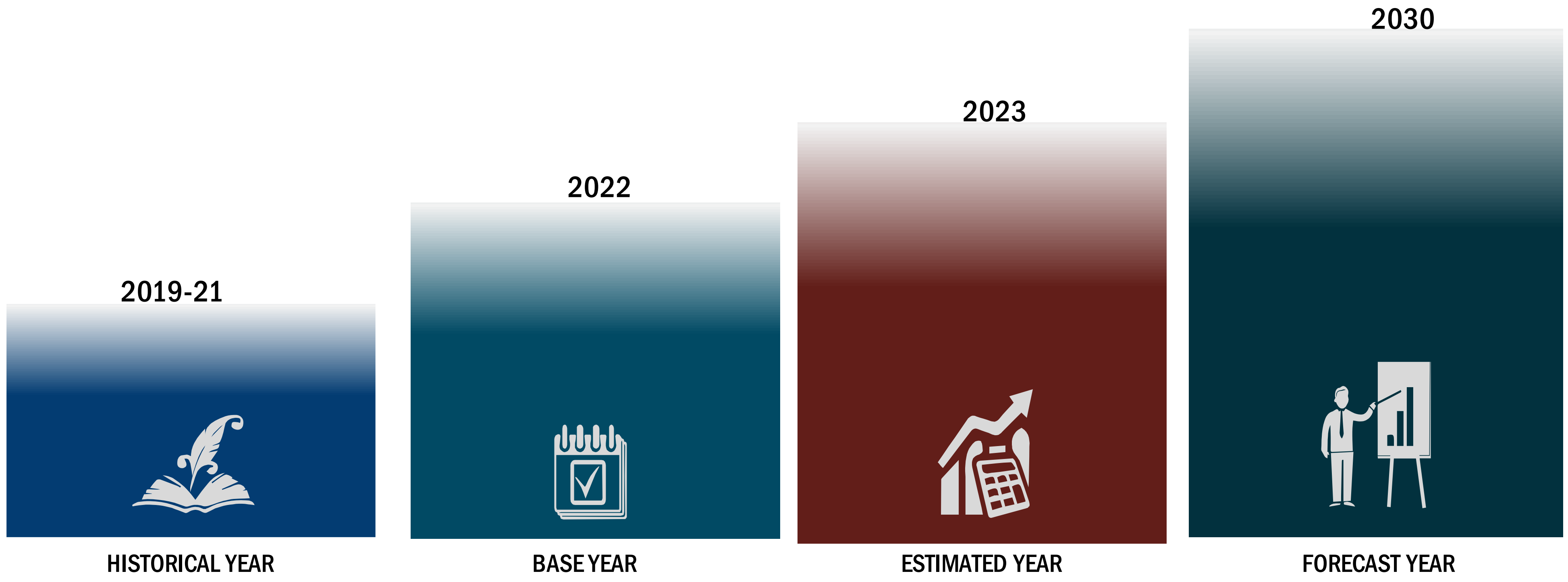
Wastewater treatment involves eliminating pollutants from used or polluted water, ensuring its safe return to the environment or potential reuse. The process includes primary, secondary, and tertiary treatment stages, effectively purifying the water for release into rivers, lakes, oceans, or non-drinking applications like irrigation and industry. The core objective is to safeguard public health, ecosystems, and water quality, mitigating human-induced environmental harm.

1.2. RESEARCH SCOPE & PREMISE

The report provides market value for base year 2022 and a yearly forecast from 2023 to 2030 in terms of Revenue (USD Million). Market for each aforementioned segment is present for India for the above-mentioned forecast period.

Key industry dynamics, regulatory scenario, and future markets of Water and Wastewater Treatment market are analyzed to understand their impact on demand for the forecast period. Growth rates have been estimated using correlation, regression and time-series analysis.

FIGURE 1. YEARS CONSIDERED IN THE STUDY



1.3. RESEARCH METHODOLOGY

A research methodology is a systematic approach for assessing or conducting a market study. Researchers tend to draw on a variety of both qualitative and quantitative study methods, inclusive of investigations, surveys, secondary data and market observation.

Such plans can focus on classifying the products offered by leading market players or simply use statistical models to interpret observations or test hypotheses. While some methods aim for a detailed description of the factors behind an observation, others present the context of the current market scenario.

1.3.1. SECONDARY RESEARCH MODEL

Extensive data is obtained and cumulated on a substantial basis during the inception phase of the research process. The data accumulated is consistently filtered through validation from the in-house database, paid sources as well reputable industry magazines.

A robust research study requires an understanding of the overall value chain. Annual reports and financials of industry players are referred thoroughly to have a comprehensive idea of the market taxonomy.

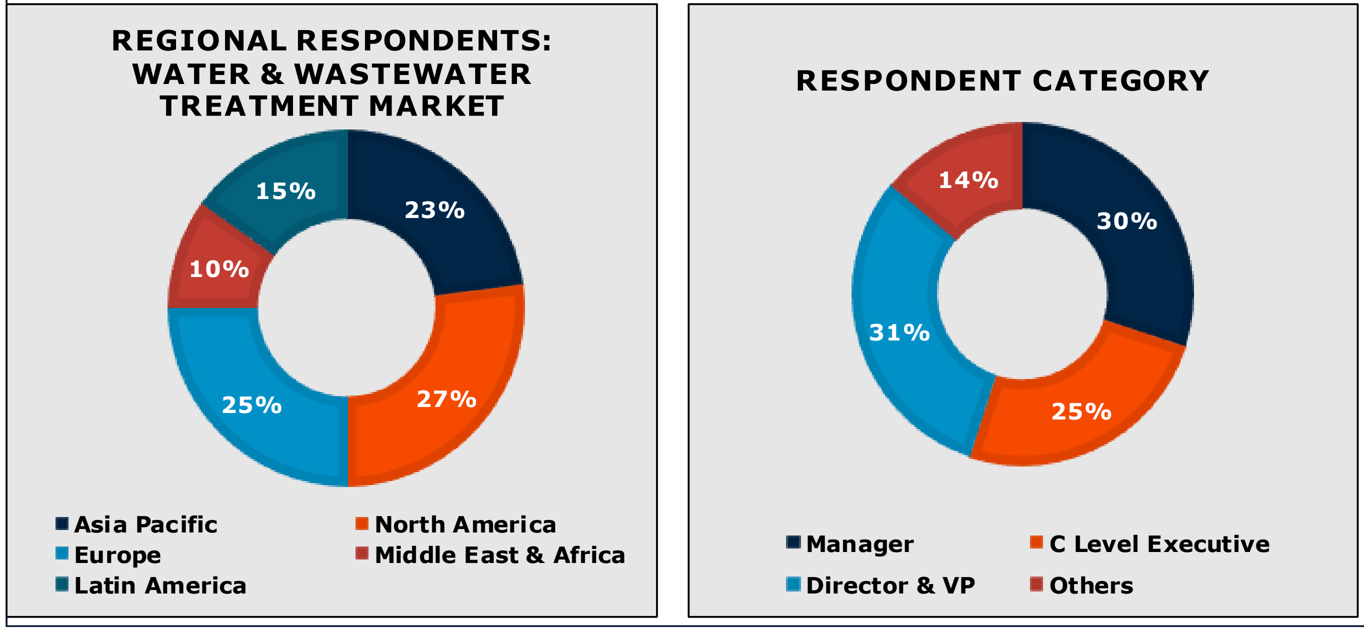
1.3.2. PRIMARY RESEARCH MODEL

Post conglomeration of the data obtained through secondary research; a validation process is initiated to verify the numbers or figures. This process is usually performed by having a detailed discussion with the industry experts. Discussions with the subject matter experts were conducted to obtain quantitative and qualitative information and validate our market research findings.

However, we do not restrict our primary interviews only to the industry leaders. Our team covers the entire value chain while verifying the data. A significant number of suppliers and stakeholders are interviewed to make our findings authentic. The current trends, which include the drivers, restraints, and opportunities, are also derived through the primary research process.

FIGURE 2. PRIMARY INTERVIEW BREAKDOWN: INDIA WATER AND WASTEWATER TREATMENT MARKET

Primary Interview Breakdown : Water And Wastewater Treatment Market



Stakeholder(s)	
Stakeholder Domain	**Percentage**
COO/EVP/VP/Executives	47%
Manufacturer/Project Management Executives	38%
Industry Experts	15%

1.4. MARKET ESTIMATION

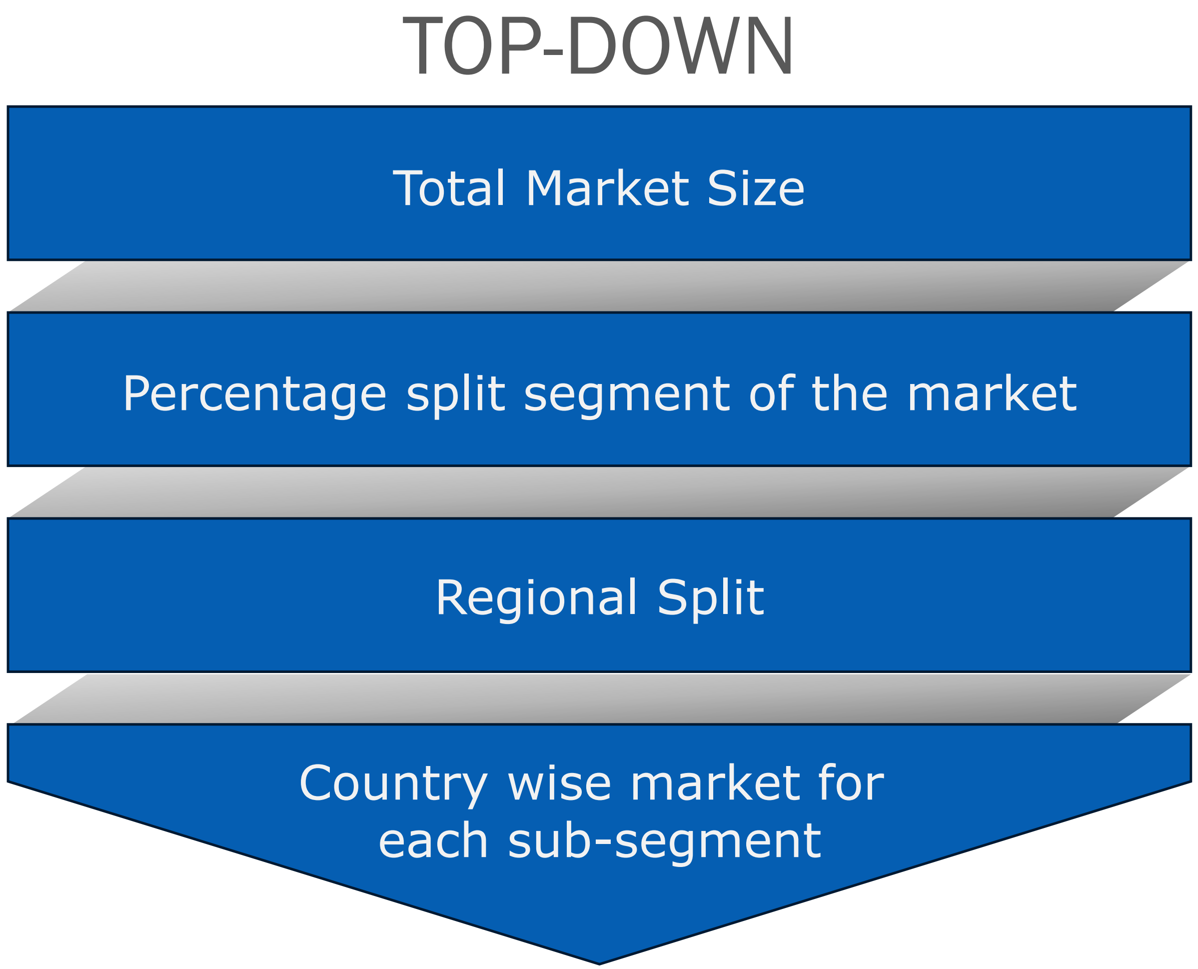
The market estimation is conducted by analyzing the data collected through both secondary and primary research. This process involves market breakdown, bottom-up and top-down approach.

Moreover, while forecasting the market a comprehensive statistical time series model is designed for each market. Macroeconomic indicators have been taken into consideration to understand the current trends of the market. The process of data triangulation method to arrive at the final market estimates verifies each data point.

Top-down, as well as the bottom-up approach, were used for the estimation and validation of the global market. These methods were applied extensively for the estimation of the market size of the sub-segments as well. Key stages for the market estimation included:

- Identification of the key players in the industry through extensive secondary research.
- Determination of the industry’s supply chain and market size (in terms of value) through primary and secondary research processes.
- Determination of percentage shares, splits, and breakdowns of each sub segments using secondary sources and its validation through primary sources.

FIGURE 3. TOP-DOWN APPROACH



1.4.1. MARKET SHARE BASED APPROACH

The global as well as key regional market players involved in the market were identified through extensive research. The market share of major players for the total product was estimated in a manner that approximately 80% of the products market was covered. The market revenue was then extrapolated to reach the global market value for the market.

Brand-wise regional market for each player was estimated on the basis of the products offered by the companies present in each region/country. Along with products, the analyst also covered the regional as well as end-use market trends to determine the forecasts.

Thus, the regional/country-wise market was estimated for each product segment for each End-Use.

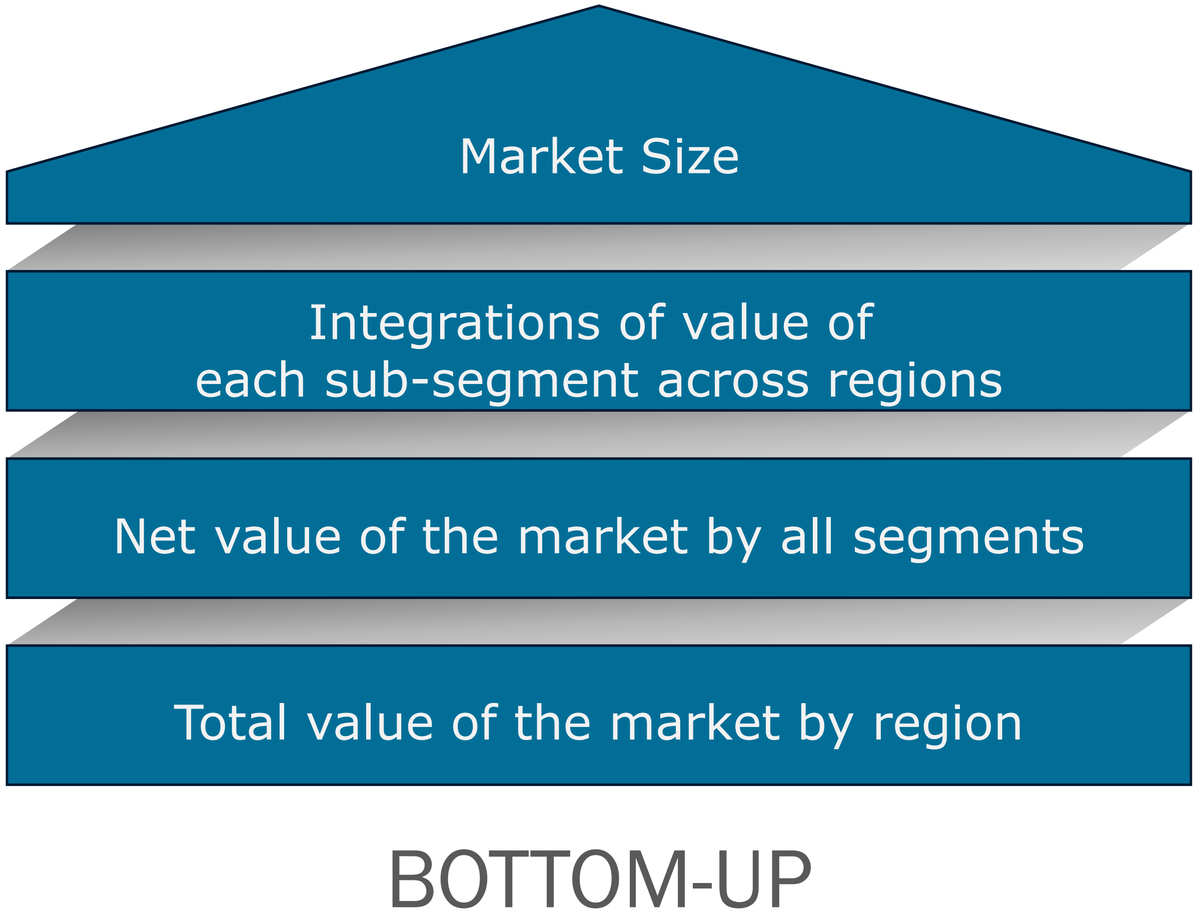
1.4.2. END-USE BASED APPROACH

The average selling price (ASP) of each product was determined. A comprehensive analysis was carried out to obtain average selling prices of all materials of products offered by market players operating in an individual region/country. The obtained data were used to calculate the average selling price for each product material. Furthermore, Volume consumption for each product material was determined in each region/country.

Market revenue was estimated using average selling price and the volume consumption of products for each End-Use segment in every region/country.

The market values from both the approaches were triangulated to calculate the global market value.

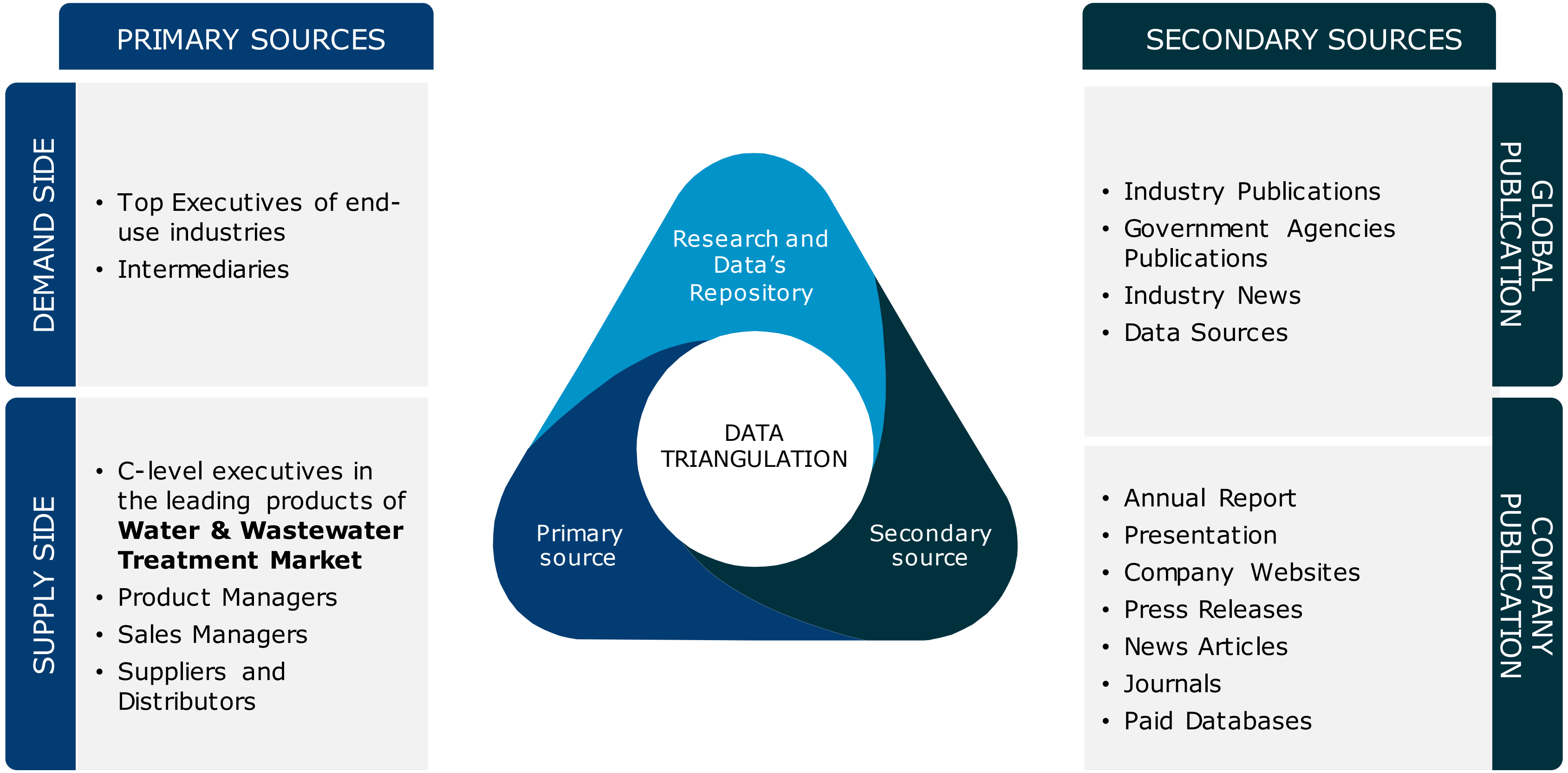
FIGURE 4. BOTTOM-UP APPROACH



1.5. DATA TRIANGULATION

The process of data triangulation method was applied to arrive at the final market estimates verify each data point. Upon estimation of the global market size using the market size estimation approaches as explained above; the market was split into several segments and sub-segments. To complete the overall market estimation process and reach accurate statistics of the individual market segment and sub-segment, the data triangulation and market breakdown processes were applied, wherever applicable. The data was triangulated by studying various factors and trends from both the production side and consumption sides in the industry. Moreover, while forecasting the market a comprehensive statistical time series model was designed for the market. Macroeconomic indicators were taken into consideration to understand the current trends of the market.

FIGURE 5. DATA TRIANGULATION



Source: Journals & Articles, Press releases, Company websites, Investor presentations & Whitepapers, Annual Reports, Primary Interviews, and Reports and Data

1.6. ASSUMPTIONS & LIMITATIONS

Parameter	Description
Market Value	For the Water and Wastewater Treatment market study value is considered in USD Billion
Exchange Rate	The exchange rate fluctuations are assumed to be stable enough, that it does not have a significant effect on market forecasts
Price	Average Selling prices are considered
Economic & Political Stability	It is assumed that all countries have economic & political stability

2. WATER AND WASTEWATER TREATMENT MARKET OVERVIEW

2.1. EXECUTIVE SUMMARY

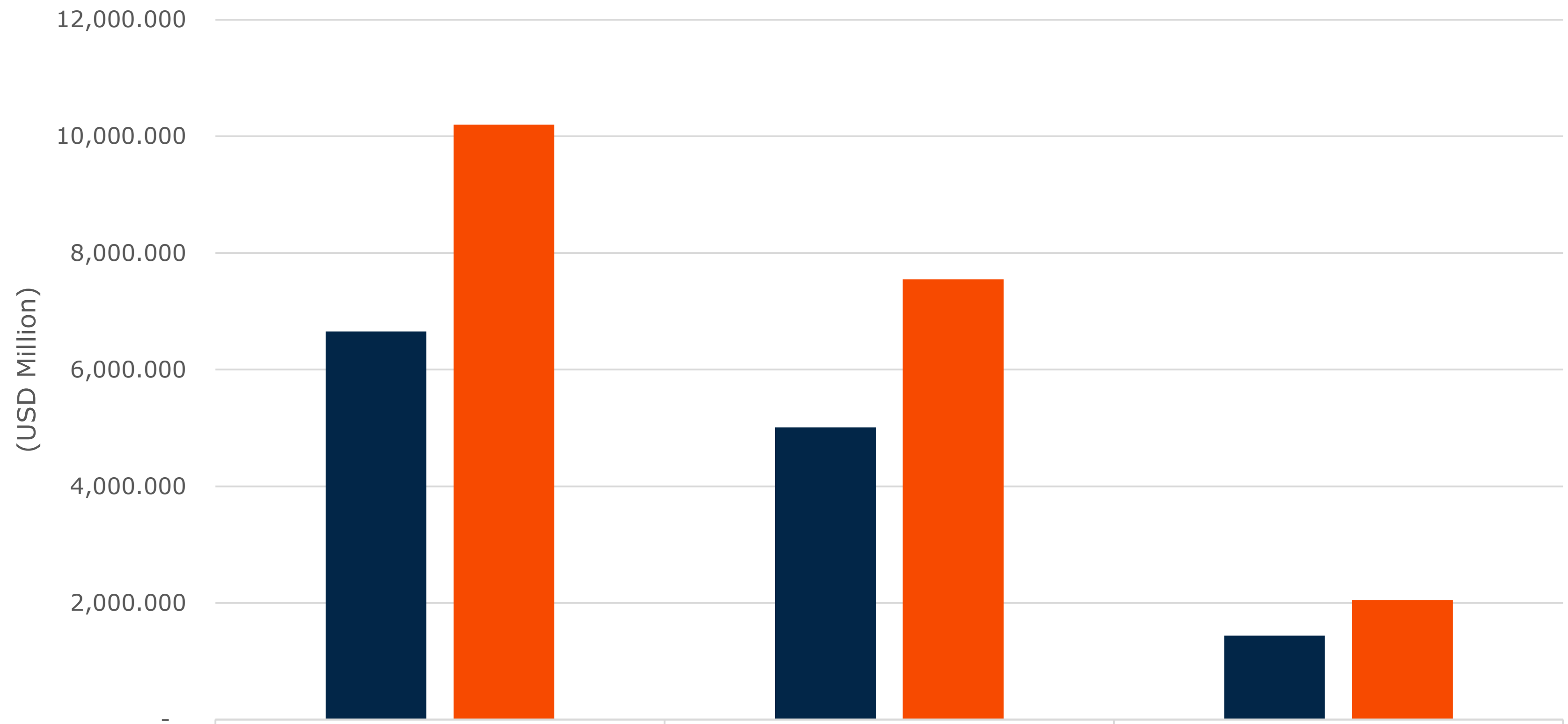
The India Water and Wastewater Treatment market is expected to grow at a CAGR of 6.08% in terms of value to reach USD 19,799.980 Million in 2030 from USD 12,380.787 Million in 2022.

In India, the demand for drinking water and the production of wastewater have surged exponentially due to the country's robust economic growth and rapid urbanization. The premier cities and towns, constituting over 70% of the urban population, are responsible for a significant portion of wastewater generated per person. Alarmingly, untreated urban wastewater accounts for a substantial 70% of all discharges into rivers and oceans. Growing concerns about environmental degradation drive the market's growth prospects in India. The susceptibility of India's population to water supply changes and wastewater issues is pronounced. With more than 70% of households relying on agriculture and a significant portion of cultivated land being rain-fed, climate change impacts on the monsoon have severe ramifications for agriculture and vulnerability. To address these challenges, the Indian government has launched ambitious initiatives like the Jal Jeevan Mission-Har Ghar Jal, AMRUT, NAMAMI Gange Programme, and SWAJAL, aimed at expanding water and wastewater treatment infrastructure.

The business of water and industrial water treatment is advancing at twice the rate of industrial GDP growth, as companies recognize the essentiality of water preservation for their operations. Thermal power plants are the major consumers of industrial water, accounting for 87.8% of total usage. Industries like power, textile, pulp and paper, and FMCG are the primary clients for water solution providers, suggesting that the growth of India's industrial sector will significantly impact market expansion. Water and wastewater management represent a promising niche within India's environmental technology sector. The projected water demand in India is expected to double the available supply by 2030. Responding to this challenge, both public and private sectors are actively planning comprehensive water treatment and distribution systems. The demand for advanced treatment technologies is rising, supported by government initiatives such as the Atal Mission for Rejuvenation and Urban Transformation, National Mission for Clean Ganga, Jal Jeevan Mission, and Community Drinking Water Schemes.

In May 2019, the establishment of the Jal Shakti Ministry unified various water-related agencies to ensure safe drinking water for India's population. Subsequently, the Jal Jeevan Mission was launched to provide piped drinking water to 146 million households across 700,000 villages by 2024, with a significant budget allocation. This ambitious initiative has created opportunities for water meter suppliers, water quality monitoring systems, IT systems for water management, tertiary treatment technologies, and water-focused Engineering, Procurement, and Construction firms. In various sectors like power, food and beverage, chemicals, pharmaceuticals, refineries, and textiles, the private industry is gravitating toward advanced treatment technologies, particularly reverse osmosis membranes, for wastewater treatment. The shift from chemical treatment to membrane-based technologies is underway, and concepts like wastewater recycling and zero discharge systems are gaining traction, supported by innovative technologies like sequencing batch reactors (SBR) and membrane bioreactors (MBR). Leading the way, Tamil Nadu and Gujarat are pioneering the establishment of desalination plants to bolster drinking water supply, while several industries are adopting desalination facilities for process water needs. Industries are increasingly embracing principles like Reuse, Recycle, and Zero Liquid Discharge to enhance water management and reduce environmental impact.

FIGURE 6. INDIA WATER AND WASTEWATER TREATMENT MARKET: TYPE (IN USD MILLION)

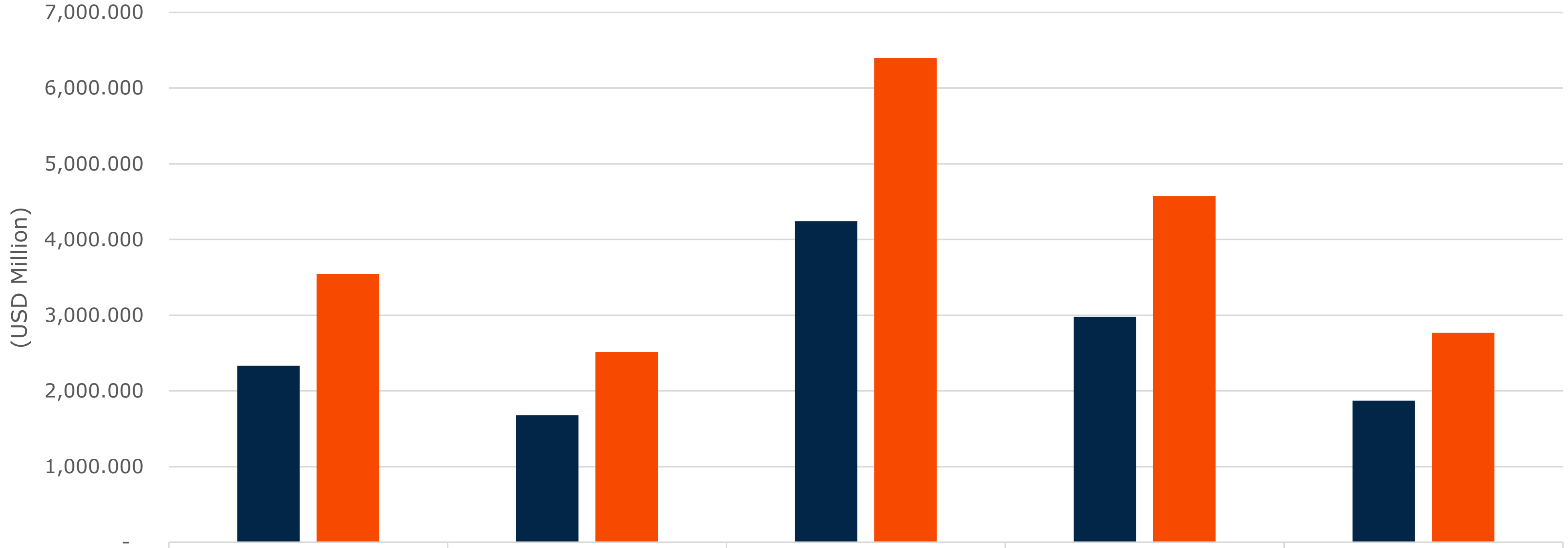


	Water Treatment	Sewage Treatment	Effluent Treatment
2023	6,654.796	5,008.400	1,437.961
2030	10,201.477	7,549.278	2,049.225

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

Based on type, the water treatment segment is expected to have major share in the water and wastewater treatment market with a CAGR of 6.29% in terms of value. The water treatment sector plays a critical role in addressing the country's mounting water challenges, driven by factors such as population expansion, urbanization, and industrialization. As India grapples with issues of water scarcity and pollution, the demand for effective water treatment solutions is burgeoning. Stringent environmental regulations and a growing awareness of the importance of sustainable water management are further propelling the adoption of advanced treatment technologies. This shift is particularly evident in industries such as manufacturing, power generation, and pharmaceuticals, which require substantial water resources while striving to reduce their ecological footprint. The government's initiatives, like the Swachh Bharat Abhiyan and the National Mission for Clean Ganga, also emphasize the need for comprehensive water and wastewater treatment solutions. These factors collectively create a favorable landscape for the water treatment segment to dominate the Indian water and wastewater treatment market. As the nation strives for holistic water management, the sector's consistent growth promises to address the pressing challenges of water scarcity and contamination, contributing to a sustainable and healthier future for India.

FIGURE 7. INDIA WATER AND WASTEWATER TREATMENT MARKET: OFFERING (IN USD MILLION)

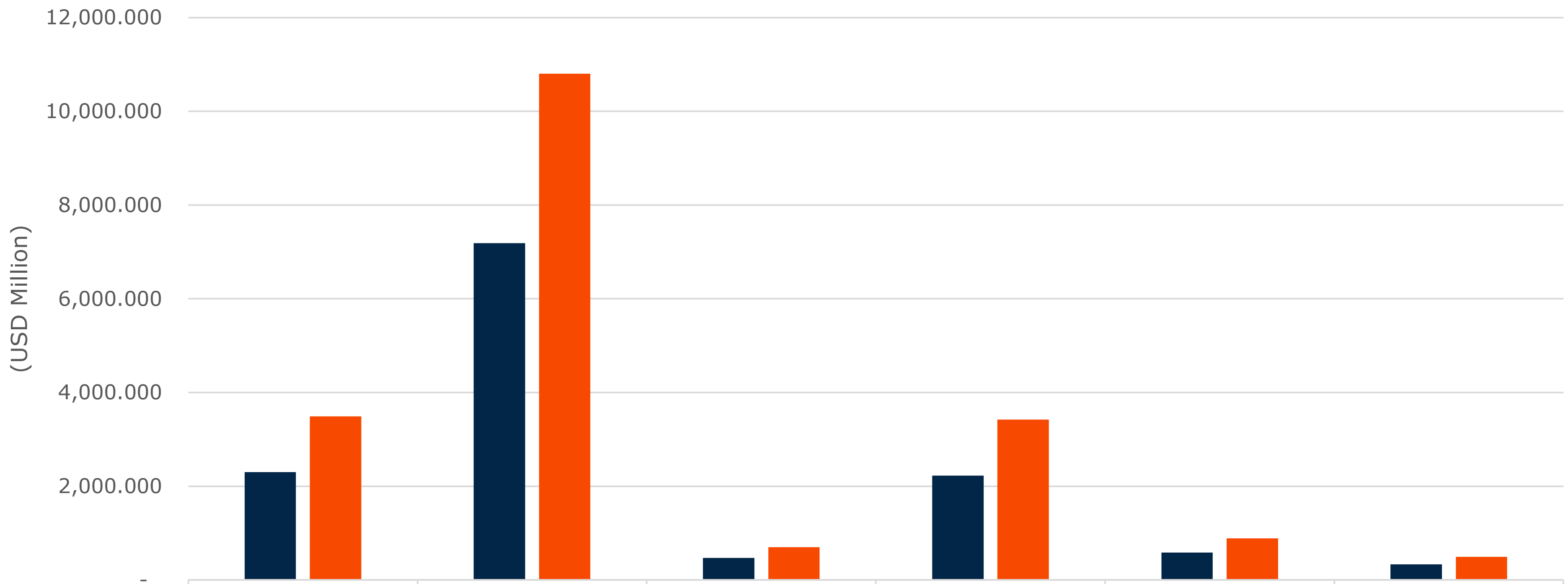


	Treatment Technologies	Treatment Chemicals	Process Control and Automation	Design, Engineering, and Construction Services	Operation and Maintenance Services
2023	2,331.020	1,677.738	4,240.167	2,979.416	1,872.816
2030	3,545.169	2,516.035	6,395.672	4,573.019	2,770.086

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

Based on offering, the process control and automation segment is expected to have major share in the water and wastewater treatment market with a CAGR of 6.05% in terms of value. Process control and automation technologies are revolutionizing the water and wastewater treatment landscape in India. These advanced systems offer real-time monitoring, data analytics, and remote operation capabilities, enhancing operational efficiency, minimizing human intervention, and optimizing resource utilization. As industries and municipalities grapple with escalating water scarcity and stricter environmental regulations, these technologies prove indispensable in ensuring sustainable water management practices. The driving force behind this projected growth is multifaceted. Rising population, urbanization, and industrialization are straining water resources, necessitating more efficient and effective treatment processes. Moreover, increasing awareness of the need for environmental preservation is prompting investments in modern water treatment solutions. The Indian government's initiatives towards cleaner water bodies and the 'Make in India' campaign further stimulate the demand for innovative, homegrown technologies.

FIGURE 8. INDIA WATER AND WASTEWATER TREATMENT MARKET: EQUIPMENT (IN USD MILLION)

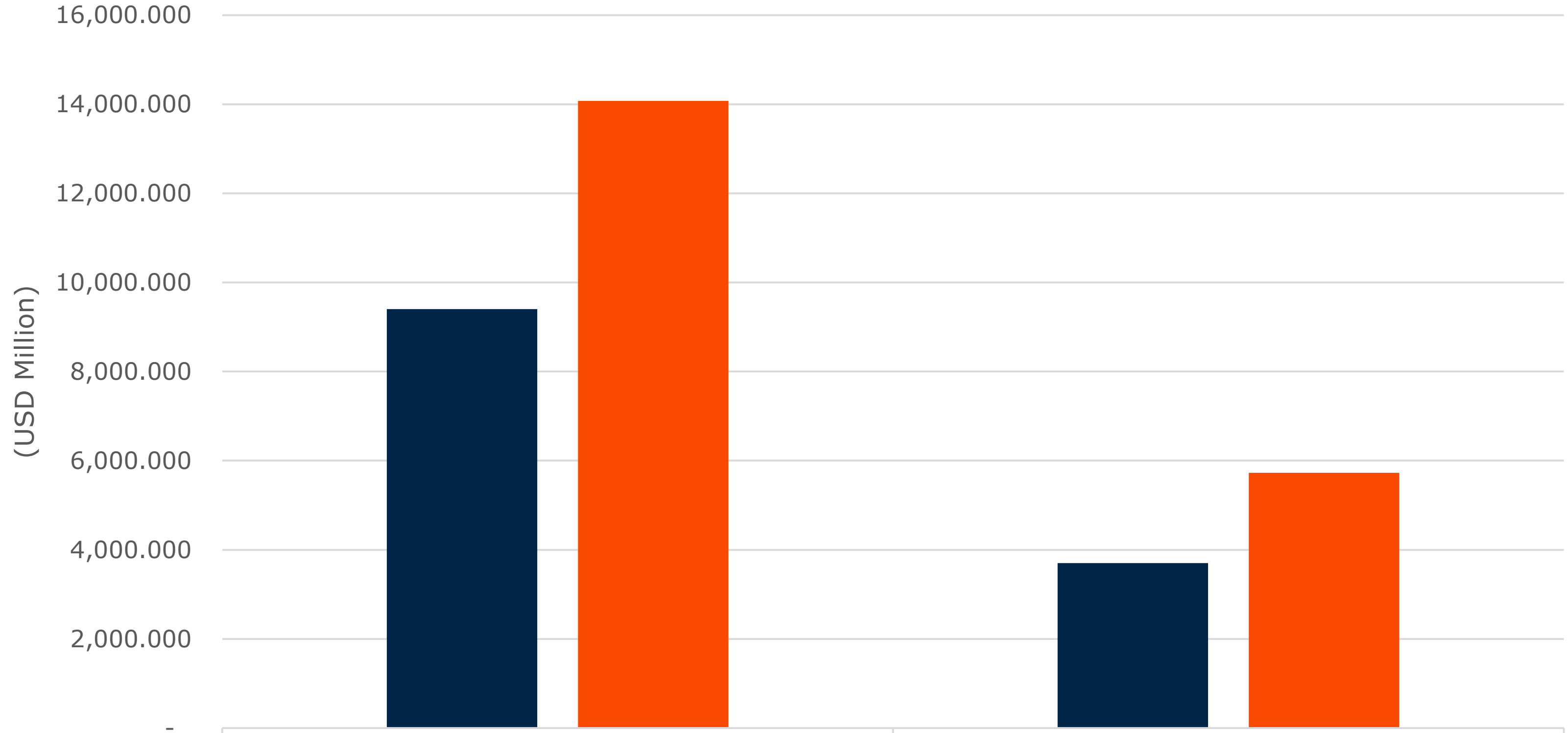


	Filtration	Disinfection	Adsorption	Desalination	Testing	Others
2023	2,300.102	7,188.642	472.160	2,224.839	583.470	331.944
2030	3,492.374	10,804.486	700.809	3,419.981	889.787	492.543

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

Based on equipment, Disinfection segment is expected to have major share in the water and wastewater treatment market with a CAGR of 5.99% in terms of value. As environmental concerns and health awareness gain prominence, the need for effective disinfection processes in water and wastewater treatment becomes paramount. This segment's anticipated prominence is further reinforced by advancements in disinfection technologies, ensuring the mitigation of harmful pathogens and contaminants from water sources, safeguarding public health and ecosystem integrity. India's burgeoning population, urbanization, and industrial expansion accentuate the significance of reliable water treatment practices. As such, the Disinfection segment's growth is symbiotically linked to these demographic and economic trends. From chemical disinfectants to cutting-edge UV and ozone treatment solutions, the sector is witnessing a dynamic fusion of innovation and application.

FIGURE 9. INDIA WATER AND WASTEWATER TREATMENT MARKET: END-USE (IN USD MILLION)

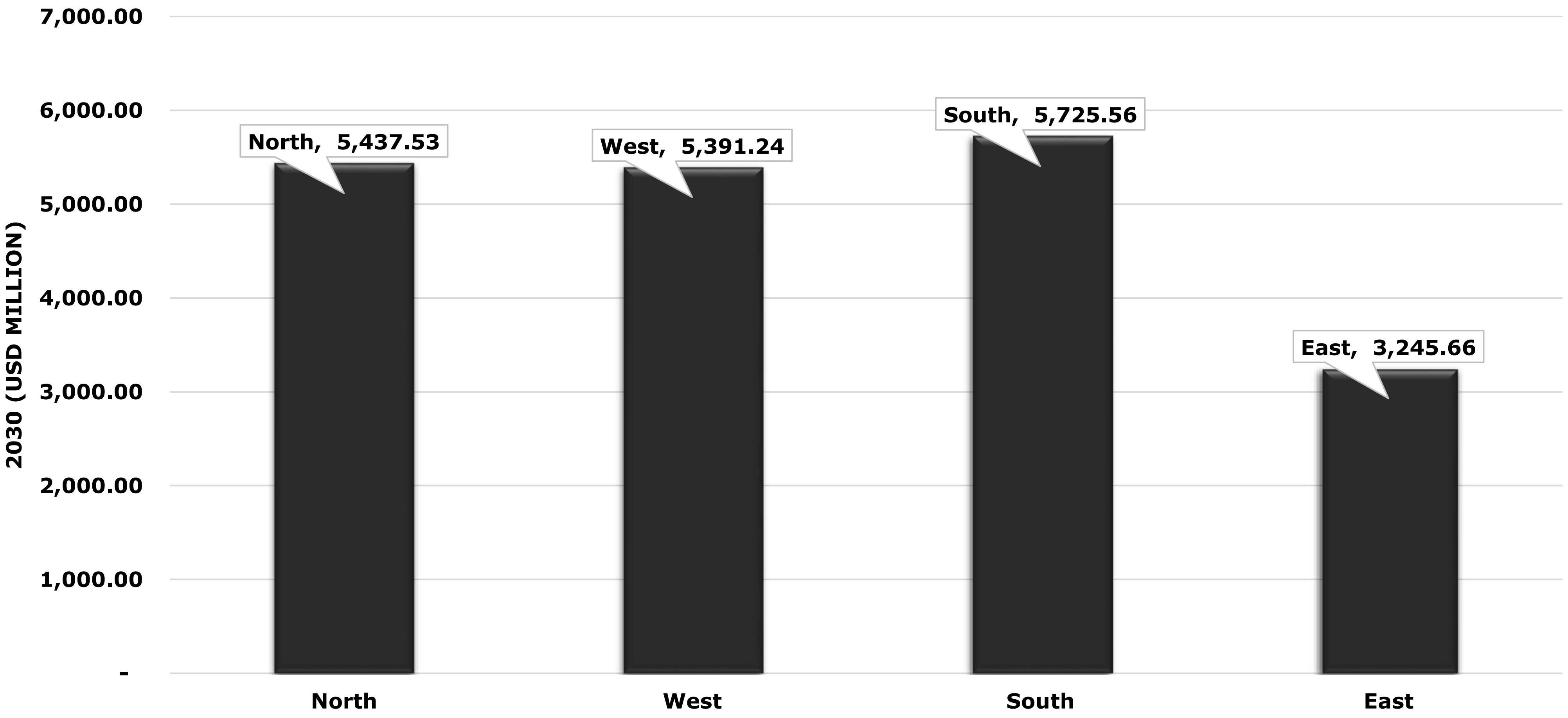


	Municipal	Industrial
2023	9,401.306	3,699.852
2030	14,074.535	5,725.445

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

Based on end-use, the municipal segment is expected to have major share in the Water and Wastewater Treatment market with a CAGR of 5.93% in terms of value. The municipal sector's prominence can be attributed to the ever-growing urban population and the imperative of ensuring clean and potable water for cities and towns across the nation. As urbanization accelerates, so does the demand for efficient water and wastewater management solutions. The municipal segment encompasses a wide array of applications, including water purification, sewage treatment, and recycling, which collectively contribute to sustainable urban development. In a country where access to clean water remains a critical concern, the municipal segment's projected growth reflects a commitment to address this challenge head-on. Government initiatives, regulatory frameworks, and public-private partnerships further amplify the sector's significance, fostering investments and technological advancements in wastewater treatment, distribution, and reuse. As India strives to strike a balance between rapid urbanization and environmental stewardship, the pivotal role of the municipal segment becomes unmistakable. With an anticipated CAGR of 5.93% in value, this segment not only drives economic growth but also underscores the nation's commitment to equitable access to clean water resources, thus setting a sustainable trajectory for India's water and wastewater treatment endeavors.

FIGURE 10. INDIA WATER AND WASTEWATER TREATMENT MARKET: REGION (IN USD MILLION)



Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

Based on region, south India is expected to have major share in the Water and Wastewater Treatment market with a CAGR of 6.11% in terms of value. Several factors contribute to South India's anticipated dominance in this sector. The region's burgeoning population, urbanization, and industrialization are driving unprecedented demand for effective water and wastewater treatment solutions. With increasing environmental awareness, stringent regulations, and the imperative to ensure sustainable resource management, the need for advanced treatment technologies is paramount. South India's geographical diversity, encompassing both urban conglomerates and rural communities, underscores the multifaceted nature of the water and wastewater treatment challenge. This diversity necessitates adaptable and scalable solutions that can cater to a wide spectrum of requirements. As a result, the market is witnessing an influx of innovative technologies and practices aimed at addressing this complexity.

TABLE 1. SOME OF THE MAJOR WATER AND WASTWATER TREATMENT COMPANIES PROFILED IN THE REPORT ARE AS FOLLOWS:

COMPANY	HEADQUARTERS
Ion Exchange India Ltd	Maharashtra, India
VA TECH WABAG LTD.	Chennai, India
Larsen & Toubro Limited	Maharashtra, India
Thermax Limited	Maharashtra, India
Triveni Engineering & Industries Ltd.	Noida, India
KIRLOSKAR BROTHERS LIMITED (INDIA).	Maharashtra, India
IVRCL Infrastructures and Projects Ltd	Hyderabad, India
NCC Limited	Kolkata, India
Praj Industries	Maharashtra, India
SPML Infra Limited	Kolkata India

Veolia India	Uttar Pradesh, India
SUEZ Group	Paris, France
Evoqua Water Technologies LLC	Pennsylvania, United States
Ecolab	Minnesota, United States
Aquatech International LLC	Pennsylvania, United States

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

TABLE 2. SOME OF THE MAJOR WATER AND WASTWATER INFRASTRUCTURE COMPANIES PROFILED IN THE REPORT ARE AS FOLLOWS

COMPANY	HEADQUARTERS
Felix Industries Ltd	Gujrat, India
Tata Projects Limited	Maharashtra, India
SHAPOORJI PALLONJI	Maharashtra, India
Hindustan Dorr-Oliver Ltd	Maharashtra, India
AECOM	Haryana, India
Hitachi, Ltd	Tokyo, Japan
Black & Veatch Holding Company	Kansas, United States
HCC	Maharashtra, India
Gammon India Limited	Maharashtra, India
Shivsu Canadian Clear International Ltd	Chennai, India

IDE Technologies India Pvt Ltd	Uttar Pradesh, India
Ionic Engineering Technology Pvt. Ltd	Maharashtra, India
Forbes Marshall	Maharashtra, India
Oryana Ventures	Maharashtra, India
SFC ENVIRONMENTAL TECHNOLOGIES PVT. LTD	Maharashtra, India

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

3. INDICATIVE METRICS

3.1. THE MACRO INDICATORS

3.1.1. RISING DEMAND FOR WATER AND WASTEWATER TREATMENT

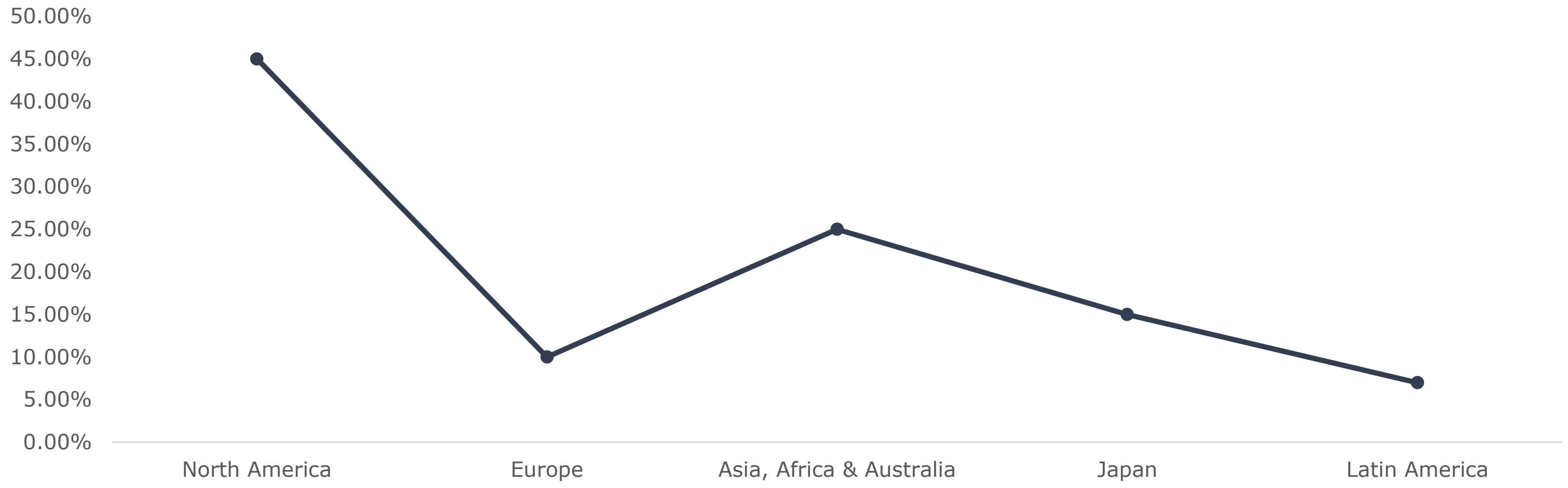
The quality of the water is one of the essential parameters for human health, ecosystem, and social and economic development. Moreover, rapidly increasing global population has been resulting in degradation of the natural environments, with major challenges being the need for sufficient and safe water supplies and resources. Governments of various countries, private firms, manufacturing sectors, and water resource organizations and management are aiming to minimize water pollution and promoting use of water and wastewater treatment processes and techniques. Also, adoption of water and wastewater treatment would help in protecting the ecosystem from untreated effluent discharge and reuse of industrial water, and produce nutrients, energy, and other recoverable materials.

Furthermore, the need of proper wastewater treatment has been became the keynote of UN's campaign at the occasion of The World Water Day. In a number of developing countries in the low-income areas of cities and towns, a wide proportion of wastewater is directly discharged without or with very little treatment into the informal drainage channel system and closest surface water drain. Several urban-based hospitals and industries including, small-scale mining and motor garages discharge medicinal waste, highly toxic chemicals, oils, and grease, into water bodies, whereas improper household effluent and human waste management system would adversely impact the water bodies. Hence, demand for water as a result of rapid urbanization would require adoption of new approaches for collection and management of wastewater. Treated water can then be reused for agriculture activities and industrial activities. In industrial sectors, the treated water can be utilized within the facilities or between various other businesses through ‘industrial symbioses. For instance, the treated water can be utilized for industrial cooling or heating activities, irrigation, toilet flushing, and vehicle washing, among others. As per several research, demand for water would exceed supply by 40 per cent in 2030. As a result, treatment of water and wastewater will become increasingly crucial, and this is expected to support market growth over the forecast period.

3.1.2. GROWING PHARMACEUTICAL INDUSTRY

Over the past years, the pharmaceutical sector has become an essential part of the healthcare system globally and plays a vital role in the human development by enhancing the quality of life and minimizing the time spent in hospitals. Much progress over the past years is due to advancements in science and technology, and this has further resulted in the emergence of one of the most research-based industries, which has led to a new era in development of medicines. Increase in research activities led to evolving and promising aspects for groundbreaking cell and gene therapies. During the COVID-19 pandemic major research initiatives and numerous activities were carried out and still further research is ongoing. These ongoing research activities help in studying epidemics and pandemics, and in searches for cures for chronic diseases. Currently, the pharmaceutical industry is considered as one of the largest and fastest growing industries across the globe.

FIGURE 11. GLOBAL PHARMACEUTICAL SECTOR, 2020



Source: India Brand Equity Foundation, International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS), Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank

This rise in the global pharmaceutical sector is expected to drive demand for water and wastewater treatment over the forecast period. High purity water is widely used as one of the key ingredients throughout production processes of various products in the pharmaceutical and healthcare sectors. Utilizing various treatment technologies for very pure water enables the measurement of organic molecule or pollutant levels. This aids in guaranteeing the water, which eliminates the influence of germs and other organic components that could impair the quality of the final product. Additionally, it provides an assessment of cleaning efficiency for the pharmaceutical industry's participants to maintain equipment used in the production of pharmaceuticals. Further, a number of standard tests for the examination of water purity and water for injections have been developed by a number of organizations, including the European Pharmacopoeia, United States Pharmacopoeia (USP), and Japanese Pharmacopoeia. Therefore, a growing pharmaceutical business would have a favorable impact throughout the projection period.

3.1.3. GROWING OIL & GAS INDUSTRY

The oil & gas industry is among the major industries and plays an important role in national and global economy as the world's primary fuel sources. The industry is a global powerhouse of thousands of workers across the world and generates billions of dollars globally each year. In regions with the major presence of National Oil Companies (NOCs), oil and gas companies are vital and often contribute significantly towards national GDP. The three key areas in the industry include upstream, downstream, and midstream. Upstream entails the search for underwater and underground natural gas fields or crude oil fields, and the drilling of exploration wells and drilling into established wells to recover oil and gas. Midstream involves the transportation, storage, and processing of oil and gas. Downstream is the process of filtering the raw materials obtained during the upstream phase. This means refining crude oil and purifying natural gas.

Large volume of wastewater is generated in the oil & gas industry, and various projections suggest that these volumes will continue to rise. The majority of wastewater currently generated in the oilfield-related processes is managed by disposal or through a using a practice known as underground injection, where that water can no longer be accessed or used. Rising concerns in this regard is resulting in various organizations and key stakeholders in the market focusing on implementing more appropriate and eco-friendly wastewater management practices. This is particularly evident in water scarce areas of the globe, and also necessary measures and steps to be taken to treat and renew water and wastewater for other purposes after various processes are being examined. Use of proper treatment technologies in the industry can reduce demand for fresh water and wastewater reuse can be made mandatory practice in order to save resources and raw materials and to meet the principles of economic and environmental sustainability of the oil & gas industry.

3.1.4. GROWING FOOD & BEVERAGE INDUSTRY

Growth of the food and beverage industry is projected to increase continuously. The industry spans the processing of fresh, prepared, or packaged food, as well as alcoholic and nonalcoholic beverages. It also includes manufacturing, packaging, and distribution to meet consumer demand. Rapid globalization, urbanization, and expanding global population has been contributing significantly to expansion and growth of the food & beverage industry. The food & beverage industry working cycle includes regulations, research & development, harvesting, food processing, marketing and consumption.

The water supply and water quality in the F&B industry is critical to the end-product as well as the safety of the ingredients as well as the health and safety of consumer. Microbiologically contaminated or impure water quality can not only affect the quality of the manufactured food and beverages but can degrade the product quality and decrease the shelf life of the product. The World Health Organization (WHO) & FDA have put into place stringent guidelines, which clearly state that properly treated, disinfected water needs to be used for manufacturing, cleaning, and processing of food products.

4. GLOBAL MICRO-ECONOMIC OVERVIEW

4.1. GLOBAL MACROECONOMIC OVERVIEW

According to the World Bank's Global Economic Prospects report, following a robust rebound in 2021, the global economy is now facing a significant slowdown. This deceleration is attributed to several factors, including the emergence of new COVID-19 variants, a surge in inflation rates, rising debt levels, and increasing income inequality. These challenges pose a threat to the recovery, particularly in emerging and developing economies. Additionally, according to estimates published by the Organization for Economic Co-operation and Development (OECD), in the first two decades of the 21st century, emerging markets have witnessed rapid economic development, although at different speeds across different regions. While the economic growth in the OECD member countries has consistently been below the world average, emerging Asian countries have systematically outperformed the economies of other regions.

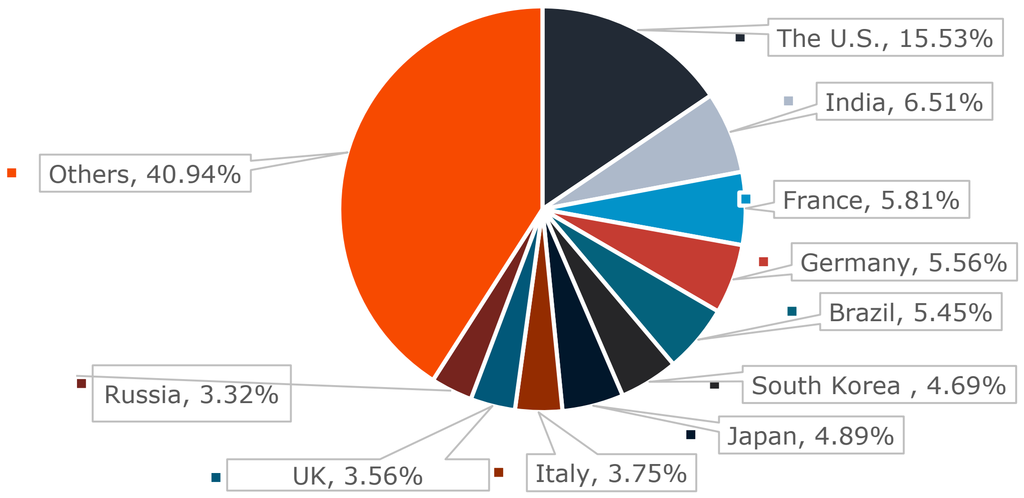
4.2. ECONOMIC IMPACT OF COVID-19 PANDEMIC ON MAJOR ECONOMIES

When the covid19 pandemic started in China it sent shock waves to countries across the globe. As the number of cases across the globe was on a rise, it caused the governments across the world to take drastic action in the form of lockdowns and implementation of strict social distancing measures, to stop the impending catastrophe. These actions had a dramatic impact on the global economy, as industrialists across the globe were forced to halt their production, leading to supply chain disruptions and impairing of various industries. Thus, plummeting the global markets. With China being the epicenter of this pandemic, the export demand shrunk in these countries due to travel restrictions. However, there were possible interventions by the government such as policies providing transport subsidies for export commodities. Companies relying on Asian countries for supply have been hit with a supply crunch as the flow of materials was restricted, thus raising the importance of local players in the market to fulfill demand from end-use sectors that are ramping up productions. Companies are relying on lowering capital expenditure directed to the mines with the highest margins and lowest operating costs as companies are focusing on rebuilding profitability.

The coronavirus outbreak has overturned major economic sectors in the U.S., where the pandemic slowdown has deeply impacted business and jobs. In the global pandemic scenario, the global GDP fell by 2%, whereas developing countries accounted for a 2.5% fall in GDP along with 1.8% in industrial countries as a result of slowing down of economic activities, with supply and demand disruptions. With increasing awareness about the potential risks of COVID-19 across the globe, there have been massive efforts to add capacity and strength to the healthcare system rapidly. As a result of the novel coronavirus pandemic, governments have pushed several nations toward a lockdown. However, nowadays most countries are withdrawing lockdown measures due to COVID-19.

The spread of COVID 19 has disrupted economic activities and has hurt major industries like manufacturing along with the service industry. COVID 19 has dramatically diminished consumer discretionary spending to a freeze on business activities including hiring, capital budgets, and reduction in essential operational expenses. Levying of import tariffs and export restrictions adds to the supply crisis in the market in the wake of the COVID- 19 outbreak.

FIGURE 12. COVID-19 GLOBAL STATISTICS: MAJOR AFFECTED NATIONS: AS OF 17TH AUG-2023

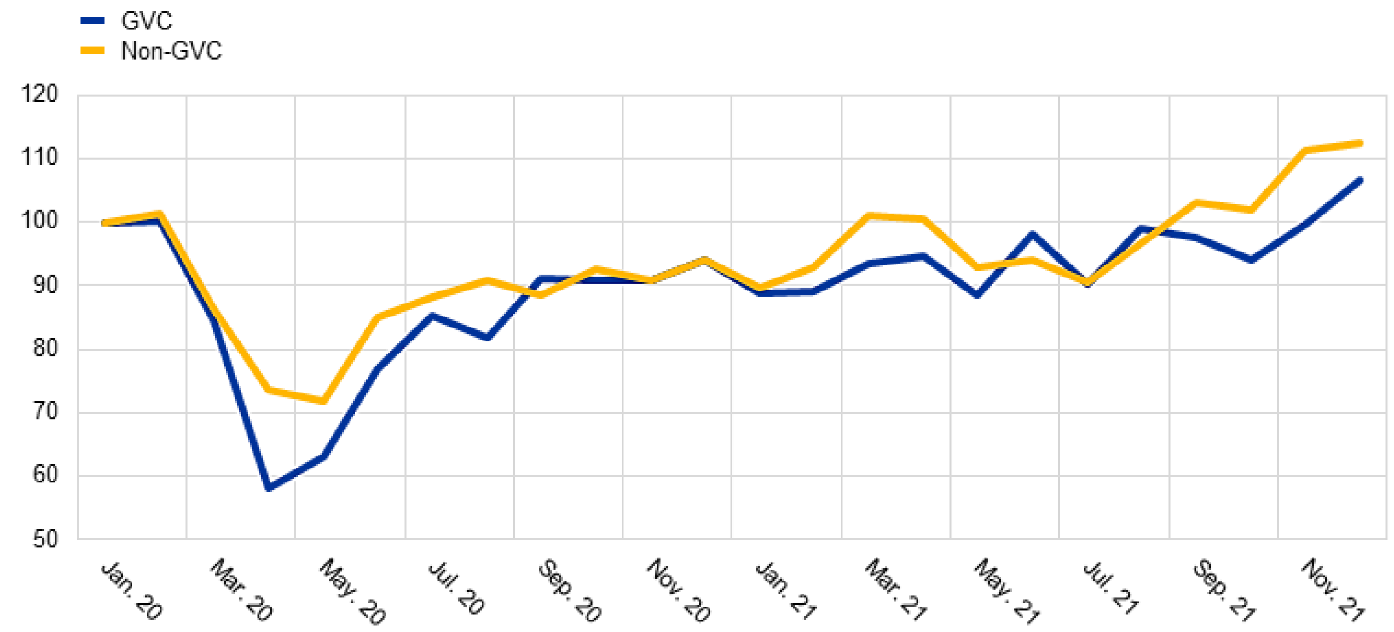


Source: Worldometer estimates

As per the International Labor Organization, all the industries are witnessing a massive drop in demand and investment due to the covid-19 pandemic situation. It struggles with a widespread stoppage of economic activity, as workers stay at home, supply chains come to a halt, and factories are shut down. Restrictions imposed on citizens' movement and the sudden stoppage of economic activity are anticipated to affect severe contraction in the Gross Domestic Product. Companies engaged in prescheduled delivery contracts have delayed delivery dates for local and global clients, and at predetermined prices have to procure raw materials at high prices disturbing operating costs.

With an adverse multiplier effect on the economy through backward and forward linkages, especially in developed countries, the industrial sector plays a vital role as a growth driver. Production plants halting is the most persistent challenge faced by this market, the downfall in production has lowered the demand for the chemicals required to produce end-use products, resulting in lower capacity utilization, and cost pressure to sustain the market for the companies.

FIGURE 13. COVID-19 CRISIS ON EXPORT PERFORMANCE OVER TIME OF GVC FIRMS AND NON-GVC FIRMS



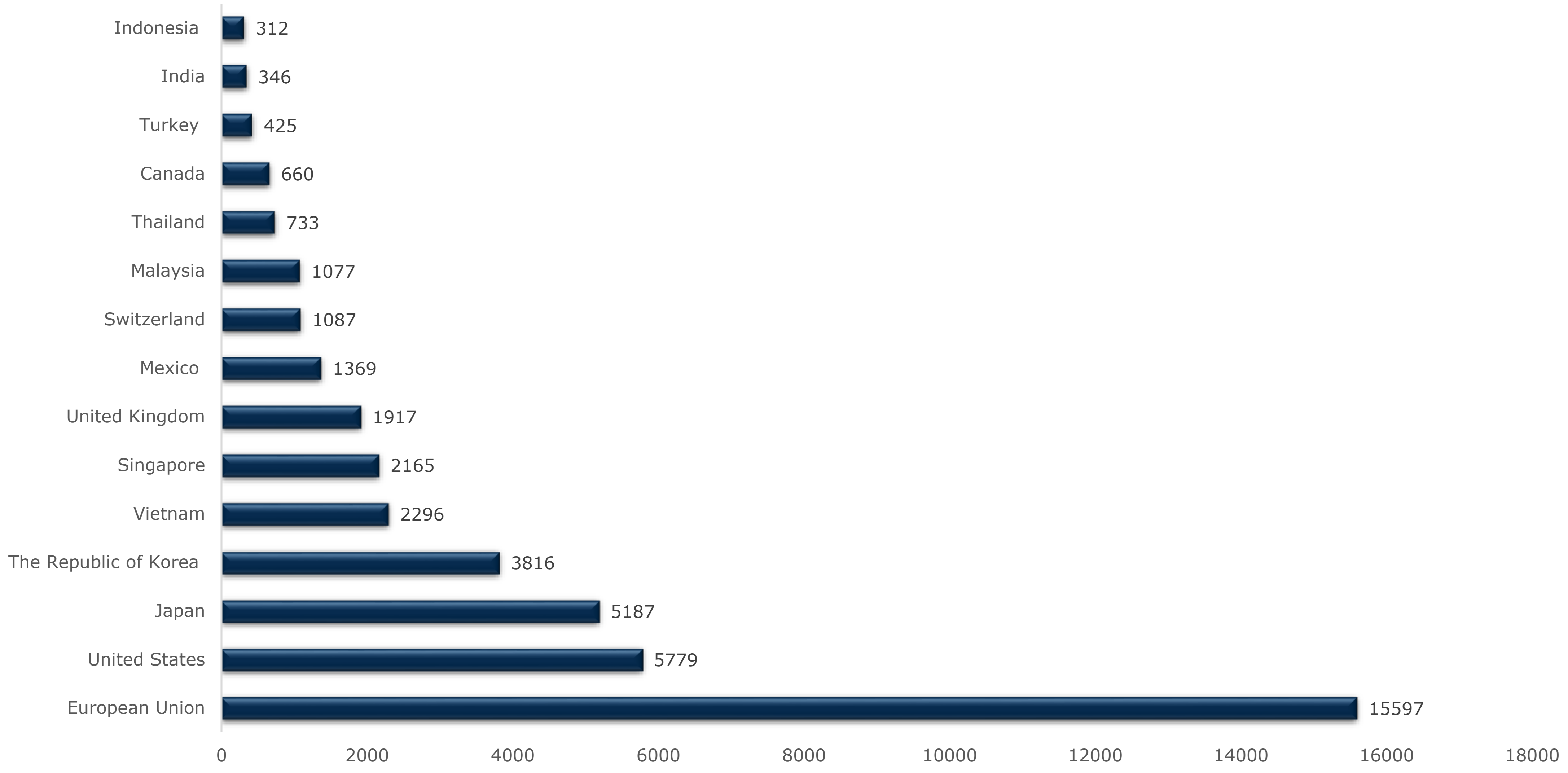
Source: World Health Organization (WHO), GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

On the supply side, measures taken to control the spread of the virus are compelling the chemical and petrochemical manufacturers to reduce the operating rates of their production units, which has not only caused the shortage of raw material availability for a large number of manufacturers but has also resulted in volatility in the prices of these raw materials worldwide. This disruption in the supply chain and the unavailability of the manufacturers to find alternative raw materials suppliers on the fact that international sea logistics systems have been heavily impacted by the virus have compelled the manufacturers to reshape their current and adapt strategies that can enable them to strengthen their supply chain. The global demand has stagnated, and historical capacity expansion has given way to regional overcapacity with a global average utilization of about 40-70%. Another challenge stems from the intensive capital investment required, and many manufacturing companies struggle to generate returns beyond their investment. However, local manufacturers may invest in capacity, increasing last-mile production.

4.2.1. IMPACT ON GLOBAL TRADE

The COVID-19 pandemic represents an unprecedented disruption to the global economy and world trade, as production and consumption are scaled back across the globe. The pandemic has had a noticeable impact on global economic growth. Based on estimates published by the World Trade Organization (WTO), the volume of world merchandise trade is expected to increase by 8.0% in 2021 after having fallen 5.3% in 2020, continuing its rebound from the pandemic-induced collapse that bottomed out in the second quarter of last year. However, the relatively positive short-term outlook for global trade is impaired by factors such as continued weakness in services trade, regional disparities, and lagging vaccination timetables, particularly in poor countries. Thus, the lingering effects of COVID-19 and the rising geopolitical tensions were the main factors impacting trade and output in 2022 and this is likely to be the case in 2023 as well. Interest rate hikes in advanced economies have also revealed weaknesses in banking systems that could lead to wider financial instability if left unchecked. Governments and regulators need to be alert to these and other financial risks in the coming months.

FIGURE 14. TRADE IMPACT OF THE COVID-19 (IN USD MILLION): IN 2020



Source: UNCTAD

According to UNCTAD estimates, the most affected sectors include precision instruments, machinery, automotive and communication equipment. Among the most affected economies are the European Union (USD 15.6 Billion), the United States (USD5.8 billion), Japan (USD 5.2 Billion), The Republic of Korea (USD 3.8 Billion), Taiwan Province of China (USD 2.6 Billion) and Viet Nam (USD 2.3 Billion).

4.2.2. SHUTDOWN OF FACTORIES

Manufacturing facilities are an integral part of a country's supply chain. Though shutting down of factories is a critical decision for both manufacturers and the government, the risk of growing concerns about the coronavirus, companies globally have been opting to go idle rather than risk spreading infection among workers and employees. While manufacturing countries in China and other countries in East and South-East Asia were the first ones to suffer the effects of pandemic, the rest of the countries globally registered production losses in the second and third quarters of the year. The containment measures imposed by the governments globally had severe impacts on both demand and supply due to uncertainties triggered by negative employment and income prospects, a worldwide halt of production for several months. However, based on estimates by the United Nations Industrial Development Organization, after one year of the pandemic, global manufacturing production is on a path of recovery. Estimates suggest that while in 2020, the global annual output growth had dropped by 6.8 % due to the early impacts of COVID-19, in the first quarter of 2021, the global annual output growth of 12.0 %.

4.2.3. SHORTAGE OF LABOR WORKFORCE

Based on studies conducted globally, the COVID-19 has severely impacted labor markets around the world. The pandemic had a devastating impact on the economy and jobs of nearly all countries notably due to lockdown and other containment measures taken by the government to curb the impact of the pandemic. The 2021 IMF World Economic Outlook estimates suggest that while the output in emerging and developing economies witnessed a decline of 2.2 % in 2020, the advanced and developed nations witnessed an average fall of 4.7 %. Furthermore, the economic shock had a major impact on labor markets throughout the world, particularly in the middle-income countries. Reports published by the International Labor Organization (ILO), suggest that the overall, global working hours declined by 8.8 % in 2020, which is approximately equivalent to 2,550 lakh full-time jobs (assuming a 48-hour working week). These working-hour losses take into consideration both job losses as well as the reduction in working hours for those who remained in employment.

The first quarter of 2023 was marked by ongoing economic unpredictability, widespread strikes and protests by workers, and steady inflation, which raised concerns that the world economy would recover more slowly than initially anticipated. The global economy is projected to grow by 2.8% in 2023, which is below prior projections but likely to increase as consumer and corporate confidence rebound. The worldwide unemployment rate is still low even if the world economy appears to be slowly recovering. In the first quarter of 2023, the Organisation for Economic Co-operation and Development (OECD) members' unemployment rate decreased slightly from the fourth quarter of 2022 to remain stable at 4.89%. Workers around the world have voiced their dissatisfaction with the labour market as it stands. Strikes are likely to continue until economic conditions improve or demands are met in the UK, France, Germany, and Spain. These strikes offer insight into the workers' perspective on the labour market.

4.2.3.1. IMPACT ON FOOD & BEVERAGES INDUSTRY

Water and wastewater treatment is widely used in food processing industries. The food & beverage industry remained informed regarding how COVID-19 was impacting the food & beverage industry. As the coronavirus crisis profoundly altered life around the globe, food processing plants are among the vital enterprises that have to keep running. Unlike most microorganisms that can negatively impact food facilities, the novel coronavirus that causes COVID-19 does not pose a direct danger to consumers; and the consensus is that it cannot be transmitted through food or packaging. The major risk is to workers, who have to work in close proximity to each other on the facility floor.

4.2.3.2. IMPACT ON PHARMACEUTICALS INDUSTRY

The outbreak of the pandemic has been reported to be one of the most significant events to impact economies in generations with the potential for ripple effects in the automotive market and supply chain. Accordingly, pharmaceutical raw material and suppliers from all tiers may need to rethink the supply chain model, from the sourcing of raw materials to the production of finished products and everything in between. Since manufacturers rely heavily on just-in-time production, their supply chains were immediately disrupted. In China, almost two-thirds of auto production was directly affected by the country’s industrial shutdown, which had a large impact on their suppliers as well. Some of the most affected regions are major production hubs and home to key links in the sector’s global supply chain.

4.2.3.3. IMPACT ON SEMICONDUCTOR MARKET

After the outbreak of the pandemic several semiconductor end-use industries such as, automotive, aerospace and industrial, among others, were being shut down and halted operations at production facilities. This led to an adverse impact on the semiconductor industry as well. This decline in the production of semiconductors caused a halt in manufacturing and business operations, which resulted in the significant losses for semiconductor companies. This affected various key factors of the sector including business revenues, customer behavior, and various aspects of corporate operations, among others. Several key players faced challenges of unclear future prospects and some of them were unable to survive the crisis and losses. But after the lifting of lockdowns, demand for semiconductors has risen rapidly, but there was a scarcity on the production and supply side of the semiconductor sector. This led to an acute shortage of semiconductors to the end use industries.

4.2.3.4. IMPACT ON OIL & GAS SECTOR

Impact of COVID-19 on oil and gas industry had shown an immediate consequence of 25% reduction in petroleum usage, which will eventually recover to, if not grow, to prior levels. Long-term implications include a 30% to 40% decline in capital expenditure and research and development investments in the oil and gas sector on a regional scale in the United States, resulting in a drop in oil exploitation from 800 projects in 2019 to 265 projects in 2021. It is also likely to make oil and gas less competitive versus renewable energy sources, which are getting increasingly cheaper. As a result, if the oil and gas industry is not to lose a sizable revenue share of the energy market, rapid changes need to be made.

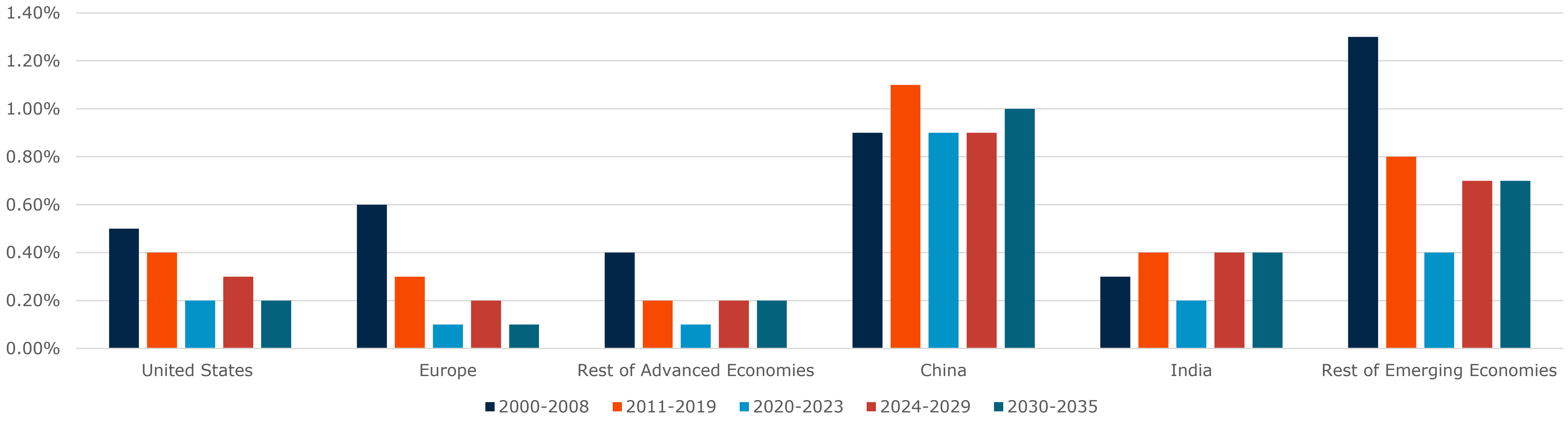
4.2.4. INSIGHT INTO ADVANCED ECONOMIES AND EMERGING MARKETS & DEVELOPING ECONOMIES

4.2.4.1. GLOBAL GDP

Advanced economies and emerging markets & developing economies offer distinct insights into the global economic landscape. Advanced economies, such as the United States, Germany, and Japan, boast developed financial systems, high per capita income, and advanced technologies. These economies drive global growth, innovate new products and services, and attract significant investments. They possess sophisticated infrastructure, well-developed institutions, and stable political environments, facilitating business operations and encouraging foreign direct investment. Furthermore, advanced economies prioritize research and development, education, and innovation, fostering technological advancements and enhancing productivity.

On the other hand, emerging markets and developing economies, including Brazil, India, and South Africa, showcase rapid economic growth potential and a large consumer base. These economies experience various challenges like infrastructure gaps, income inequality, and political instability. However, they offer promising investment opportunities due to their expanding middle class, abundant natural resources, and favorable demographics. Emerging markets often serve as manufacturing hubs and play a vital role in the global supply chain. They attract multinational corporations seeking cost advantages and market expansion.

FIGURE 15. REGIONAL CONTRIBUTIONS TO GLOBAL GDP GROWTH (AVERAGE ANNUAL % CHANGE)



Source: World Bank Data, GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

The global real GDP growth is projected to decline to 2.6 percent in 2023 from 3.3 percent in 2022. Europe, Latin America, and the US are the regions experiencing the most weakness, while Asian economies are expected to be the primary drivers of global growth due to reopening dynamics and lower inflationary pressures. The global GDP growth is anticipated to slow down further to 2.4 percent in 2024, mainly influenced by stagnant growth in the US.

Areas of weakness in the global economy include housing, bank lending, and the industrial sector. However, the strength in other sectors, particularly service-sector activities and labor markets, compensates for these weaknesses. First-half data for 2023 have exceeded expectations, leading to upward revisions in the full-year forecast for many economies. Despite inflationary pressures only moderately decreasing, tight monetary policies persist, making interest rate cuts unlikely for many central banks. The expectation remains for a slowdown in growth in the latter half of 2023 and the first half of 2024. While country-specific deviations may occur, businesses should prepare for a deceleration in global economic growth moving forward. The global economy is projected to experience relatively slow growth of around 2.5 percent for 2023-2024, reflecting a shift to a slower growth environment for the next decade, estimated at an average annual pace of 2.6 percent compared to the pre-pandemic decade's average of 3.3 percent.

Regional Insights:

- East Asia and Pacific: The growth rate is expected to decrease to 5.1% in 2022, followed by a slight increase to 5.2% in 2023.
- Europe and Central Asia: The growth rate is predicted to decline to 3.0% in 2022 and further decrease to 2.9% in 2023.
- Latin America and the Caribbean: The growth rate is projected to slow down to 2.6% in 2022 and experience a slight increase to 2.7% in 2023.
- Middle East and North Africa: Growth is forecasted to accelerate to 4.4% in 2022 before decelerating to 3.4% in 2023.

- South Asia: The growth rate is expected to accelerate to 7.6% in 2022 and then decrease to 6.0% in 2023.
- Sub-Saharan Africa: Growth is forecasted to slightly accelerate to 3.6% in 2022 and further rise to 3.8% in 2023.

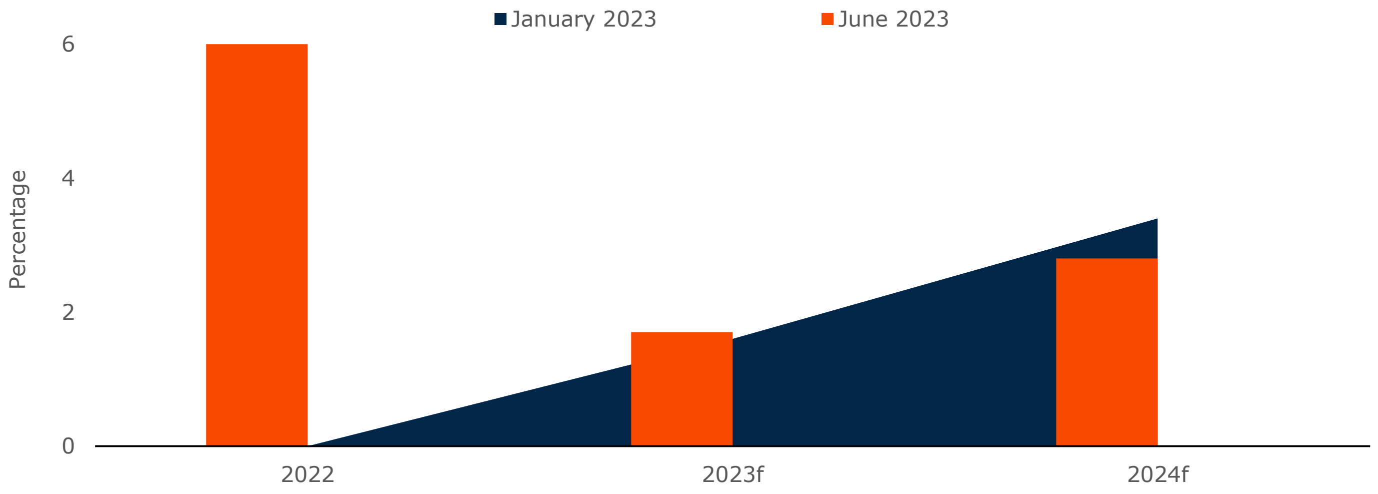
These projections highlight the diverse economic conditions across regions, indicating the need for tailored strategies and policies. Policymakers and businesses should closely monitor these trends to adapt and respond effectively to the changing economic landscape.

4.2.4.2. GLOBAL GDP AND TRADE ANALYSIS

Global trade is being dampened by subdued global demand and the continued rotation of consumption toward services. Energy prices have eased considerably since their peak in 2022 as a result of weaker global growth prospects and a warmer-than-usual winter, which reduced demand for energy for heating. Core inflation around the world has been persistent, resulting in continued monetary tightening. EMDE financial conditions continue to be restrictive, with less creditworthy borrowers facing greater financial strains.

Global growth in the trade of goods decelerated during the first half of 2023, mirroring the weakening trend in global trial production. In contrast, services trade continued to strengthen as mobility restrictions resulting from the pandemic were eased. The arrival of international tourists is projected to reach approximately 95 percent of 2019 levels in 2023, a significant increase from the 63 percent recorded in 2022 (UNWTO 2023). Pressures on global supply chains have subsided due to a decline in goods demand and improved global shipping conditions.

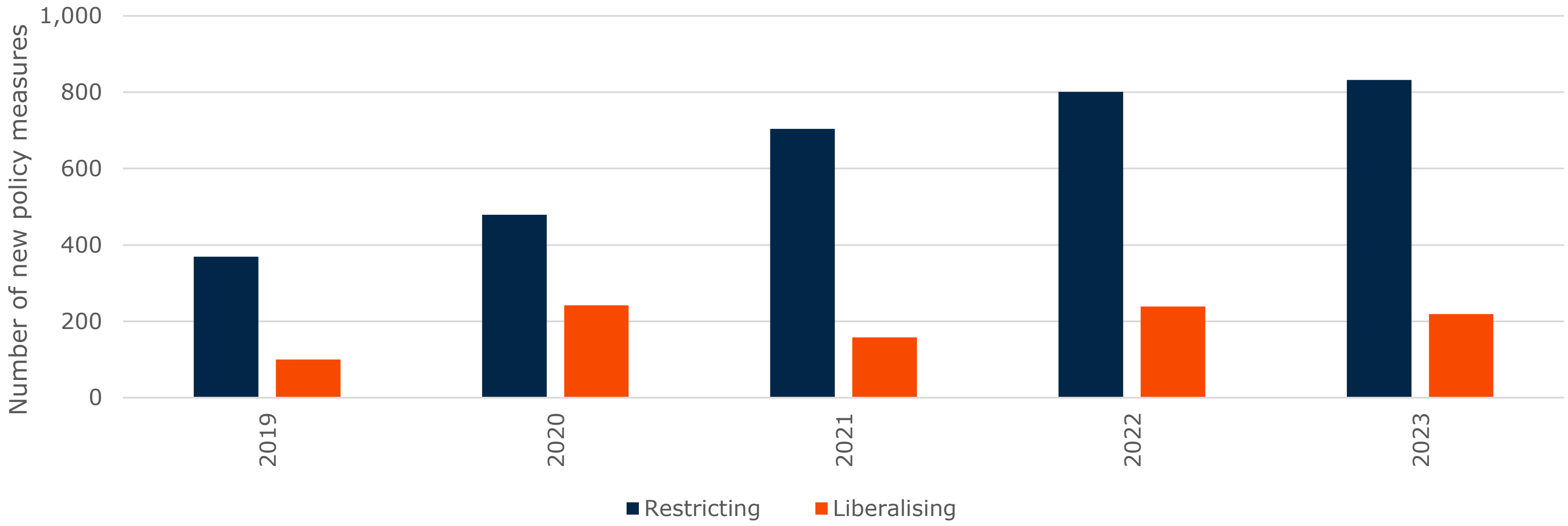
FIGURE 16. GLOBAL TRADE (% OF 2022 & 2023 FORECAST)



Source: OECD estimates, GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank, World Bank, Company Annual Report, Primary Interviews, Reports and Data

The Global Supply Chain Pressures Index and suppliers' delivery times reached their lowest levels in nearly four years during the first half of 2023, with expectations of remaining low. Throughout the pandemic, trade growth was supported by a shift in demand composition towards tradable goods and away from less trade-intensive services. However, as demand gradually returns to its pre-pandemic structure, trade growth has slowed. Additionally, the recovery in China is anticipated to be primarily driven by services, limiting the positive spillover effects on its trading partners' demand for goods and commodities. The increasing number of restrictive trade measures reflects escalating geopolitical tensions and efforts by major economies to adopt more inward-focused policies. In the long term, these factors are likely to reshape global supply chains and elevate trade costs.

FIGURE 17. GLOBAL NEW TRADE MEASURES: IN NUMBERS



Source: OECD estimates, GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank, World Bank, Company Annual Report, Primary Interviews, Reports and Data

Consequently, the responsiveness of global trade to output changes, which had already declined in the 2010s compared to previous decades, is expected to further decrease. Against this backdrop, global trade growth is forecasted to decelerate from 6 percent in 2022 to 1.7 percent in 2023. Once global consumption returns to its pre-pandemic balance between goods and services, trade is predicted to recover to 2.8 percent in 2024, only slightly outpacing GDP growth. The trade outlook faces several downside risks, including weaker-than-expected global demand, tighter global financial conditions, escalating trade tensions among major economies, mounting geopolitical uncertainties, and a further rise in protectionist measures.

4.2.4.3. GLOBAL INFLATION IMPACT

In most economies that adhere to an inflation-targeting approach, the current inflation rate exceeds the target set by central banks. As of April, the global median headline inflation stood at 7.2 percent, a decrease from its peak of 9.4 percent in July 2022. This decline can be attributed to favorable base effects resulting from lower commodity prices and reduced pressures in the supply chain. The moderation in energy prices has also contributed to a slightly milder global inflation in the first quarter of 2023. However, measures of core inflation indicate that the decrease in inflation has been slow, suggesting that the trend of disinflation observed since last year has not made significant progress.

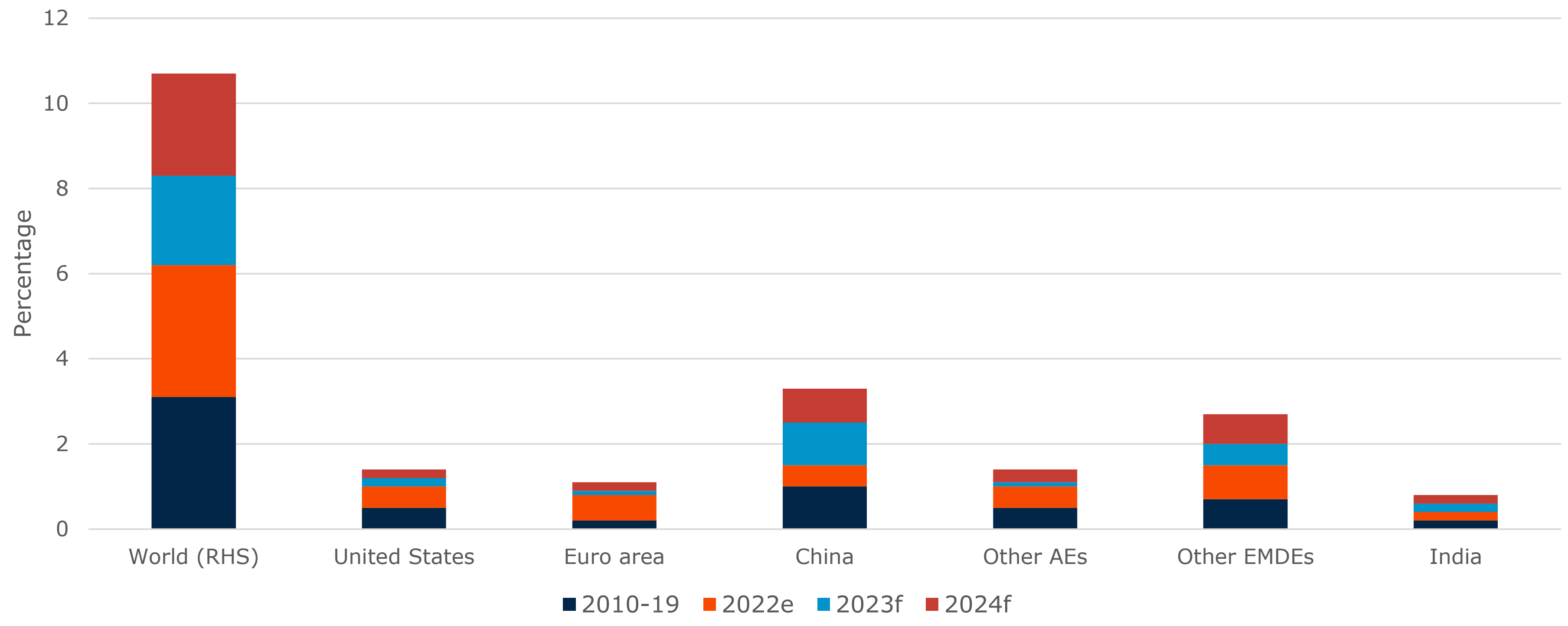
In recent months, emerging market and developing economies (EMDEs) have experienced a slowdown in median core inflation, while advanced economies have seen an increase. Despite improvements in supply chain pressures and declining energy prices, high inflation in advanced economies is primarily driven by excessive demand. Lingering supply capacity issues may also contribute to this situation. In Europe, energy prices hold particular influence as they impact broader prices and contribute to inflation persistence. The discontinuation of fiscal programs that have helped mitigate price spikes for end-users may further worsen this situation. The absence of economic slack, coupled with the ability of firms and workers to exercise pricing power, has made inflation more responsive to economic activity. Market-based measures of long-term inflation compensation in some advanced economies, such as the euro area, have increased despite a decline in oil prices. This suggests a higher risk of inflation remaining above the target level. Consumer surveys indicate that medium-term inflation expectations in the United States and the euro area have remained relatively stable in 2023.

In EMDEs, inflation is either accelerating or stabilizing at elevated levels. Responses to recent shocks, such as wage indexation to inflation and untargeted fossil fuel subsidies, have contributed to widespread inflationary pressures. Sustained high inflation could pose significant challenges for EMDEs, as inflation expectations in these economies are generally less stable and more influenced by current inflation rates compared to advanced economies. Forecasts indicate that EMDEs with inflation-targeting central banks are more likely to successfully reduce inflation in the long term. The reopening of China's economy is not expected to have a significant impact on global inflation. Although domestic inflation in China may increase due to stronger economic activity, it is limited by labor market slack and a recovery that is less dependent on commodities compared to previous periods of rapid growth.

4.2.4.4. GLOBAL OUTLOOKS AND RISKS

Global growth is expected to slow this year as credit conditions tighten due to ongoing monetary tightening and banking sector stress in advanced economies. The drag from tighter financial conditions is becoming increasingly apparent and is expected to peak this year. Inflation has proved persistent but should decline as demand slows and commodity prices moderate, provided longer-term inflation expectations remain stable. Stress in systemically important banks could lead to financial crisis and protracted economic losses. Unexpected persistence in core inflation or further commodity price shocks could result in greater -than-expected monetary tightening and hence increase the risk of a resurgence of financial stress. In the longer term, the slowdown in the fundamental drivers of growth may be exacerbated by trade fragmentation and intensified climate change.

FIGURE 18. CONTRIBUTIONS TO GLOBAL GROWTH: IN PERCENTAGE



Source: OECD estimates, GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank, World Bank, Company Annual Report, Primary Interviews, Reports and Data

Bank balance sheets have sustained losses from recent economic weakness and the unusually rapid rise in interest rates. This could be exacerbated by declines in house prices, which are already taking place in countries accounting for half of global activity. The nature of banking sector vulnerabilities varies, with greater risks in some regions associated with potential loss of liquidity, and others suffering from low bank profitability or limited capital buffers. Financial stress scenarios center on a sharp tightening of financial conditions in advanced economies equivalent to 30 percent of that seen during the 2007-09 global financial crisis. In the first scenario, advanced economy stress does not lead to major spillovers, and the global economy avoids recession as central banks loosen policy, with inflation declining more rapidly than the baseline. In the second scenario, substantial spillovers lead to global financial stress. This pushes the global economy into recession, with inflation falling below target in many countries despite aggressive policy loosening.

Inflation forecasts have been repeatedly revised up—further such revisions could lead to more monetary tightening. Spillovers to emerging market and developing economies (EMDEs) from rising U.S. rates are especially severe when they reflect a more hawkish Federal Reserve, an important feature of the latest tightening cycle. Further increases in bond yields would make borrowing unaffordable for many EMDEs. Global potential growth may decline more than expected. On the upside, continued resilience in advanced-economy labor markets could boost consumption.

5. INDIAN MICRO-ECONOMIC OVERVIEW

5.1. INDIAN MACROECONOMIC OVERVIEW

Following the challenging circumstances caused by the pandemic, the Russian-Ukraine conflict, and inflationary pressures, the Indian economy is currently making strides towards recovery, displaying a widespread revival across various sectors. This resurgence positions India to reclaim its pre-pandemic growth trajectory by the fiscal year 2023. Furthermore, economic indicators indicate that India's GDP growth is expected to maintain its strength in the fiscal year 2024, with forecasts ranging between 6% to 6.8%. An encouraging factor driving this recovery is the significant increase in private consumption during the first half of the fiscal year, reaching its highest level since FY15. Consequently, this upswing in consumption has stimulated production activities, leading to enhanced capacity utilization across sectors.

The involvement of both the Central Government's capital expenditure and private capital expenditure has emerged as pivotal drivers of growth for the Indian economy in the current year. Strengthened corporate balance sheets have facilitated higher private investment, while the government's capital expenditure has also contributed to this positive momentum. It is worth noting that the micro, small, and medium enterprises (MSME) sector has witnessed an average credit growth of over 30.6% from January to November 2022, indicating support for small businesses. Another positive development is the achievement of bringing retail inflation back within the target range set by the Reserve Bank of India (RBI) in November 2022. This accomplishment signifies effective monetary policy measures aimed at managing inflationary pressures. Additionally, the Indian Rupee has demonstrated favorable performance compared to other emerging market economies between April and December 2022, showcasing relative stability and resilience.

The Indian economy has also experienced robust direct tax collections from April to November 2022, further bolstering the optimistic economic outlook. Furthermore, there has been an improvement in employment generation, evident through a decline in urban unemployment rates and an accelerated net registration in the Employee Provident Fund, indicating an expansion of job opportunities. To sustain and enhance economic growth, India intends to capitalize on the expansion of public digital platforms and implement measures to augment manufacturing output. These strategies are expected to contribute further to the country's economic recovery and pave the way for a promising future.

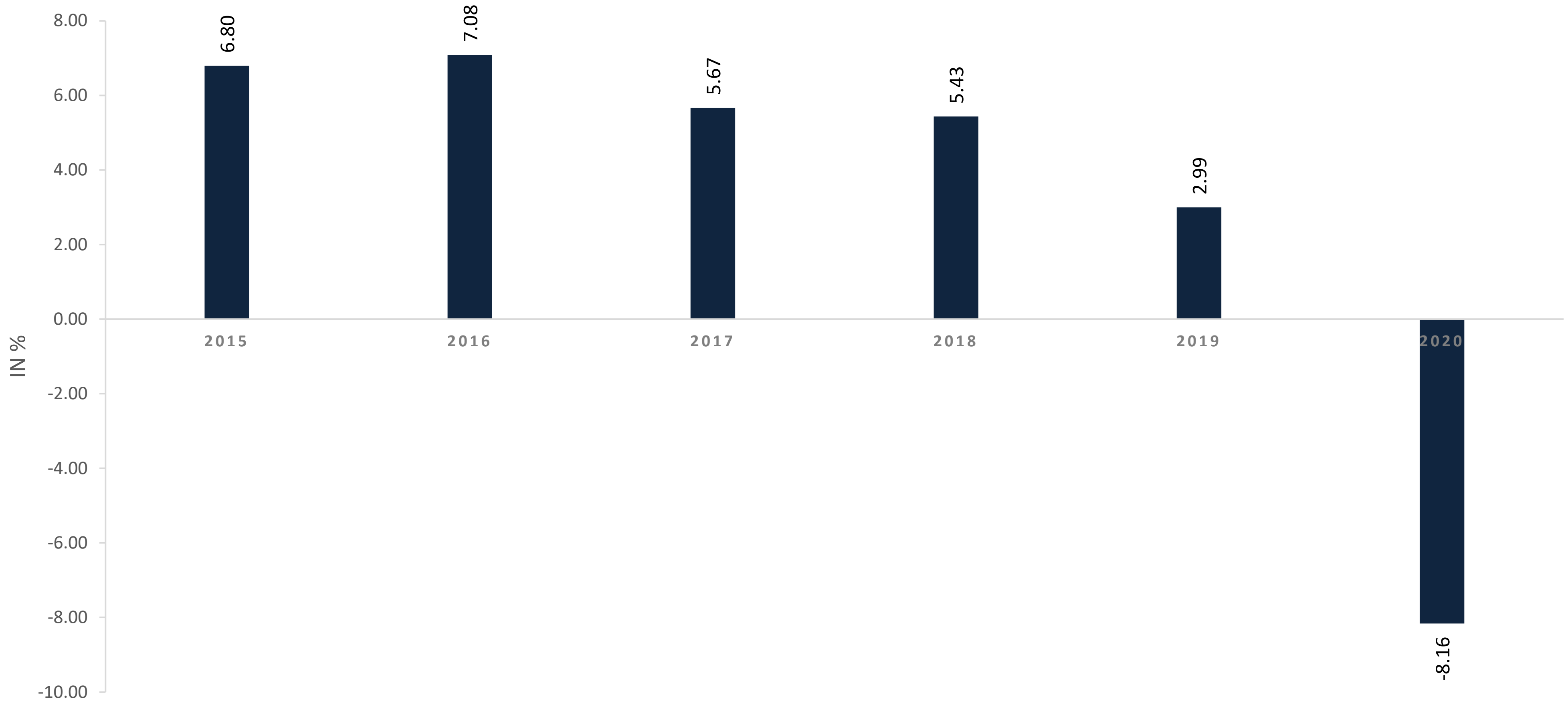
5.1.1. TREND IN GDP AND GVA

TABLE 3. INDIAN GDP, 2017-2023

Year	GDP (% Growth)	Growth/Decline
2017	6.80%	Decline 1.46%
2018	6.53%	Decline 0.26%
2019	4.04%	Decline 2.49%
2020	-7.96%	Decline 12.01%
2021	9.5%	Growth 17.6%
2022	6.01%	Decline 2.3%

Source: Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

FIGURE 19. GDP PER CAPITA GROWTH (ANNUAL %)



Source: Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

TABLE 4. INDIAN GDP, 2022-2026 (FORECASTED)

Year	GDP (INR LAKHS)	GDP GROWTH
2022	188,509,313,200.00	8.63%
2023	209,467,238,000.00	8.39%
2024	231,742,175,500.00	8.18%
2025	256,049,744,900.00	8.09%
2026	282,500,969,500.00	7.99%

Source: Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

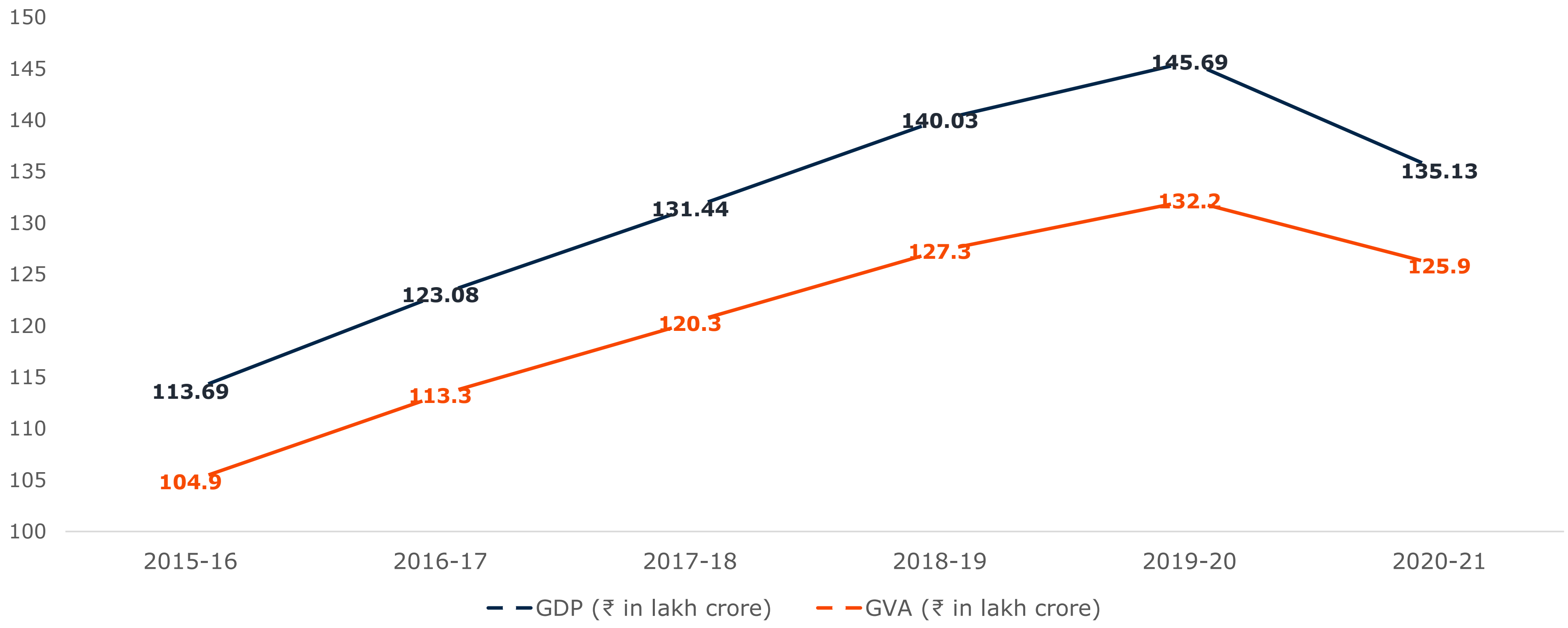
5.1.2. PER CAPITA GDP, INCOME AND PER CAPITA CONSUMPTION (PAST & OUTLOOK)

TABLE 5. GDP PER CAPITA, 2017-2020 (HISTORICAL), 2021-2023 (FORECASTED)

Year	GDP Per Capita (INR)
2017	172,628.48
2018	184,780.21
2019	202,066.75
2020	197,130.66
2021	234,963.36
2022	264,033.10
2023	302,257.16

Source: World Bank, Bureau of Indian Standards, Company Annual Report, Primary Interviews, Reports and Data

FIGURE 20. GDP AND GVA [AT CONSTANT (2011-12) PRICES]



Source: Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

Gross Domestic Product (GDP) measures the annualized change in the inflation-adjusted value of all goods and services produced by the economy. It is the broadest measure of economic activity and the primary indicator of the economy’s health. The most important and the fastest growing sector of the Indian economy are services. Trade, hotels, transport and communication; financing, insurance, real estate, and business services, and community, social and personal services account for more than 60% of GDP. Agriculture, forestry, and fishing constitute around 12% of the output but employs more than 50% of the labor force. Manufacturing accounts for 15% of GDP, construction for another 8%, and mining, quarrying, electricity, gas, and water supply for the remaining 5%.

Real GDP or GDP at Constant (2011-12) Prices in the year 2022-23 is estimated at INR 159.71 lakh crore, as against the First Revised Estimates of GDP for the year 2021-22 of INR 149.26 lakh crore. The growth in real GDP during 2022-23 is estimated at 7.0 per cent as compared to 9.1 per cent in 2021-22. 4. Nominal GDP or GDP at Current Prices in the year 2022-23 is estimated at INR 272.04 lakh crore, as against the First Revised Estimates of GDP for the year 2021-22 of INR 234.71 lakh crore. The growth in nominal GDP during 2022-23 is estimated at 15.9 per cent as compared to 18.4 per cent in 2021-22. 5. GDP at Constant (2011-12) Prices in Q3 2022-23 is estimated at INR 40.19 lakh crore, as against INR 38.51 lakh crore in Q3 2021-22, showing a growth of 4.4 percent. GDP at Current Prices in Q3 2022-23 is estimated at INR 69.38 lakh crore, as against INR 62.39 lakh crore in Q3 2021-22, showing a growth of 11.2 percent.

Gross value added (GVA) is defined as the value of output less than the value of intermediate consumption. While GVA gives a picture of the state of economic activity from the producers' side or supply side, the GDP gives the picture from the consumers' side or demand perspective. A sector-wise breakdown provided by the GVA measure can better help the policymakers decide which sectors need incentives/stimulus or vice versa. As with all economic statistics, the accuracy of GVA as a measure of overall national output is heavily dependent on the sourcing of data and the fidelity of the various data sources in capturing the vast labyrinth of activities that constitute a nation’s economic life. To that extent, GVA is as susceptible to vulnerabilities from the use of inappropriate or flawed methodologies as any other measure.

5.2. OVERVIEW OF CONSTRUCTION GVA (2012-2023)

According to IBEF, the construction market (USD 1.42 trillion) by 2027 expanding at a compound annual growth rate (CAGR) of 17.26% during the 2022-2027 forecast period. The Indian construction industry serves as a pivotal driver of the nation's economic growth. It plays an indispensable role in propelling overall development by laying the foundation for various projects. The emphasis placed on robust infrastructure by the government underscores its paramount significance. Anticipated to exhibit a Compound Annual Growth Rate (CAGR) of 17.26% through 2022, the Indian construction sector is on track to reach an impressive valuation of USD 738.5 billion. Noteworthy is its contribution: 55% to the steel industry, 15% to the paint industry, and 30% to the glass industry. Prominent growth sectors within this industry include export cargo (10%), highway construction/widening (9.8%), power generation (6.6%), import cargo (5.8%), and cargo handling at major ports (5.3%).

Foreign Direct Investment (FDI) in this sector has amounted to USD 25.66 billion between April 2000 and March 2020, as per the records of the Department for Promotion of Industry and Internal Trade (DPIIT). Moreover, the Indian construction industry's growth trajectory has surged, with a projection of 5.6% during 2016-20 compared to 2.9% during 2011-15. By 2022, India is poised to ascend as the world's third-largest construction market. Facilitating this objective, the Indian government has been actively crafting and implementing policies aimed at expediting the time-bound creation of top-notch infrastructure across the nation. This extends from power plants and bridges to dams, roads, and urban development ventures.

The Indian construction industry's prowess is evident on multiple fronts. In 2018, the World Bank's Logistics Performance Index (LPI) ranked India at 44 out of 167 countries, and in 2019, the nation secured the second position in the Agility Emerging Markets Logistics Index. Notably, 2019 witnessed significant mergers and acquisitions within the Indian construction sector, totaling USD 1.461 billion in deals. The most substantial private equity investment of USD 1.9 billion was executed in the acquisition of Pipeline Infrastructure India by Canadian asset management firm Brookfield. Demonstrating its dynamism, the National Highways Authority of India (NHAI) accomplished the construction of a record-breaking 3,979 kilometers of highways alongside the nation's electricity production reaching 1,252.61 billion units. However, the endeavor to achieve a USD 5 trillion economy by 2025 and fulfill the aspirations of its enterprising populace necessitates a continuous focus on constructing and enhancing existing infrastructure.

The National Infrastructure Pipeline (NIP): To advance this aim, a pioneering initiative led by a High-Level Task Force under the aegis of the Secretary of the Department of Economic Affairs (DEA) and the Ministry of Finance culminated in the formation of the National Infrastructure Pipeline (NIP). The NIP is a groundbreaking whole-of-government initiative dedicated to enhancing project preparation and attracting investments into infrastructure. Its mission revolves around bestowing world-class infrastructure upon Indian citizens, thus augmenting their quality of life. Central to the NIP's mandate is cultivating a favorable environment for substantial private investment in infrastructure across all levels of government. This initiative aspires to conceptualize, implement, and manage public infrastructure projects in alignment with efficiency, fairness, inclusivity, and disaster resilience goals.

The NIP introduces a streamlined institutional, regulatory, and implementation framework for infrastructure development. This framework adheres to global best practices and standards, leveraging cutting-edge technology to enhance service quality, efficiency, and safety within the Indian construction industry. In effect, the NIP is set to bolster the implementation of more infrastructure projects and generate employment opportunities. Its overarching aim is to elevate citizens' quality of life by providing equitable access to infrastructure, thereby fostering more inclusive growth.

Role of Developed Infrastructure and NIP: Developed infrastructure serves as a catalyst for heightened economic activity within a nation. The NIP is strategically poised to fortify this dynamic by offering well-prepared projects, curtailing aggressive bidding, and mitigating project delivery failures. It also ensures enhanced access to financial resources. For financial institutions and investors, the NIP instills confidence by virtue of its comprehensive project preparation and competent authority-led project monitoring.

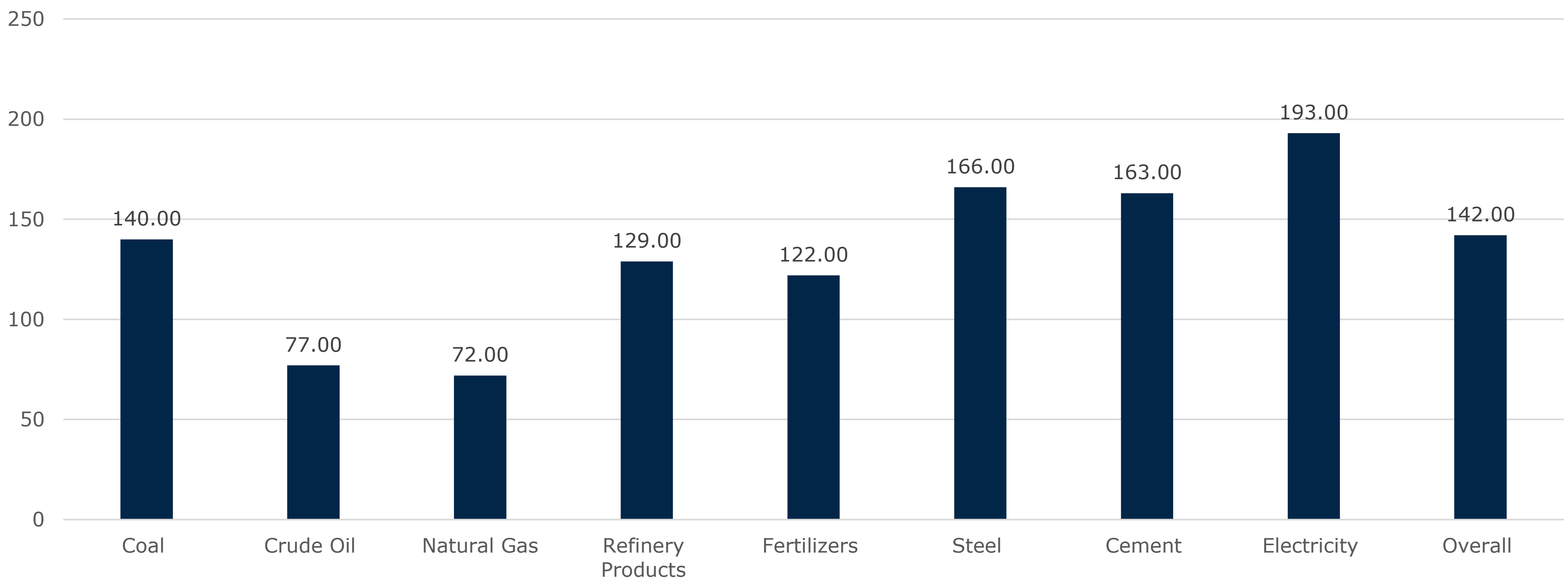
Government Endeavors: The Government of India, as of April 2020, has laid out a formidable roadmap for constructing roads valued at INR 15 lakh crore (USD 212.80 billion) over the ensuing two years. This endeavor is harmonious with the Union Budget 2020-21, which earmarked INR 1,69,637 crore (USD 24.27 billion) to propel transport infrastructure development. In addition, the Ministry of Housing and Urban Affairs and the Indian Railways have been allocated INR 50,040 crore (USD 6.85 billion) and INR 72,216 crore (USD 10.33 billion) respectively. The energy sector and communication sector have also been designated investment opportunities worth USD 300 billion over the next decade and INR 38,637.46 crore (USD 5.36 billion) to develop post and telecommunications departments.

Strategic Initiatives: Notably, the government's strategic initiatives such as "Housing for All" and the "Smart City Mission" underscore its commitment to surmounting bottlenecks within the infrastructure sector. These endeavors collectively contribute to the holistic and transformative growth of India's construction landscape.

5.3. INFRASTRUCTURE SECTOR BUDGET ALLOCATION OVERVIEW (2023-2024)

The government's commitment to strengthening India's infrastructure continues to be evident in the Budget for the fiscal year 2023-24. With a steadfast focus on development, numerous initiatives and investments have been earmarked to transform and enhance the country's infrastructure landscape. Here are some of the key highlights from the budget allocation for the infrastructure sector:

FIGURE 21. INFRASTRUCTURE INDEX OF 8 CR. INDUSTRIES FY23 (TILL SEP-22)



Source: IBEF, International Water Association, Company Annual Reports, Primary Interviews, and Reports and Data

- **Capital Investment Boost:** In an ambitious move, the budget allocates a significant capital investment of Rs.10 lakh crore (USD 122 billion), marking a 33% increase. This surge in investment corresponds to 3.3% of the GDP and is nearly three times the amount allocated in the fiscal year 2019-20, reflecting the government's dedication to infrastructure development.
- **Railway Advancements**: A monumental leap is seen in the allocation for the Railways sector, with a capital outlay of Rs. 2.40 lakh crore (USD 29 billion) - the highest ever recorded. This substantial increase, approximately 9 times the 2013-14 allocation, underscores the government's commitment to modernizing and expanding the country's rail network.
- **Boosting Private Investment**: Recognizing the importance of private investment in infrastructure development, an Infrastructure Finance Secretariat is being established. This initiative aims to foster opportunities for private investment in various sectors, including railways, roads, urban infrastructure, and power.
- **Encouraging State Investment**: The government's commitment to encouraging state-level investments is evident through the extension of a 50-year interest-free loan to state governments. This move aims to incentivize investment in infrastructure and complementary policy actions, with a significantly enhanced outlay of Rs. 1.3 lakh crore (USD 16 billion).
- **Critical Transport Connectivity**: Identifying the importance of last and first-mile connectivity for vital sectors such as ports, coal, steel, fertilizer, and food grains, 100 critical transport infrastructure projects are set to be initiated with a substantial investment of Rs. 75,000 crores (USD 9 billion), including contributions from private sources.
- **Enhancing Air Connectivity**: The government aims to improve regional air connectivity by reviving 50 additional airports, heliports, water aerodromes, and advance landing grounds.
- **Urban Infrastructure Development Fund (UIDF)**: To support urban infrastructure development in Tier 2 and Tier 3 cities, the establishment of the Urban Infrastructure Development Fund (UIDF) is announced. Managed by the National Housing Bank, this fund will leverage resources from priority sector lending shortfall.

- **Technology and Education Focus**: To promote indigenous AI capabilities, three centers of excellence for Artificial Intelligence will be established in prominent educational institutions. Additionally, a Digital Public Infrastructure for agriculture will be developed to provide farmer-centric solutions and foster growth in the agri-tech industry.
- **Healthcare and Education Expansion**: Significant steps are being taken to bolster the healthcare and education sectors. Plans include establishing 157 new nursing colleges in conjunction with existing medical colleges and setting up a National Digital Library for Children and Adolescents.
- **Infrastructure for North-Eastern Region**: Allocations for the development of the North-eastern region are emphasized, with funding provided for initiatives such as PM DevINE and Northeast Special Infrastructure Development Scheme (NESIDS).
- **Leveraging Global Investment**: The infrastructure sector is drawing substantial Foreign Direct Investment (FDI), evident from investments in construction and development projects.

The infrastructure sector has become the biggest focus area for the Government of India. India plans to spend USD 1.4 trillion on infrastructure during 2019-23 to have a sustainable development of the country. The Government has suggested investment of Rs. 5,000,000 crores (USD 750 billion) for railways infrastructure from 2018-30. India's GDP is expected to grow by 8% over the next three fiscal years, one of the quickest rates among major, developing economies, according to S&P Global Ratings. India and Japan have joined hands for infrastructure development in India's Northeast states and are also setting up an India-Japan Coordination Forum for development of Northeast to undertake strategic infrastructure projects for the region.

5.4. INDUSTRIAL GROWTH AND TREND IN PRODUCTION

Industrial production refers to the output of industrial establishments and covers sectors such as mining, manufacturing, electricity, gas and steam and air-conditioning. This indicator is measured in an index based on a reference period that expresses a change in the volume of production output. The Denta Properties and Infrastructure Pvt. Ltd. would benefit from the GoI's 'Aatmanirbhar Bharat Abhiyaan', or Self - Reliant India, campaign, which provides a range of incentives to attract and localise manufacturing and production in the country.

The Production-Linked Incentive (PLI) Scheme is an initiative launched by the Government of India to boost domestic manufacturing across various sectors. The objective of the PLI scheme is to encourage local production and reduce import dependence. Under the scheme, the government offers financial incentives to eligible companies based on their production levels and performance. In the context of the blow molding industry, the PLI scheme can have a positive impact by incentivizing companies to expand their manufacturing capabilities and increase production of blow-molded products in India. This, in turn, can help reduce the country's reliance on imports of such products and create more job opportunities. The scheme offers financial incentives to eligible companies that meet certain performance criteria, such as minimum investment, production, and quality standards.

Further, the GOI has recently announced Production Linked Incentive (PLI) Scheme for the pharmaceutical sector. The objective of the PLI scheme for the pharmaceutical sector is to promote domestic manufacturing and reduce import dependence in the industry. The scheme is aimed at promoting the production of high-value drugs, APIs (active pharmaceutical ingredients), and medical devices. The PLI scheme for the pharmaceutical sector has a budgetary allocation of Rs. 15,000 Crore and is expected to attract significant investment in industry. The financial year of 2022-2023 being the first year of production for the PLI Scheme, DoP has ear marked Rs 690 crore as the budget outlay. The scheme is expected to create more than 20,000 jobs and help India become a global manufacturing hub for pharmaceuticals. As of January 31, 2023, sales of about INR 36,000 cr have been reported by the select 55 applicants. The Department of Pharmaceuticals also implements two other PLI schemes, namely PLI for Bulk Drugs and PLI for Medical Devices, which have achieved significant milestones in the first year of implementation.

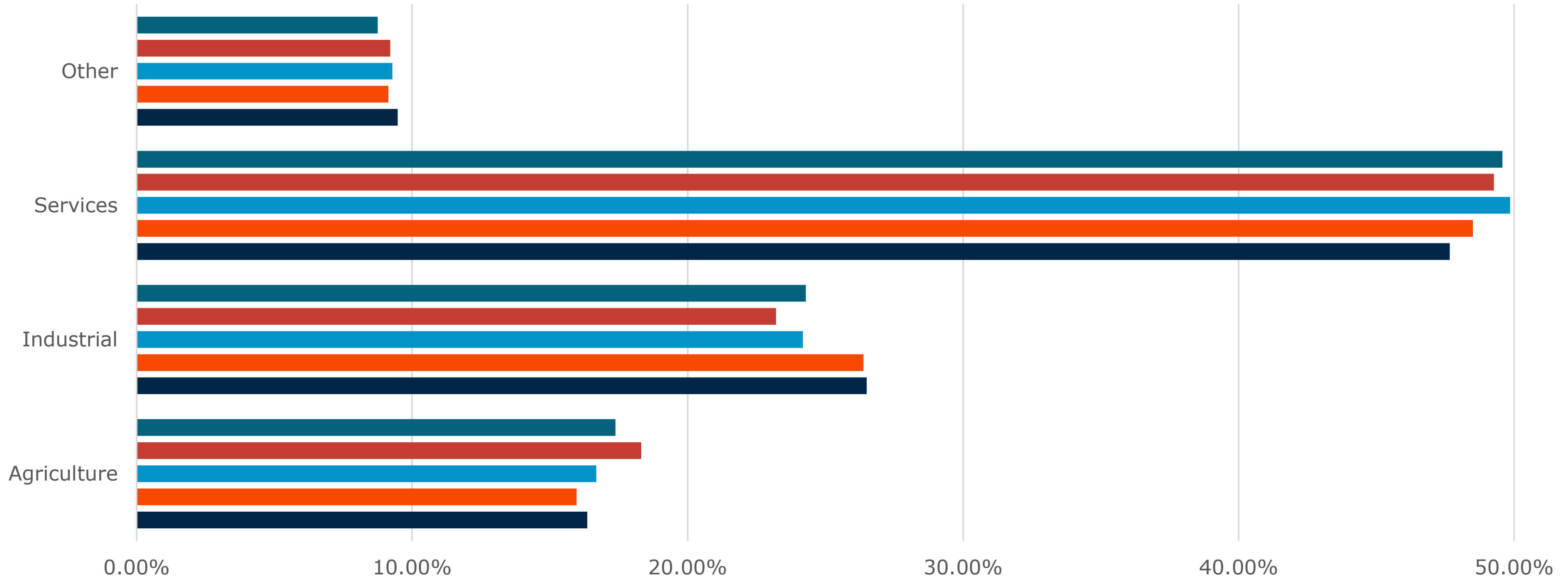
Moreover, On May 17, 2023, the Union Cabinet, led by Prime Minister Shri Narendra Modi, granted approval for the introduction of the Production-Linked Incentive (PLI) Scheme 2.0 for IT Hardware, aimed at enhancing India's manufacturing capabilities and promoting exports under the Atmanirbhar Bharat initiative. The scheme was officially notified on May 29, 2023, and starting from June 01, 2023, applications for the PLI Scheme 2.0 for IT Hardware will be accepted. The primary objectives of the PLI Scheme 2.0 for IT Hardware are to bolster and expand the manufacturing ecosystem in India by encouraging local production of components and sub-assemblies. It also allows for a longer period for developing the domestic supply chain. The scheme offers increased flexibility and options for applicants, tying incentives to incremental sales and investment thresholds to further encourage growth. Notably, the scheme includes incentives for semiconductor design, IC manufacturing, and packaging as well. The approved budget for the PLI Scheme 2.0 for IT Hardware is INR 17,000 crore. It is anticipated that this scheme will result in a total production worth approximately INR 3.35 lakh crore, attracting an additional investment of INR 2,430crore in the electronics manufacturing sector, and generating around 75,000 additional direct job opportunities.

Additionally, it is expected that, GOI has also announce PLI Scheme chemicals sector. The objective of the PLI scheme for the chemical sector is to boost domestic manufacturing and reduce import dependence in the industry. The scheme is aimed at promoting the production of high-value chemicals and specialty chemicals, which are currently being imported. Under the Union Budget 2023-24 the government allocated INR 173.45 crore to the Department of Chemicals and Petrochemicals. PLI schemes have been introduced to promote Bulk Drug Parks, with a budget of INR 1,629 crore. Moreover, the scheme also aims to encourage local companies to set up or expand existing manufacturing units along with focusing on inviting foreign companies to set up manufacturing units in India. Increased production, sale and export by companies availing the PLI Scheme in these sectors would increase the demand for our industrial packaging products. Its future expansion plans have been formulated considering these growth opportunities and Company is geared up to exploit these for the benefit of all its stakeholders.

Further, the Quick Estimates of the Index of Industrial Production (IIP) for February 2023, based on the 2011-12 scale, indicate a value of 138.7. The individual sector indices for Mining, Manufacturing, and Electricity for the same month are 129.0, 136.8, and 174.0 respectively. It should be noted that these Quick Estimates are subject to revision in future releases, following the revision policy of IIP. Based on the Use-based classification, the indices for February 2023 are 139.7 for Primary Goods, 104.4 for Capital Goods, 143.2 for Intermediate Goods, and 164.0 for Infrastructure/Construction Goods.

Additionally, the indices for Consumer durables and Consumer non-durables in February 2023 are 108.4 and 154.3 respectively. Detailed information on the Quick Estimates of the Index of Industrial Production for February 2023, categorized by sector and 2-digit level of National Industrial Classification (NIC-2008), as well as by Use-based classification, can be found in Statements I, II, and III respectively. Statement IV provides month-wise indices for the past 12 months, categorized by industry groups (based on the 2-digit level of NIC-2008) and sectors, to aid users in understanding the changes in the industrial sector. The indices for January 2023 have undergone the first revision, while those for November 2022 have undergone the final revision, taking into account the updated data received from the source agencies. The Quick Estimates for February 2023, the first revision for January 2023, and the final revision for November 2022 have been compiled with response rates of 92 percent, 94 percent, and 95 percent respectively.

FIGURE 22. SHARE OF INDIAN GDP BY SECTOR

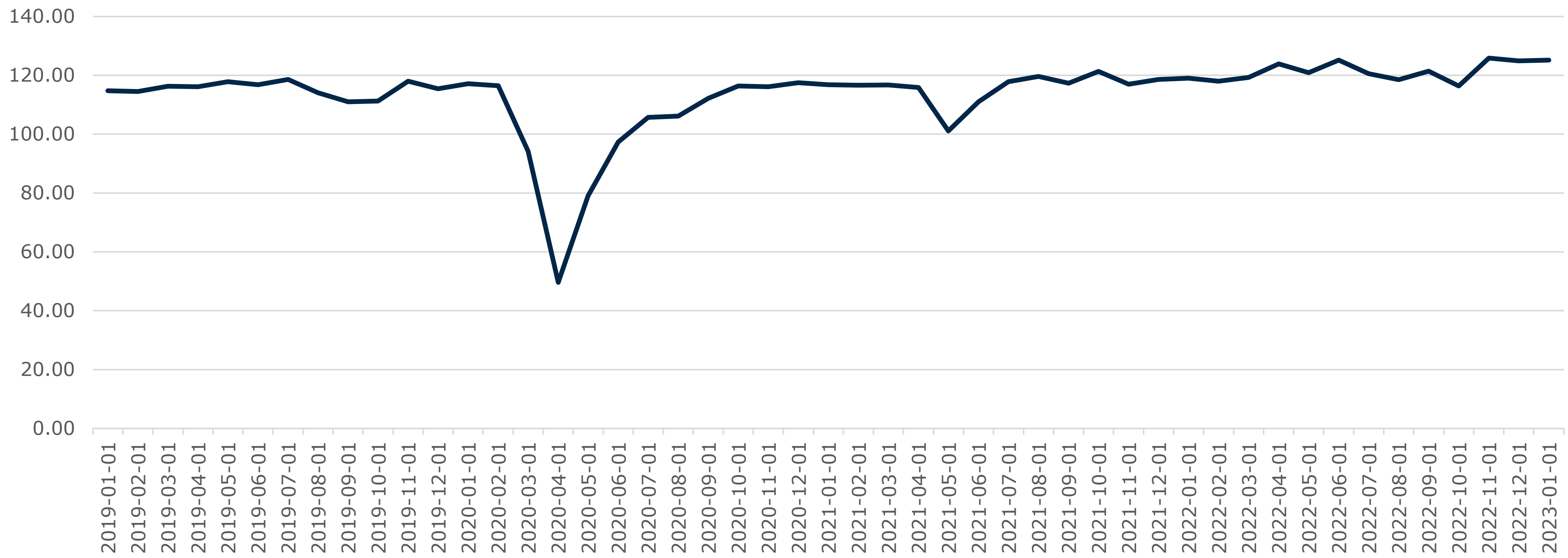


	Agriculture	Industrial	Services	Other
2021	17.38%	24.29%	49.58%	8.75%
2020	18.32%	23.21%	49.27%	9.20%
2019	16.68%	24.18%	49.86%	9.28%
2018	15.97%	26.38%	48.51%	9.14%
2017	16.36%	26.50%	47.67%	9.47%

Source: JSTOR, Bureau of Indian Standards, Company Annual Report, Primary Interviews, Reports and Data

Manufacturing has emerged as one of India's fastest growing sectors. The government in the region has been adopting several policies to ensure an increased production of goods and to make India a self-reliant economy. For instance, the Make in India program has been launched to map India as a manufacturing hub and make the Indian economy globally recognized. Through the scheme, the government aims to create 1,000 lakh new jobs in the industry by 2022. Moreover, the region is also likely to become a high-tech manufacturing center as global giants such as GE, Siemens, HTC, Toshiba and Boeing have established or are in the process of establishing manufacturing facilities in India with the help of Make in India. Similarly, to expand its smartphone assembly industry and improve its electronics supply chain, in March 21, the government announced cash incentives of more than INR 750,000 lakhs to each company which will set up chip fabrication units in the country.

FIGURE 23. INDIA INDUSTRIAL PRODUCTION (2019-2023)

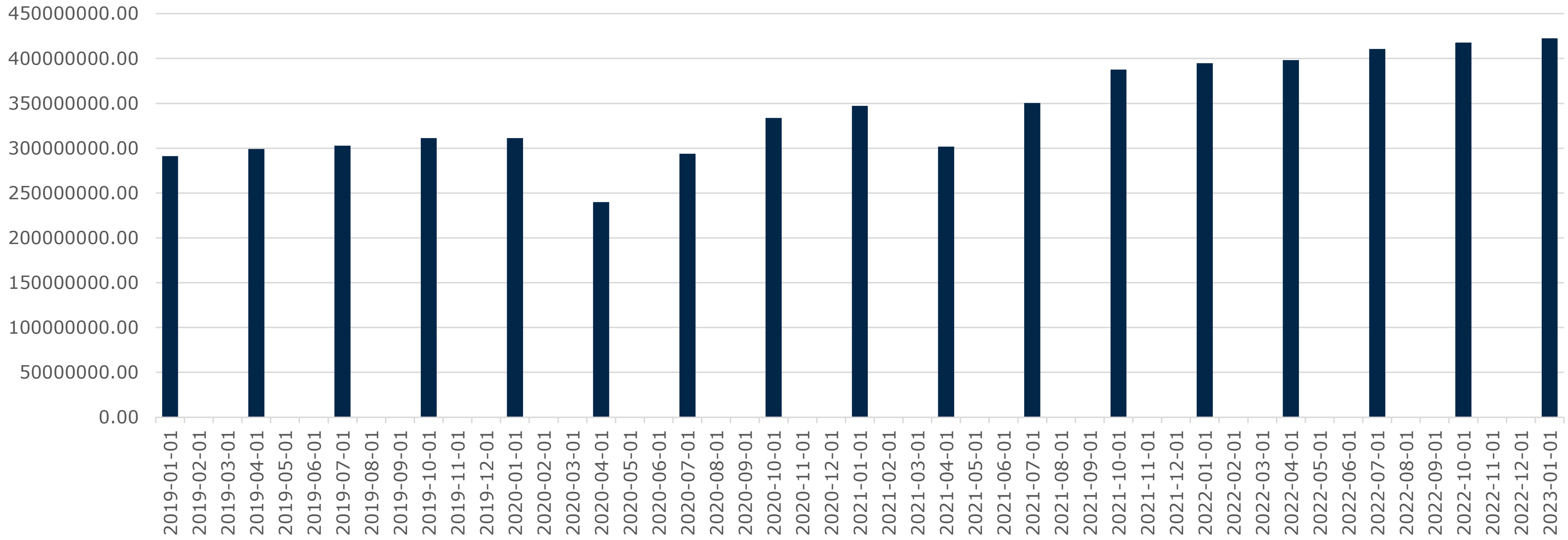


Source: Trading Economies, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

The region is also gradually progressing on the road to Industry 4.0 through the Government of India’s initiatives. For instance, the Smart Advanced Manufacturing and Rapid Transformation Hubs or SAMARTH Udyog Bharat 4.0 is an Industry 4.0 initiative of Ministry of Heavy Industry & Public Enterprises, Government of India under its scheme on Enhancement of Competitiveness in Indian Capital Goods Sector. The adoption of this scheme is likely to increase productivity, efficiency and quality in processes, and also ensure greater safety for workers by reducing jobs in dangerous environments. The scheme would also aid in enhancing decision making with data-based tools and improve competitiveness by developing customized products.

5.4.1. TREND ANALYSIS OF PRIVATE FINAL CONSUMPTION EXPENDITURE (PFCE) AND OUTLOOK

FIGURE 24. PRIVATE FINAL CONSUMPTION EXPENDITURE IN INDIA, QUARTERLY, SEASONALLY ADJUSTED (INR LAKH)



Source: Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

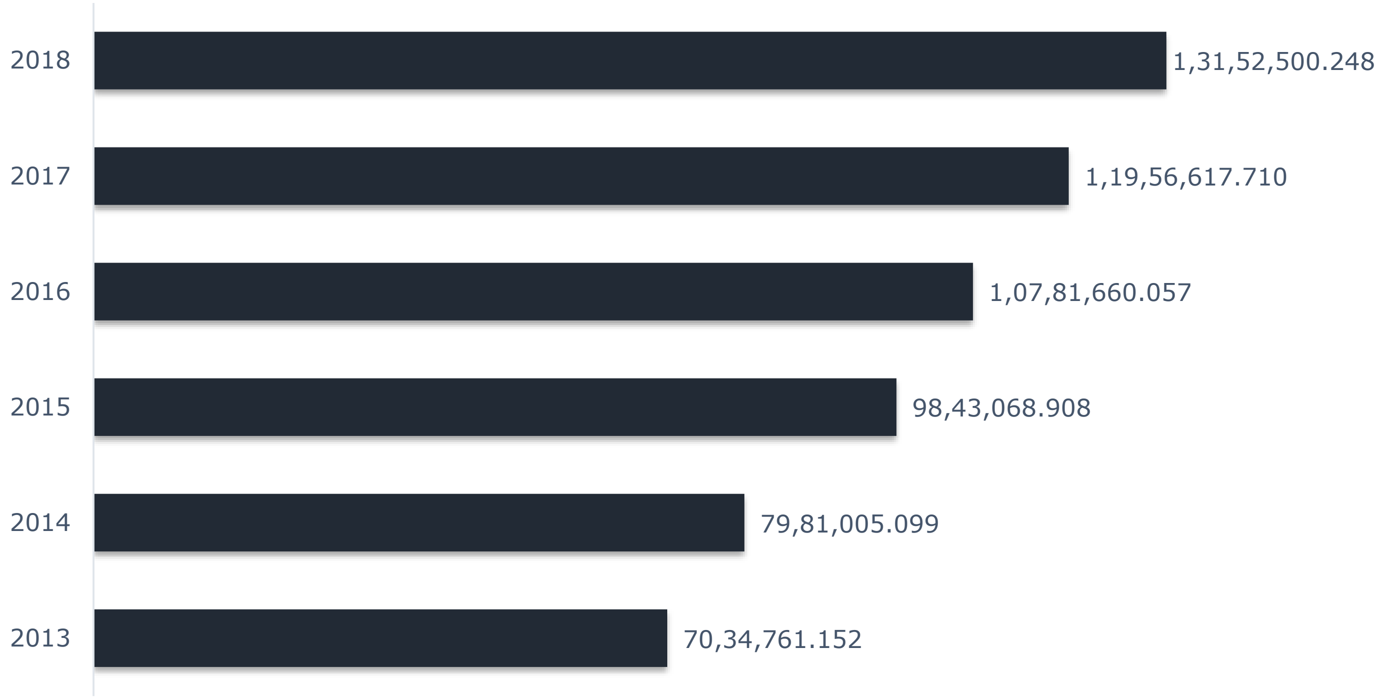
India's private final consumption expenditure (PFCE) declined by six% in nominal terms to Rs.115.7 lakh crore in 2020-21 from Rs.123.1 lakh crore in 2019-20. Consumption expenditure growth has been slowing through the last decade. Growth in PFCE that averaged at 16.2% per annum during 2010-14, fell to 12.1% per annum during 2014-17 and further down to 10.5% per annum during 2017-20.

The PFCE was also a predominant source of fall in India's real GDP in 2020-21. It declined faster than the fall in overall GDP. Contribution of PFCE to real GDP fell to 55.95% in 2020-21 from 57.1% in 2019-20. This shrinking of consumption expenditure has a direct impact on the intermediate industries that feed India's consumption engine. Industries like steel, fibers, chemicals and services such as transport, trade and finance will face headwinds as the PFCE shrinks. A sharp fall in PFCE also indicates a fall in the standard of living of people of India in general and a possible rise in poverty. A return to earlier PFCE levels would require growth to accelerate and employment and household incomes to rise. But this is a significant challenge. The recent fall in per capita real PFCE is so steep that India needs to catch-up from its levels three years ago.

Purchasing power of households got eroded severely during 2020-21 due to a fall in income and high inflation. The year witnessed large-scale job and income losses. The average number of people employed reduced from 4,089 lakhs in 2020-19 to 3,877 lakhs in 2020-21. The average for 2020-21 glosses over big losses and gains as the informal workers moved in and out of the labor market in response to the lockdowns and their relaxations during the year. The impact of these movements was severe on household incomes.

5.4.2. TREND ANALYSIS OF DISPOSABLE HOUSEHOLD INCOME AND OUTLOOK

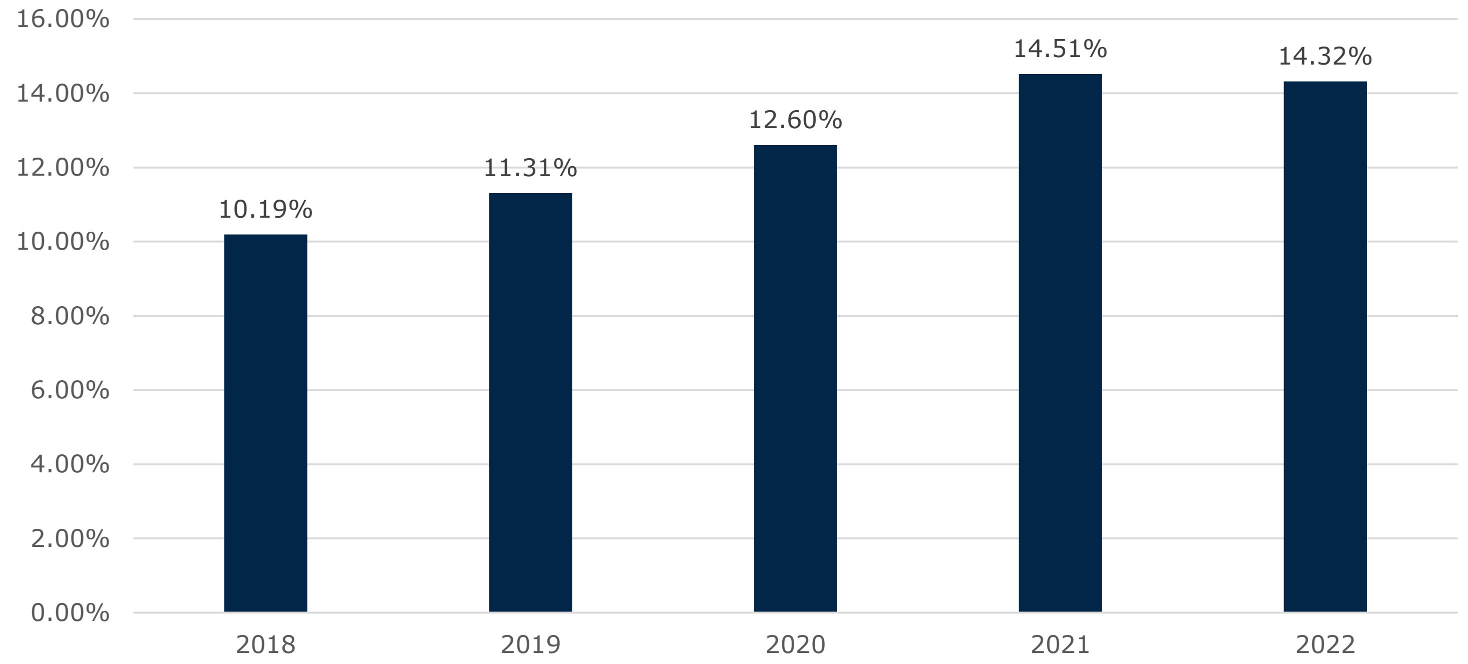
FIGURE 25. GROSS NATIONAL DISPOSABLE INCOME (INR LAKHS)



Source: GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

Disposable income is closest to the concept of income as generally understood in economics. Household disposable income is income available to households such as wages and salaries, income from self-employment and unincorporated enterprises, income from pensions and other social benefits, and income from financial investments (less any payments of tax, social insurance contributions and interest on financial liabilities). ‘Gross’ means that depreciation costs are not subtracted. Household income in India was drastically impacted due to the coronavirus (COVID-19) lockdown as of April 2020. There was a significant decrease in the level of income with households reporting a fall in income from about nine% in late February to a whopping 45.7% in mid-April. Rise in income saw a contrasting trend indicating similar results; from 31% in late February to 10.6% on April 2020.

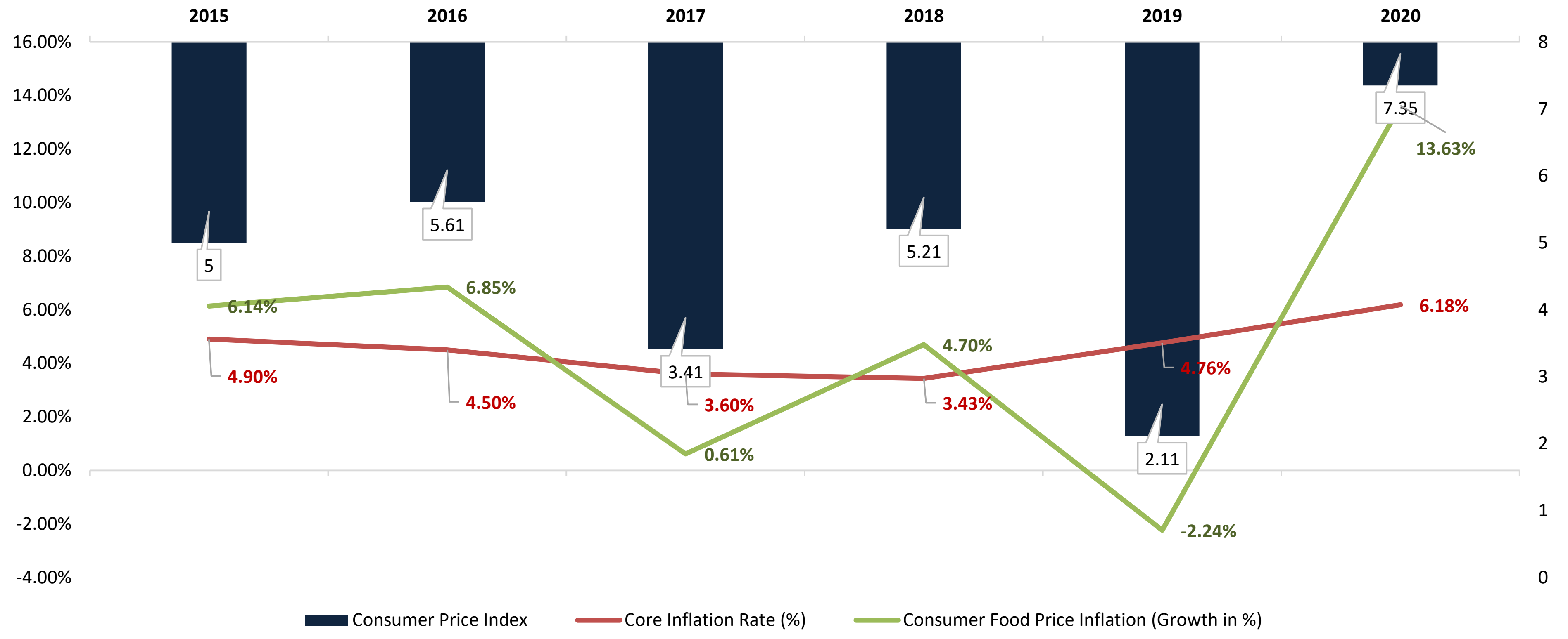
FIGURE 26. INDIA'S HOUSEHOLD DEBT: % OF GDP



Source: GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

5.5. CONSUMER PRICE INFLATION WITH DISAGGREGATION INTO CORE AND FOOD INFLATION

FIGURE 27. CONSUMER PRICE INDEX VS. CORE INFLATION RATE VS. CONSUMER FOOD PRICE INFLATION GROWTH



Source: GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

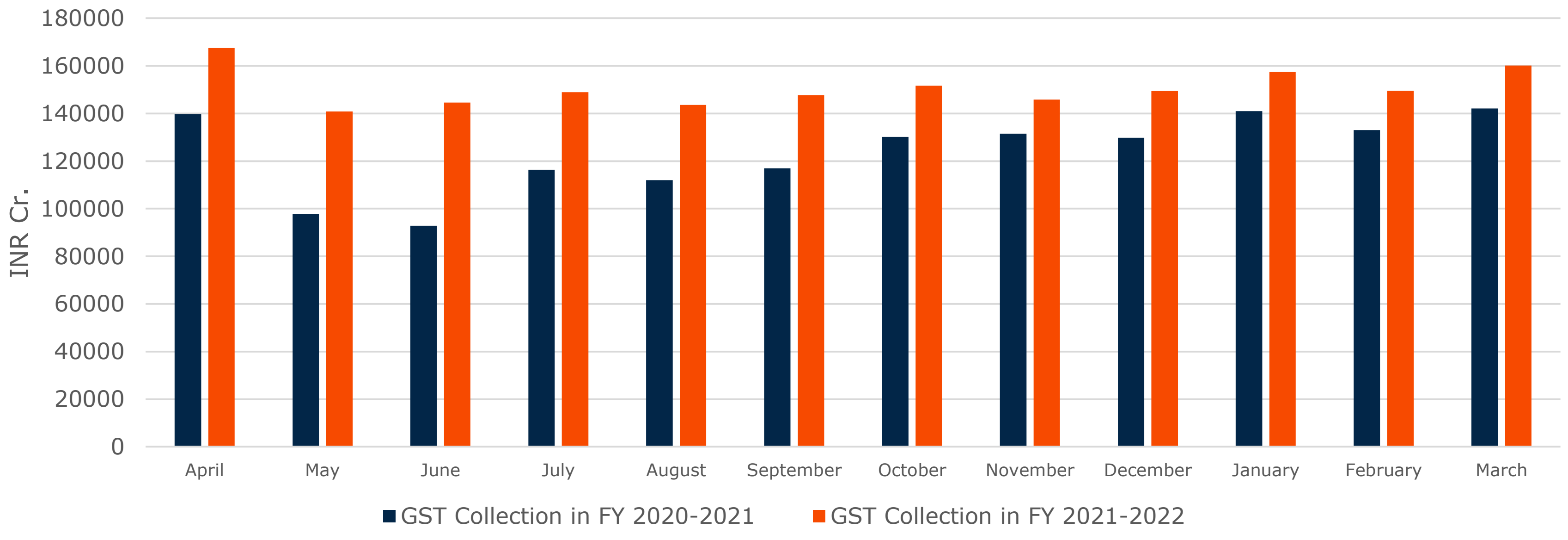
Consumer price inflation in India went through three phases in 2022. A rising phase up to April 2022 when it crested at 7.8 per cent, then a holding pattern at around 7.0 per cent up to August 2022 and then a decline to around 5.7 per cent by December 2022. The rising phase was largely due to the fallout of the Russia-Ukraine war and a shortfall in crop harvests due to excessive heat in some parts of the country. Prompt and adequate measures by the Government of India and the Reserve Bank of India (RBI) have reined in the rise in inflation and brought it within the Central Bank's tolerance limit. In contrast, major Western countries, which pumped stimulus during the pandemic periods, continue to grapple with high levels of inflation.

The rise in prices is a constant concern for policymakers because it disproportionately affects the general population. This issue is particularly felt in developing economies where essential items make up a larger portion of people's expenses compared to developed countries. In India, inflation has been relatively stable, staying below the Reserve Bank of India's target rate of 4 percent between 2017 and 2019. However, in 2020, disruptions in the supply chain caused inflation to exceed the upper limit of 6 percent set by the RBI. The COVID-19 pandemic had a greater impact on the supply of essential goods, food, medicine, and industrial products, leading to increased cost-push inflation in the country. As the pandemic subsided, a conflict between Russia and Ukraine caused inflation worldwide, primarily driven by soaring prices of crude oil and other commodities. Prices reached a ten-year high, putting a strain on household budgets and prompting central banks to tighten monetary policies. Developed economies, faced with an ailing global economy and unprecedented inflation rates, had no choice but to raise interest rates.

The US Federal Reserve's rate hikes resulted in a stronger US dollar, making fuel imports more expensive. The IMF projects that inflation in advanced economies will rise from 3.1 percent in 2021 to 7.2 percent in 2022, the highest since 1982. In September 2022, the Euro area experienced a rate of 10.0 percent, while the US reached its highest inflation rate in 40 years at 9.1 percent in June 2022, which later moderated to 6.5 percent in December 2022. The UK witnessed a 9.2 percent annual price rise in December 2022, and Germany experienced inflation of 8.6 percent in the same month. Among emerging markets, Brazil saw a moderation in price trends, but Turkey faced inflation rates above 80 percent from August to November 2022, which slightly declined to 64.3 percent in December 2022. The war exacerbated the effects of a strong recovery in demand for goods and services following the pandemic. In emerging markets and developing economies (EMDEs), inflation is expected to have increased from 5.9 percent in 2021 to 9.9 percent in 2022, according to the IMF's projections in October 2022.

5.6. GST COLLECTIONS AND THEIR TREND

FIGURE 28. TREND IN GST COLLECTION (INR CRORE)



Source: GST Council of India, Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, World Bank Company Annual Report, Primary Interviews, Reports and Data

The month of March 2023 witnessed a significant milestone in India's tax landscape as the gross Goods and Services Tax (GST) revenue collection crossed the INR 1.5 lakh crore mark for the fourth time in the current fiscal year. This accomplishment, coupled with record-breaking Integrated GST (IGST) collections, reflects the strength and effectiveness of the GST system implemented in the country. This write-up presents an overview of the revenue collection figures for March 2023, highlights the growth compared to the previous year, discusses return filing trends, and provides state-wise data for GST collections.

Revenue Collection Figures for March 2023: In March 2023, the gross GST revenue collected amounted to INR 1,60,122 crore. The revenue distribution breakdown includes INR 29,546 crore for Central GST (CGST), ₹37,314 crores for State GST (SGST), INR 82,907 crore for IGST (including INR 42,503 crore from the import of goods), and INR 10,355 crore for cess (including INR 960 crore from the import of goods). Notably, the IGST collection reached its highest-ever level during this month.

Settlements and Total Revenue for CGST and SGST: As part of regular settlements, the government allocated INR 33,408 crore to CGST and INR 28,187 crore to SGST from IGST. Consequently, the total revenue for the Centre and the States for March 2023, after the IGST settlement, stood at INR 62,954 crore for CGST and INR 65,501 crore for SGST.

Growth Comparison and Return Filing Trends: The revenues generated in March 2023 exhibited a 13% increase compared to the GST revenues recorded in the same month of the previous year. Import of goods contributed to an 8% growth in revenue, while domestic transactions (including import of services) demonstrated a 14% surge in revenue compared to March of the preceding year. Moreover, the month of March 2023 witnessed the highest-ever filing of returns, with 93.2% of statement of invoices (in GSTR-1) and 91.4% of returns (in GSTR-3B) for February being filed by March 2023. These figures reflect a substantial improvement from the corresponding month in the previous year, which saw filing rates of 83.1% and 84.7% for statement of invoices and returns, respectively.

Gross Collection Figures for FY 2022-23: The total gross collection for the fiscal year 2022-23 reached INR 18.10 lakh crore, with an average monthly collection of INR 1.51 lakh crore. This represents a remarkable 22% increase in gross revenues compared to the previous year. In the final quarter of the fiscal year, the average monthly gross GST collection amounted to INR 1.55 lakh crore, surpassing the average monthly collections of INR 1.51 lakh crore, INR 1.46 lakh crore, and INR 1.49 lakh crore in the first, second, and third quarters, respectively.

5.7. INDIAN ECONOMY OUTLOOK & ECONOMIC IMPACT OF COVID-19 ON INDIAN ECONOMY

The pandemic's impact on India was evident in a large GDP decline in FY21. Despite the Omicron wave of January 2022, the Indian economy began to recover the next year, FY22. Since the pandemic's onset in January 2020, the third wave has had less of an impact on Indian economic activity than the prior waves. Mobility enabled by localised lockdowns, rapid vaccine coverage, light symptoms, and speedy recovery from the virus all helped to keep economic output losses to a minimum in the January-March quarter of 2022. As a result, output in FY22 surpassed its pre-pandemic level in FY20, putting the Indian economy ahead of many other countries in terms of full recovery. The Omicron variant experience inspired cautious optimism that it was possible to remain physically mobile and engage in economic activities despite the epidemic. Thus, FY23 began with the firm confidence that the pandemic was rapidly fading, and that India was prepared to expand significantly and quickly return to its pre-pandemic growth path.

Some of the key highlights include.

- The growth rates of Primary sector (comprising Agriculture, Forestry, Fishing and Mining & Quarrying), Secondary sector (comprising Manufacturing, Electricity, Gas, Water Supply & Other Utility Services, and Construction) and Tertiary sector

(Services) have been estimated as 3.9 %, 12.0 % and 8.8 respectively in 2021-22 as against a growth of 2.4 %, -0.2 per cent and -8.2 %, respectively, in the previous year. The growth in real GVA during 2021-22 is on account of growth in ‘Mining and Quarrying’, ‘Manufacturing’, ‘Electricity, Gas, Water Supply & Other Utility Services’, ‘Construction’, ‘Trade, repair, Hotels and Restaurants’, ‘Transport, Storage and Communication & Services related to Broadcasting’ and ‘Other services’ as may be seen from Statement 4.2B. However, ‘Agriculture, Forestry and Fishing’, ‘Financial Services’, ‘Real Estate, Ownership of Dwelling & Professional Services’ and ‘Public Administration and Defence’ have witnessed modest growth during this period.

- Services account for more than half of the Indian economy and was the most impacted by the COVID-19 related restrictions, especially for activities that need human contact. Although the overall sector first contracted by 8.4 % in 2020-21 and then is estimated to grow by 8.2 % in 2021-22, it should be noted that there is a wide dispersion of performance by different sub-sectors. Both the Finance/Real Estate and the Public Administration segments are now well above pre-COVID levels. However, segments like Travel, Trade and Hotels are yet to fully recover. It should be added that the stop-start nature of repeated pandemic waves makes it especially difficult for these sub-sectors to gather momentum.
- India’s exports of both goods and services have been exceptionally strong so far in 2021-22. Merchandise exports have been above INR 2,21,80,863 Lakhs for eight consecutive months in 2021-22, despite a rise in trade costs arising from global supply constraints such as fewer operational shipping vessels, exogenous events such as blockage of Suez Canal and COVID-19 outbreak in port city of China etc. Concurrently, net services exports have also risen sharply, driven by professional and management consulting services, audio visual and related services, freight transport services, telecommunications, computer and information services. From a demand perspective, India’s total exports are expected to grow by 16.5 % in 2021-22 surpassing pre-pandemic levels. Imports also recovered strongly with revival of domestic demand and continuous rise in price of imported crude and metals. Imports are expected to grow by 29.4 % in 2021-22 surpassing corresponding pre-pandemic levels.

- Inflation would likely slow to 5% in FY2023, assuming oil and food prices remain stable, and then to 4.5% in FY2024 as inflationary pressures ease. In tandem, monetary policy is likely to be tighter in FY2023 as core inflation remains high, before becoming more flexible in FY2024. The current account deficit is expected to fall to 2.2% of GDP in fiscal year 2023 and 1.9% in fiscal year 2024. Goods export growth is expected to decrease in FY2023 before rebounding in 2024, as production-linked incentive schemes and initiatives to improve the business environment, such as reduced labour regulations, boost performance in electronics and other sectors of industrial growth. Growth in service exports has been strong, and it is likely to continue to boost India's overall balance of payments position.

5.8. CURRENT GEOPOLITICAL SENARIO

Since 2020, the global economy has been hit by at least three major shocks, breaking from the past pattern of severe but spaced-out economic shocks. The pandemic caused a contraction of the global output, followed by the Russian-Ukraine conflict leading to worldwide inflation and synchronized policy rate hikes by central banks, including the Federal Reserve. This led to an appreciation of the US Dollar and wider Current Account Deficits (CAD) in net importing economies, as well as lower global growth forecasts for 2022 and 2023 by the IMF, due to persistent inflation and the frailties of the Chinese economy. The rising debt of the non-financial sector in advanced economies, combined with monetary tightening and persistent inflation, may lead to a financial contagion and elevated downside risks to the global outlook.

Post the pandemic, the global economic recovery was progressing until the Russia-Ukraine conflict started in Feb 2022, disrupting the restoration of supply chains and trade. This conflict has now lasted almost a year and caused as many disruptions as the pandemic did in two years. The prices of key commodities such as oil, gas, fertilizers, and wheat skyrocketed, worsening inflationary pressures fueled by large fiscal stimuli and accommodative monetary policies. Inflation in advanced economies, which received most of the global fiscal expansion and monetary easing, reached historical highs. Rising commodity prices also led to higher inflation in emerging markets, which were previously experiencing lower inflation due to their governments' calibrated fiscal stimulus to address the 2020 contraction.

The Indian economy has recovered from the pandemic and is poised for growth in FY23, outpacing many other nations. However, it faced inflation challenges in FY23, exacerbated by the European strife. The government and RBI, along with easing global commodity prices, managed to bring retail inflation within the RBI's upper tolerance target in November 2022. The depreciating rupee, although better than most currencies, remains a challenge, with the possibility of further policy rate hikes by the US Fed. The CAD may also persist due to elevated global commodity prices and strong growth momentum in the Indian economy.

Despite challenges, India is projected to be the fastest-growing major economy at 6.5-7.0% in FY23 by agencies worldwide. The optimistic growth forecasts are driven by the resilience of the Indian economy, seen in the rebound of private consumption as the leading driver of growth. This uptick in consumption has increased production activity and capacity utilization across sectors. The near-universal vaccination coverage overseen by the government, along with the world's second-largest vaccination drive involving over 2 billion doses, has brought people back to the streets to spend on contact-based services and lifted consumer sentiments, leading to a prolonged rebound in consumption.

6. MARKET SEGMENTATION & IMPACT ANALYSIS

6.1. SEGMENTATION ANALYSIS

Type	Offering	Equipment	End Use
•Water Treatment •Sewage Treatment •Effluent Treatment	•Treatment Technologies •*Activated Sludge Process* •*Membrane Bio Reactor* •*Moving Bed Bio Reactor* •*Sequencing Batch Reactor* •*Upflow Anaerobic Sludge Blanket Reactor* •*Submerged Aerated Fixed Film Reactor* •*Other Treatment Technologies* •Treatment Chemicals •*Corrosion Inhibitors* •*Scale Inhibitors* •*Biocides & Disinfectants* •*Coagulants & Flocculants* •*Chelating Agents* •*Anti-Foaming Agents* •*Ph Adjusters and Stabilizers* •*Others* •Process Control and Automation •Design, Engineering, and Construction Services •Operation and Maintenance Services	•Filtration •Disinfection •Adsorption •Desalination •Testing •Others	•Municipal •*Government and Public Utilities* •*Local Communities* •Industrial •*Power Generation* •*Oil and Gas* •*Food and Beverage* •*Chemicals* •*Pharmaceuticals* •*Others*

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

The estimations have been provided in terms of revenue (USD Million) on the India level, with 2022 as the base year and a forecast period from 2023 to 2030.

6.2. WATER AND WASTEWATER TREATMENT MARKET

Global trade and industrial production are growing at rates that are significantly higher than average compared to the previous 10 years. However, the pandemic and the Russia-Ukraine conflict have contributed to rising inflation, which is primarily being driven by sharp increases in prices of food and energy. This is making life difficult for those on low incomes and posing serious risks to food security in some of the world's poorest economies. In almost all economies, growth is projected to be noticeably weaker than anticipated. Europe, which is majorly vulnerable to the conflict due to dependency on oil imports and also the steady refugee inflows taking a toll, is home to a number of the worst-hit countries in the region. Commodity price increases is also having a major impact on countries across the globe. This adds to inflationary pressures, reduces real wages and spending, and slows the recovery process.

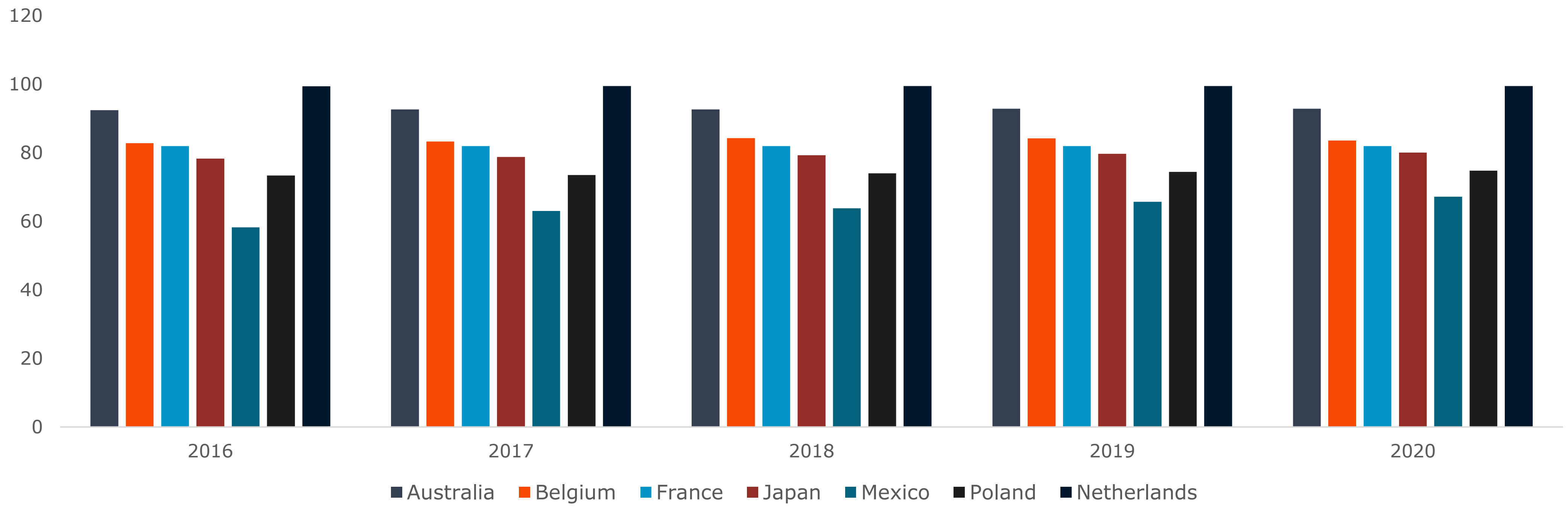
The difference between the world's water supply and demand is predicted to increase to 40% by 2030. Demand already outpaces supply in many areas, and in other areas, water shortage is impeding economic progress. While economic development and more unpredictable weather patterns enhance competition for access to water, affecting citizens, farms, industries, and governments, water insecurity raises the possibility of a global food crisis. This indicates that various stakeholders from all spheres of society must be involved in any solutions to the global water dilemma. Improved water supply and sanitation, and better water resource management boost global economic growth and contributes significantly to poverty eradication. Furthermore, investing in water and wastewater treatment solutions is a good business, as new and more advanced solutions, equipment, and enhanced water management solutions can be developed, and deployed, and enhance or increase efficiency of treatment and production and productivity within economic sectors.

The importance of sustainability and the need to mitigate climate change, issues related to water, rapid urbanization along with increasing global population have been gaining significant prominence in recent years. According to the 2015 United Nations World Water Development Report, the world is expected to register a 40% decline in water supply by 2030 unless the management of this resource is dramatically improved. The complexities associated with water treatment including technological, logistical, and regulatory make bundled design, construction and operation service packages highly profitable. In addition, water infrastructure, industrial needs, and uses together with environmental norms and regulations make the global water quality monitoring equipment for highly sensitive and competitive applications. There are numerous measurement methods for identifying the amount of organic and inorganic substances in water and wastewater, including Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Organic Carbon (TOC) to name a few.

A large amount of wastewater treated by municipal and industrial wastewater treatment plants makes the regulation of treated wastewater an effort crucial to the health and safety of humans and the environment. Because there can be striking variations in flow rate and organic content of water coming to a treatment plant which results from surge in rainfall or changes in the chemical usage in industrial plants, it is crucial to have access to reliable, real-time water quality data.

Wastewater treatment refers to the treatment of wastewater done in wastewater treatment plants operated by public departments or by private companies regulated by public authorities. ‘Population connected to wastewater treatment’ is the share of population with their wastewater being treated at wastewater treatment plants. Developed countries such as Germany have high rate of wastewater treatment of sewage water, prior to its disposal in the large water bodies. Such initiatives are vital for the growth of water treatment assistive technologies such as TOC, BOD, COD, and other parameter-based equipment.

FIGURE 29. WASTEWATER TREATMENT (% POPULATION CONNECTED)



Source: OECD.Stats, International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS), Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank

Freshwater is considered a finite resource, which is crucial for agriculture, industry, and human existence. If freshwater is unavailable in adequate quantity and appropriate quality, the goals for sustainable development cannot be attained. Water pollution coupled with wasteful use of freshwater threatens the future of development projects globally.

While the degradation of water quality is almost invariably the result of human activities, certain natural phenomena have also resulted in the reduction of water quality below the standard required for different purposes. Natural calamities such as torrential rainfall and hurricanes also lead to excessive erosion, mudflows, and landslides, which increase the content of suspended materials in rivers and lakes. In addition, naturally occurring areas of trace metals, high nutrients, trace metals, salts, and other constituents also limit the use of water. Common examples include salinization of surface waters through evaporation in semi-arid and arid regions. Another example can be the high salt content of some aquifers under some geological conditions. For instance, some aquifers have a high content of carbonates, and thus treatment before use for industrial applications is a necessity.

Almost all human activities can and do have an adverse impact on water quality. Water quality is influenced by Non-Point Source Pollution (NSP) through farming activities as well as Point-Source Pollution (PSP) mainly coming from sewage treatment and industrial discharge. Agricultural pollutants include excessive nutrients such as nitrates and phosphates, pesticides and fertilizers, sediments, and fecal microbes. Release of toxic chemicals and wastewater from factories and industries, over-flows from aquifers, long-range atmospheric transport of pollutants are among some major causes of water quality degradation currently.

6.2.1. OPPORTUNITIES FOR CONTRACTORS OR TECHNOLOGY/EQUIPMENT PROVIDERS

Demand for water for municipal and industrial use has increased in parallel with expanding urbanization and industrialization in countries across the globe. This offers major growth potential for players operating in the water and wastewater treatment market as well as governments to focus on innovation and more advanced solutions, particularly in the areas of infrastructure, technologies, and services. Major replacement or upgrade is required for many current water and wastewater treatment plants to be able to cater to the more demanding standards. At both, the federal and state government levels, environmental clearances from pollution control bodies are a required. In addition, there has been a large investment gap in this market, which can be bridged by the private sector by choosing the right technologies, ratcheting up funding sources, and putting plans into action. Municipal wastewater collection, treatment and reuse presents the opportunity for both environmental restoration and for addressing rising water needs of various economic sectors.

For many economies, like India for instance, moving toward a circular economy is essential for guaranteeing social and economic stability. To do this, a framework that makes use of clever legislation, market-based tools, research and innovation, incentives, and information sharing for voluntary initiatives can be created. Also, rather than relying on solutions at the end of the product life, technology or equipment providers should be able to focus on building ways through the value chain. This can be accomplished by lowering the amount of energy used in production, reducing the volume of water needed to deliver services, thereby developing a market for secondary raw materials, encouraging and supporting waste reduction and high-quality waste separation by consumers, and facilitating clustering of activities so as to prevent by-products from becoming waste. In addition, freshwater allotment for drinking in urban and rural areas must be rationalized to account for the specific industry. Adopting micro irrigation techniques should similarly promote efficient water use in agriculture applications. For wastewater to be recycled and reused, each of these uses should be dependent on the others.

India mostly imports water treatment equipment from the U.S., China, and other economies. However, businesses with offices in India of all sizes and specialties will discover exciting market potential in the country, especially if these businesses provide goods and services for gathering, transporting, treating, monitoring, and analysis of water and wastewater for a variety of end-uses and consumers. There are currently well-established water treatment companies in India that offer cutting-edge technologies, but some face difficulties that must be overcome and solutions explored, which in future could open up and present major revenue potential and expansion opportunities for market players.

Companies can focus on specializing in the following infrastructure solutions, technologies, and services, which will be well-positioned to cater to needs in the market and can provide great opportunities. Some include:

- Integrated solutions such as performing feasibility studies, designing, technical consulting and providing operation and online maintenance services; and successfully offer such solutions.
- Companies should consider entering into Joint Venture (JV) or other types of partnerships or mergers with strategic depth
- Systems and equipment for water supply, sewerage treatment, as well as efficient use and reuse of water; such offerings should be addressed primarily to industrial sectors which account for a high degree of pollution
- Develop advanced technical designs and equipment for wastewater systems (collection, conveyance, monitoring, and analysis)
- Innovate with equipment for wastewater treatment, including treatment technologies, biogas regeneration through anaerobic treatment of municipal and industrial wastewater
- Technical designs, equipment and maintenance of equipment for disinfecting water by electrolysis
- Explore more solutions for the efficient use of water.
- Instruments to analyse water (including water-saving devices for private households)
- Water purification systems for municipal, community, and household use
- Technical designs and equipment for rainwater harvesting systems
- Equipment for water saving and water recycling
- Systems for rehabilitation of sewage (including septic system rehabilitation)
- Packaged and transportable sewerage and wastewater treatment systems

These requirements can be transformed into growth opportunities by key players such as contractors and technology, or equipment providers in the future.

6.3. INDIA CURRENT KEY PRACTICES IN WATER AND WASTEWATER MANAGEMENT

India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. With the present population growth-rate (1.9% per year), the population is expected to cross the 1.5 billion mark by 2050. The Planning Commission, Government of India has estimated the water demand increase from 710 BCM (Billion Cubic Meters) in 2010 to almost 1180 BCM in 2050 with domestic and industrial water consumption expected to increase almost 2.5 times. The trend of urbanization in India is exerting stress on civic authorities to provide basic requirement such as safe drinking water, sanitation and infrastructure. The rapid growth of population has exerted the portable water demand, which requires exploration of raw water sources, developing treatment and distribution systems.

With a geographical territory of nearly 3.287 million square kilometers, the vast land of India relies on rivers, oceans and lakes for its reserves. For instance, rivers like the Ganga, Yamuna and Brahmaputra among the other major 19 rivers provide water to the northern region. Whereas the rivers, Cauvery, Krishna and Godavari constitute the prominent water resources of south India. Dam projects like the Tehri Dam of Uttarakhand and the Bhakra Nangal project in Himachal Pradesh are providing a boost to the optimum utilization of this resource for energy generation within the country. Although the country accumulates nearly 4000 billion cubic meters (BCM) annually, as per the Central Water Commission of India, nearly 80-95% of water is accumulated during the monsoon season, ranging from June to September. Hence, being rain dependent is seen to increase the pressure on the limited supply of water. Furthermore, the growing population of the country, increase in urbanization, agricultural demand as well as industrial progress has resulted in a

20% fall in per capita water availability from 2000 to 2020. Additionally, although water consumption per person is nearly 2 liters for survival, with a population of 1.4 billion, the country is facing an acute water crisis. It has also been reported by the National Commission for Integrated Water Resource Development (NCIWRD) in 2020, that the proportion of water used for agriculture has been reducing since the past two decades, and is seen to be diverted for industrial uses. For instance, almost 83.30% of total water storage was being availed by agriculture, whereas the NCIWRD states that 72.48% would be used by this primary sector till 2025. Hence, there has been a shift of directing water resources towards industrial and chemical developments such as infrastructural projects and fossil fuel extraction. Similarly, the Central Pollution Control Board of India suggests that 500 BCM capacity of water is utilized by various processing and manufacturing industries out of the 4000 BCM acquired per year. Chemical residues, effluents being released in lakes and rivers along with a deterioration of water quality are the negative impacts of this precious resource being heavily used in production sector and being disposed of incorrectly in India.

Such waste water consists of solid waste, toxic waste as well as chemical waste generated by factories and warehouses. Chemicals and reagents like phenols, arsenic, cadmium and lead among other materials are being detected in India's such waste waters regions. These materials, also known as persistent bio accumulative toxins, are hazardous for aquatic flora, fauna, and for humans. As a result, up to 70% of surface water in the country is contaminated with 40 million liters of such polluted water entering other water bodies, as per the Asian Development Research Institute. Although such contamination might be restricted to industrial areas, their harmful reverberations affect the overall ecosystem, ranging from saline and toxic groundwater and soil for agriculture, up to the excess load on water purification systems in cities. This has also led to the rise in water borne diseases, owing to poor sanitation and water hygiene in rural regions. For example, 37.7 million people are being affected by waterborne diseases like cholera and typhoid in the country, according to a UNICEF report in 2019. There is a pressing need for waste water management in urbanized industrial zones such as the

Gurgaon-Delhi-Meerut zone and Mumbai-Pune region. Many governmental programs, incentives and private players are encouraging the growth of the water and wastewater treatment industry in India.

As a result, with the advent of newer technology in purification processes, great involvement of the Indian government in curbing water waste generation and control of industrial effluents through different programs is supporting this sector. Additionally, the growing participation from private companies to produce mechanical parts for treatment plants and a rising awareness about environmental issues is propelling the water and waste water treatment industry forward. Furthermore, the global influence of sustainable development and funds for research and development in the sector are also some of the important influencing factors for the growth of this sector in the country.

Rainwater Harvesting

Rain Water Harvesting can be defined as the collection and storage of rainwater for future uses--domestic, agricultural, industrial, and so on--as a means to replenish groundwater by allowing the accumulated rainwater to seep back into the earth through assisted means, thereby recharging the water levels below the ground. With increased urbanization, the supply of clean, potable drinking water for the majority is becoming increasingly difficult. Rainwater may be viewed as a valuable renewable resource for all regions. Domestically, it is used to provide potable water, small-scale irrigation, and, most typically, to refill and maintain groundwater levels. It is mostly helpful for agricultural purposes in countries/regions with dry, arid climates with little or no rainfall. It assists farmers in reaping the benefits of nature by catching rainwater and giving a less expensive option for clean water. Farmers in steep and hilly terrains benefit from catching runoffs on sloping terrains to reduce soil erosion loss.

Tamil Nadu was the first Indian state to make rainwater collecting mandatory for buildings in order to address groundwater depletion in 2001, and the state has enjoyed huge advantages as a result. Groundwater levels in Chennai surged about 50% in five years, and water quality improved as a result. The effectiveness of this effort was aided by mass awareness campaigns in both rural and urban regions. Following the success of the Tamil Nadu model, several states enacted different laws and regulations, and even the Parliament contributed to the cause by drafting national legislation, The Rainwater (Harvesting and Storage) Bill, in the Lok Sabha in 2016. The Rainwater (Harvesting and Storage Bill) was introduced as a Private Member's Bill in Lok Sabha in 2016 to allow for mandatory rainwater harvesting in all government, residential, commercial, and institutional buildings in order to save rainfall and maintain groundwater recharge. It suggested building rainwater collecting facilities on properties with an area more than or equal to 1100 square meters to fulfill a portion of its overall water needs. The person in charge of the affairs of the mentioned establishment is responsible for ensuring compliance with the rules and regulations. For example, in the case of a residential society, the Secretary of the society is accountable; in the case of an office, the person responsible is a manager, and so on. The government is required to develop an action plan to educate the public about rainwater harvesting through the internet and other relevant campaigns, as well as to encourage and provide financial assistance to Non-Governmental Organizations and other organizations actively involved in rainwater harvesting. The Bill also recommended a punishment of up to two years in prison and/or a fine of Rs. ten lakhs for failure to comply with the requirements of the Bill.

Himachal Pradesh	Karnataka	Gujarat	Tamil Nadu	New Delhi	Haryana	Rajasthan	Maharashtra
• All buildings- existing and new, residential and commercial spanning over 1000 square meters are to mandatorily have rainwater harvesting systems and storage units, proportional to the size/area of the terrace. All toilet flushes are to be connected to this storage unit.	• In 2009, the government of Karnataka made it mandatory for each and every building/complex in the state spanning over 1500-meter square to adopt rainwater harvesting and management systems, and those over 2400-meter square, to construct a separate facility for the same.	• The Ahmedabad Urban Development Authority made rainwater mandatory for all buildings spanning over 1500-meter squares to construct percolation wells, to store the harvested rainwater, and one well for every additional 4000 m sq. covered in 2002.	• According to the Tamil Nadu Municipal Laws (ordinance) of 2003, the state government made it mandatory for all public and private buildings in the state to build and install rainwater harvesting systems, explicitly stating that in all those occupancies, where no such system is installed, the Municipal Authorities (authorized by the Commissioner) may after due notice to the owner, install a system and recover the costs from the property holder as property tax. Non-compliance with these provisions may lead to disconnection of the main water supply by the authorities.	• The ministry of Urban Affairs and Poverty Alleviation made rainwater harvesting mandatory for new constructions having a roof area greater than 100 meters square in 2001. Rainwater harvesting is mandatory for the regions of South and South-west Delhi, Ghaziabad, Gurgaon, Faridabad, and other notified areas, according to a notification issued by the Central Water Authority and an incentive of 6% rebate on property tax on compounds having fully functioning water harvesting systems is offered for maximum utilization of rainwater, or a 10 percent rebate on the water bills.	• The Haryana Urban Development Authority (HUDA) has made the setting up and installation of rainwater harvesting systems in all new buildings compulsory, irrespective of roof area. All neighboring industrial areas and residential colonies are required to strictly adhere to the notification, especially those having tubewells.	• The state government has made rainwater harvesting mandatory for all public and private compounds in urban areas. Rajasthan is one of those few states having a history of traditionally practicing rainwater harvesting. The local authorities have actively been working towards reviving these old water harvesting systems.	• Rainwater harvesting has been made compulsory for all buildings constructed on plots having an area equal to or greater than 1,000 sq m. in Pune, the existence of a rainwater harvesting system in a housing society is a prerequisite, whereas in Mumbai, although there is no such mandatory rule in existence, the local authorities are planning to make it mandatory for large and expansive housing societies.

Reuse and Recycling

Water reuse and recycling have become increasingly important strategies in India due to the growing water scarcity and pollution challenges faced by the country. Several initiatives and practices have been implemented to address these issues and promote sustainable water management. Industries are encouraged to implement water recycling and reuse practices to minimize their impact on freshwater sources. Many industries, such as textile, paper, and chemical, have adopted technologies to treat and reuse their wastewater for production processes. Many cities in India have established wastewater treatment plants to treat and recycle domestic and industrial wastewater. These plants use various treatment processes to remove pollutants and pathogens from wastewater before releasing it into water bodies or reusing it for non-potable purposes such as irrigation and industrial processes.

Water stress has become a recurring worry in India as a result of the rapid and uncontrolled growth in water demand for household, agricultural, and industrial requirements. More than half of the country's population is expected to be urban by 2050. This would challenge water management since the exponential increase. Furthermore, insufficient and restricted wastewater treatment facilities endanger water quality and public health. In India, the total installed capacity to treat wastewater (domestic sewage) from urban areas is 44%, or 31,841 million liters per day (MLD), compared to an estimated daily sewage output of 72,368 MLD. The actual treatment rate is only 28%, or 20,236 MLD. Even in class I (populations over 100,000) and class II (populations 50,000-100,000) towns, which account for 72% of the urban population, only 30% of the wastewater gets treated, i.e., 11,787 MLD vs the 38,254 MLD created. n demand would place a large extra pressure on already restricted freshwater supplies. The remaining untreated wastewater is released into natural water bodies such as rivers and lakes, causing contamination and affecting water quality, particularly in downstream settlements. Nonetheless, India has made significant headway in boosting its operational treatment capacity, increasing from 18,883

MLD in 2014 to 26,869 MLD in 2020, a 40% increase. However, much more has to be done to manage wastewater and meet the issues created by lack of water.

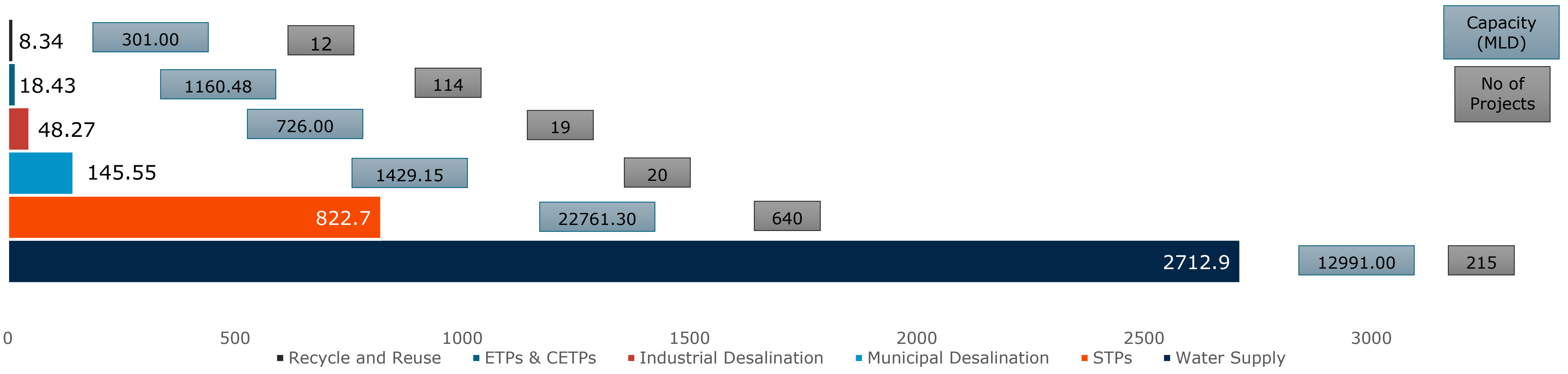
6.3.1. WASTEWATER SCENARIO IN INDIA

With 1.38 billion inhabitants, India is the world's most populous country. According to the United Nations (2021), 67% of the population lives in rural areas, while 33% is connected to metropolitan centers. The country's urban cities are expanding rapidly as a result of economic development and reforms. This increase in urban population is unsustainable without effective city planning and the supply of utility services, particularly clean and inexpensive water. Water is often allocated in cities from a shared pool with multiple sectoral needs. It is projected that by 2050, around 1450 km3 of water would be required, with approximately 75% being utilized in agriculture, 7% for drinking water, 4% in industry, and 9% for energy generation. However, due to increasing urbanization, the need for drinking water will trump rural water requirements. Many towns are located on river banks, where fresh water is used by the people and waste water is disposed of back into the river, contaminating the water supply and irrigation water. This has created significant difficulties for urban wastewater management, planning, and treatment. According to the Central Pollution Control Board (CPCB), the predicted wastewater generation in rural areas was over 39,600 million litres per day (MLD), while in urban areas it was 72,368 MLD for the year 2020-21. The projected volume in big centres is about double that of rural areas due to the availability of more water for sanitation, which has raised the level of living.

As the country's population grows, so does the need for water and its management. Water scarcity is expected to become a serious issue in the future. Furthermore, pollution's impact on water supplies is a cause of worry. Some of the major causes of water pollution are the release of industrial waste, the discharge of untreated or partially treated municipal wastewater through drains, the discharge of industrial effluent, improper solid waste management, illegal ground water abstraction, encroachments in flood plains/river banks, deforestation, improper water shade management, and the non-maintenance of e-flows and agricultural runoff, among others. The Government of India has devised a number of initiatives that focus on water conservation and restoration.

As a consequence, the number of contaminated river lengths has decreased from 351 in 2018 to 311 in 2022, and water quality has improved in 180 of the 351 contaminated River lengths (PRS) during 2018. According to research from the Ministry of Jal Shakti, a review of water quality over time reveals that in 2015, 70% of rivers examined were designated as contaminated, however in 2022, just 46% of rivers studied are identified as polluting. The need for water is only expected to rise in the coming years. The government's major priority is to provide safe drinking water. Drinking water quality has been a serious problem in rural regions over the years. The Central Water Commission (CWC) examines the country's total water resources on a regular basis, and it has designated water supply for drinking purposes as the main priority in water distribution.

FIGURE 30. SEGMENT WISE PROJECTS IN THE PIPELINE IN INDIA, 2022



Source: India Infrastructure Research

In India, the urban sewage generation was 72,368 MLD in 2020-21, whereas the existing sewage treatment capacity was 31,841 MLD. The operating capacity is 26,869 MLD, which is much less than the load generation. Only 28% of total sewage generation, or 20,236 MLD, was processed, implying that 72% of waste water is left untreated and is disposed of in various water bodies such as rivers, lakes, or subterranean water. There has been some capacity expansion, such as 4,827 MLD sewage treatment, but there is still a 35,700 MLD gap, or 49%, between waste water generation and treatment. According to a 2018 NITI Aayog assessment, India is one of the world's most water-stressed areas, with 600 million Indians under high water stress. According to the analysis, by 2030, water demand may be twice as high as supply, resulting in acute water scarcity for millions of people and a 6% drop in the country's GDP. As a result, knowing and managing our water demands and resources efficiently is becoming increasingly important. Reusing and recycling our water resources is critical for a sustainable future. According to the UN Waste Water Assessment Program assessment, high-income nations treat around 70% of the wastewater generated. In upper-middle-income nations, the percentage falls to 38%, 28% in lower-middle-income countries, and 8% in low-income countries. This amounts to around 20% of worldwide wastewater treatment. According to a recent Central Pollution Control Board report (March 2021), India's present water treatment capacity is 27.3% and its sewage treatment capacity is 18.6% (with an additional 5.2% capacity being built). Though India's waste and sewage treatment capacity is greater than the global average of roughly 20%, given the magnitude of the problem, it is far from adequate, and without immediate action, major difficulties might arise.

TABLE 6. REGION-WISE SEWAGE GENERATION AND TREATMENT CAPACITY OF URBAN CENTERS-INDIA, 2020 (MLD)

States / UTs	Sewage Generation (MLD)	Installed Capacity (MLD)	Proposed Capacity (MLD)	Operational Treatment Capacity (MLD)
East India	12226	1345	1553	440
West India	19212	13356	3161	11332
South India	20851	6114	23	4869
North India	16894	11026	90	10228

TOTAL	**72368**	**31841**	**4827**	**26869**

Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants, Ministry of Jal Shakti

Currently, there is no centrally mandated policy requirement for wastewater management in India. Water resources are mismanaged as a result of policy gaps and the lack of a defined regulatory framework. Untreated sewage waste is a major source of surface and groundwater contamination in India. The Water (Prevention and Control of Pollution) Act of 1974 was the country's first legislative legislation addressing the subject of water pollution and conservation. This Act addresses wastewater discharge as a pollution issue. This Act establishes Central and State Pollution Control Boards to be in charge of water pollution prevention and control. It punishes the act of interfering with water flow by discharging noxious chemicals into streams, wells, sewers, or land. SPCBs' operations on the ground are more thorough and direct, since it inspects sewage and trade effluents, wastewater treatment plants, and examines and establishes standards for the same. SPCBs' operations on the ground are more thorough and direct, since it inspects sewage and trade effluents, wastewater treatment plants, and examines and establishes standards for the same. According to a 2019 study report of Niti Ayog, most of the sewage treatment plants created under the Ganga Action Plan and Yamuna Action Plan are not operational, and only 7000 MLD of waste is collected and processed out of the 33000 MLD generated. According to the report, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) adopted the National Policy on Faecal Sludge and Septage Management (FSSM) in 2017 because "only 64% of India's 846 municipal sewage treatment plants were operational, resulting in a net capacity to process only 37% of the total human waste generated every day in urban India." According to official figures, 62.5% of metropolitan India's wastewater remains untreated or inadequately treated. Water pollution, conservation, recycling, reuse, and recharging are all exacerbated by the country's limited wastewater treatment infrastructure and inadequate operational maintenance.

TABLE 7. COMPARATIVE STATISTICS ON THE INVENTORY OF SEWAGE TREATMENT PLANT FOR THE YEARS 2014 AND 2020

STP Status	Nos. Of STPs (2014)	Capacity (MLD) in 2014	Nos. Of STPs (2020)	Capacity (MLD) in 2020
Operational	522	18883	1093	26869
Actual Utilization	-	-	1093	20235
Compliance	-	-	578	12197
Non-operational	79	1237	102	1406
Under Construction	145	2528	274	3566
Proposed	70	628	162	4827

Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

The issue of river pollution in India is a matter of great concern and responsibility, governed by the constitutional provisions and environmental regulations of the country. The Constitution of India, under the seventh schedule (Article 246), designates 'Water' as a State subject. Consequently, it is the responsibility of the individual States and Union Territories (UTs) to ensure the cleanliness and development of rivers within their respective jurisdictions. This distribution of authority underscores the federal nature of India's governance, where States play a pivotal role in managing their water resources.

Cleaning rivers is an ongoing and multifaceted process, necessitating collaborative efforts between the Central Government and State/UT Governments. The Government of India, recognizing the gravity of the situation, supplements the endeavors of the State/UT

Governments in addressing the challenges posed by river pollution. This support takes the form of financial and technical assistance. Financial assistance is extended to the State/UT Governments for pollution abatement in identified stretches of various rivers. This initiative falls under the Centrally Sponsored Scheme of the National River Conservation Plan (NRCP). The financing is based on a cost-sharing arrangement between the Central and State/UT Governments. The primary objective is to undertake pollution abatement works comprehensively. These works encompass a range of activities, including:

- **Interception & Diversion of Raw Sewage:** One of the critical components of pollution control is preventing raw sewage from directly entering rivers. Intercepting and diverting sewage away from water bodies is a fundamental step.
- **Construction of Sewerage Systems:** Developing an efficient sewerage system is essential for the proper collection and disposal of sewage.
- **Sewage Treatment Plants (STPs):** The establishment of STPs is crucial for treating sewage before it is released into rivers or water bodies. These plants significantly reduce the pollution load.
- **Low-Cost Sanitation:** Promoting low-cost sanitation facilities is an integral part of pollution abatement efforts.
- **River Front/Bathing Ghat Development:** Enhancing riverfront areas and bathing ghats not only improves the aesthetics but also contributes to the overall cleanliness of the rivers.

TABLE 8. TECHNOLOGICAL DISTRIBUTION WITH RESPECT TO NUMBER AND CAPACITY OF STP'S

Technology	Capacity in MLD	Number of STP's
ASP		
EA	474	30
SBR		
MBBR	2032	201
FAB		
UASB	3562	76
WSP		
OP	460	61
Any Other		

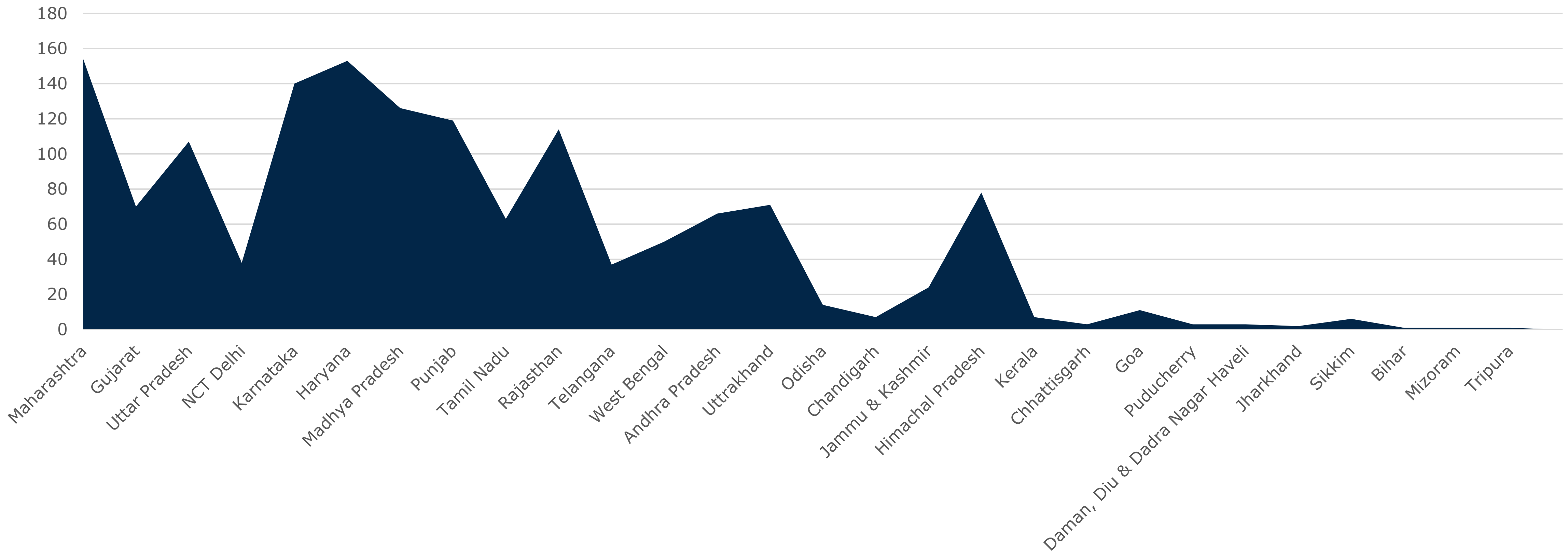
Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

The NRCP has made significant strides in its mission to clean and conserve rivers. It has covered polluted stretches in 36 rivers across 80 towns in 16 different States. The total project cost sanctioned under NRCP stands at a substantial Rs. 6248.16 crore. One of the key achievements is the creation of sewage treatment capacity, amounting to 2745.7 million liters per day (mld). This substantial increase in treatment capacity has led to a considerable reduction in the pollution load discharged into various rivers. While NRCP focuses on multiple rivers, the Namami Gange program is dedicated exclusively to the rejuvenation and conservation of the Ganga River and its tributaries. Under this program, 406 projects have been sanctioned, with 176 of them dedicated to sewage treatment, capable of treating 5270 MLD of sewage. Additionally, a sewer network spanning 5214 km has been approved. These initiatives represent a significant financial commitment, amounting to Rs. 32898 Crores. The impact is evident in the creation of sewage treatment capacity, which now stands at 1858 MLD. Efforts to combat river pollution extend beyond NRCP and Namami Gange. Programs like the Atal Mission for Rejuvenation & Urban Transformation (AMRUT) and the Smart Cities Mission, led by the Ministry of Housing & Urban Affairs, also contribute to sewerage infrastructure development. These programs are designed to transform urban areas and improve the living standards of the populace, which includes addressing sanitation and sewage management.

To ensure that industrial units and local bodies adhere to environmental standards, India has enacted two critical pieces of legislation: the Environment (Protection) Act, 1986, and the Water (Prevention & Control of Pollution) Act, 1974. These acts mandate the installation of effluent treatment plants (ETPs) or common effluent treatment plants (CETPs) by industrial units and local bodies. They must treat their effluent and sewage to comply with stipulated environmental standards before discharge into rivers and water bodies. The Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), and Pollution Control Committees (PCCs) are tasked with enforcing compliance under the provisions of these acts. Punitive actions are taken against those who fail to adhere to the prescribed norms. In addition to regulatory measures, industries are encouraged to adopt sustainable practices to reduce wastewater generation. Technological advancements play a pivotal role in this regard. Reusing and recycling wastewater are promoted as effective strategies to minimize environmental impact. Moreover, the concept of Zero Liquid Discharge (ZLD) is advocated wherever possible. ZLD involves treating wastewater to the extent that no liquid discharge is released into the environment, ensuring minimal ecological harm.

The issue of river pollution in India is a multifaceted challenge that requires concerted efforts from various stakeholders. The constitutional provisions assign the responsibility of managing rivers to State and UT governments, with the central government offering crucial financial and technical support. The NRCP and Namami Gange program have made substantial progress in cleaning and conserving rivers, with a significant increase in sewage treatment capacity. Additionally, other urban development programs contribute to sewerage infrastructure development. Stringent environmental regulations, backed by punitive actions, ensure compliance with pollution control norms by industrial units and local bodies. Encouraging sustainable practices, such as wastewater reuse and Zero Liquid Discharge, are pivotal in reducing the environmental footprint.

FIGURE 31. STATE-WISE INSTALLED STP'S

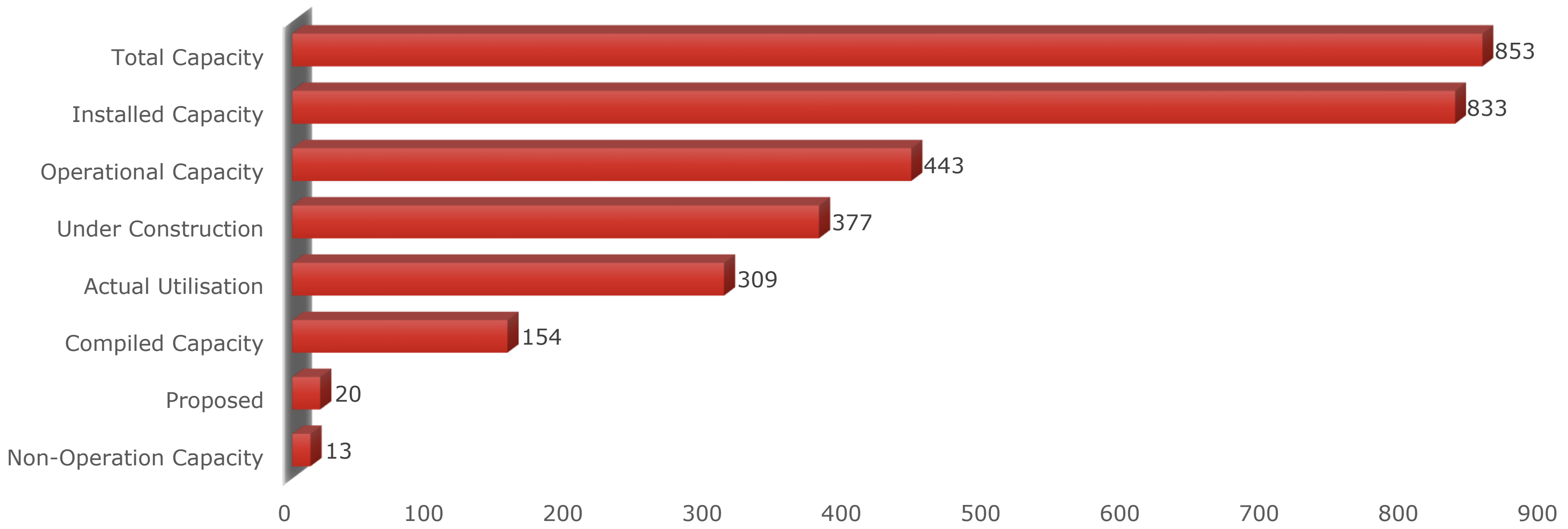


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.1. ANDHRA PRADESH

- The estimated sewage generating capacity for the state of Andhra Pradesh is 2882 MLD, with a total capacity (including projected capacity) of 853.05 MLD (67 STPs).
- The installed capacity is 833 MLD (39.61%) of the sewage generating capacity of 2882 MLD. It reveals a treatment capacity shortfall of 2049 MLD (71.09%).
- The operationalized capacity is 443 MLD (53.18%) of the 833 MLD installed capacity developed. Actual used capacity is 309 MLD, although compliant STP capacity is only 154 MLD.
- In comparison to natural treatment systems, STPs based on ASP and MBBR technologies predominate. STPs based on natural treatment systems, on the other hand, exhibit greater than 50% compliance with stipulated requirements.

FIGURE 32. SEWAGE TREATMENT CAPACITY (MLD) – ANDHRA PRADESH

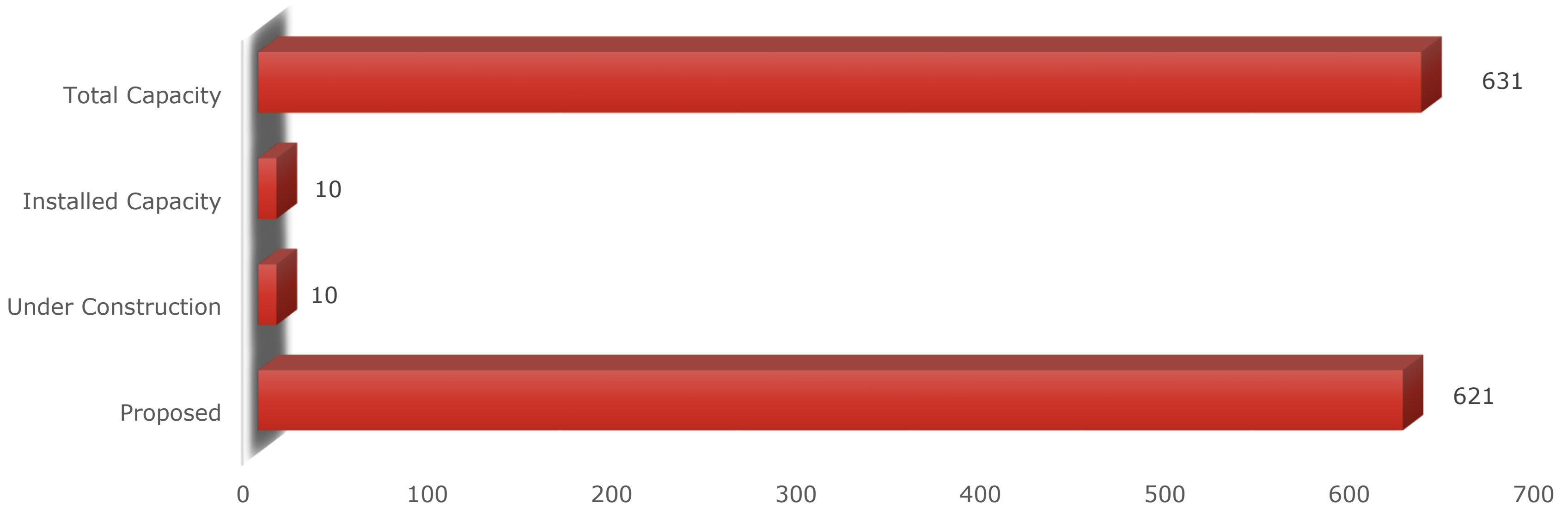


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.2. BIHAR

- The estimated sewage generation in Bihar is 2276 MLD, with a total capacity (including projected) of 631 MLD (25 STPs).
- The installed capacity is just 10 MLD (0.43%), compared to the sewage production of 2276 MLD.
- It reveals a treatment capacity shortfall of 2266 MLD (99.56%). The remaining treatment capacity is either in the planned or building stages.
- The operationalized capacity of the 10 MLD installed capacity is zero.

FIGURE 33. SEWAGE TREATMENT CAPACITY (MLD) – BIHAR

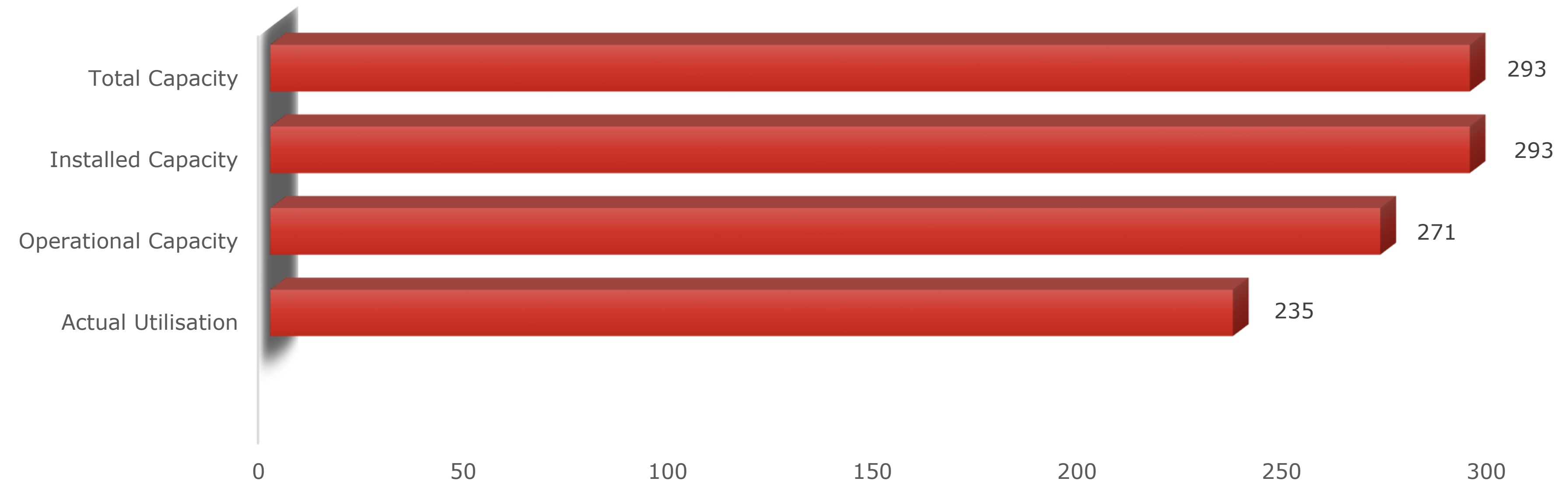


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.3. CHANDIGARH

- The estimated sewage generating capacity for the union territory of Chandigarh is 188 MLD, with a total capacity (including projected capacity) of 293 MLD (07 STPs).
- The installed capacity is 293 MLD, with a sewage generating capacity of 188 MLD. It demonstrates A total of 105 MLD of treatment capacity is available.
- The operationalized capacity is 271 MLD, out of 293 MLD of installed capacity created. (92.49%).
- The actual usable capacity is 235 MLD (86.72%) of the operating capacity of 271 MLD.

FIGURE 34. SEWAGE TREATMENT CAPACITY (MLD) – CHANDIGARH

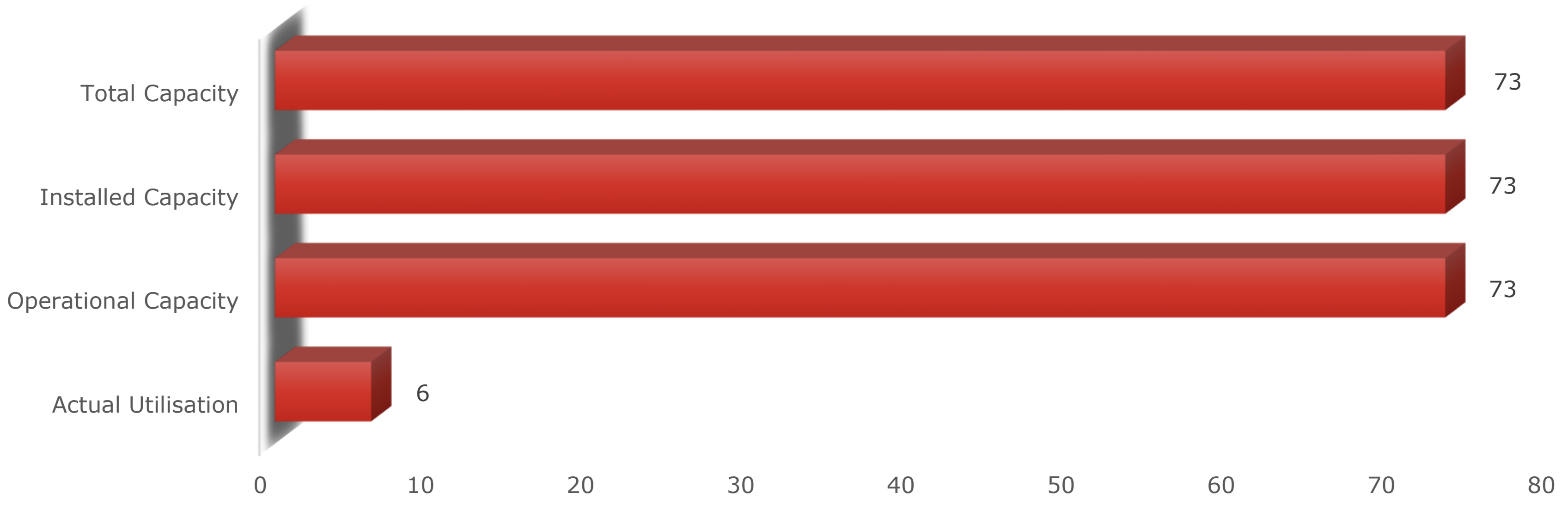


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.4. CHHATTISGARH

- The estimated sewage generation in Chhattisgarh is 1203 MLD, with a total capacity (including projected) of 73 MLD (03 STPs).
- The installed capacity is 73 MLD, with a sewage generating capacity of 1203 MLD. It reveals a treatment capacity shortfall of 1130 MLD (93.93%).
- The operationalized capacity is 73 MLD (100% of the installed capacity of 73 MLD). The actual usable capacity is 06 MLD out of a total operating capacity of 73 MLD.
- throughout comparison to natural treatment systems, STPs based on ASP technology predominate throughout the state.

FIGURE 35. SEWAGE TREATMENT CAPACITY (MLD) – CHHATTISGARH

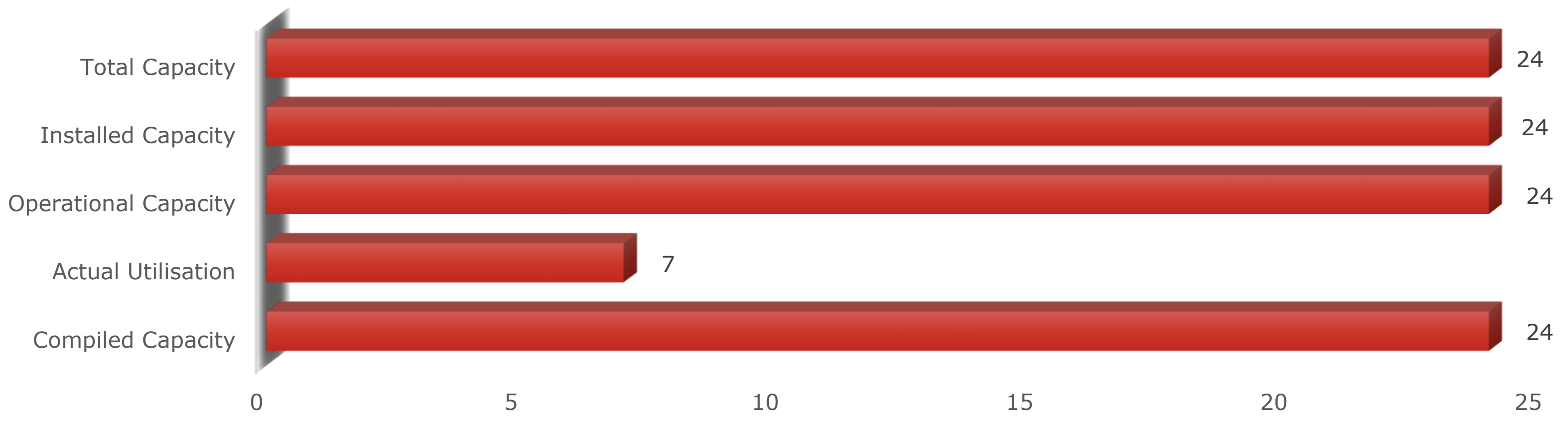


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.5. DAMAN DIU & DADRA NAGAR HAVELI

- Sewage generation in the union territory of Daman Diu and Dadra Nagar Haveli is estimated to be 67 MLD, with a total capacity of 24 MLD (03 STPs).
- The installed capacity is 24 MLD (35.82%), whereas sewage production is 67 MLD. It reveals a treatment capacity shortfall of 43 MLD (64.17%).
- Because all of the STPs are operating, the operational capacity is also 24 MLD. However, actual usable capacity is just 07 MLD of the operating capacity of 24 MLD.

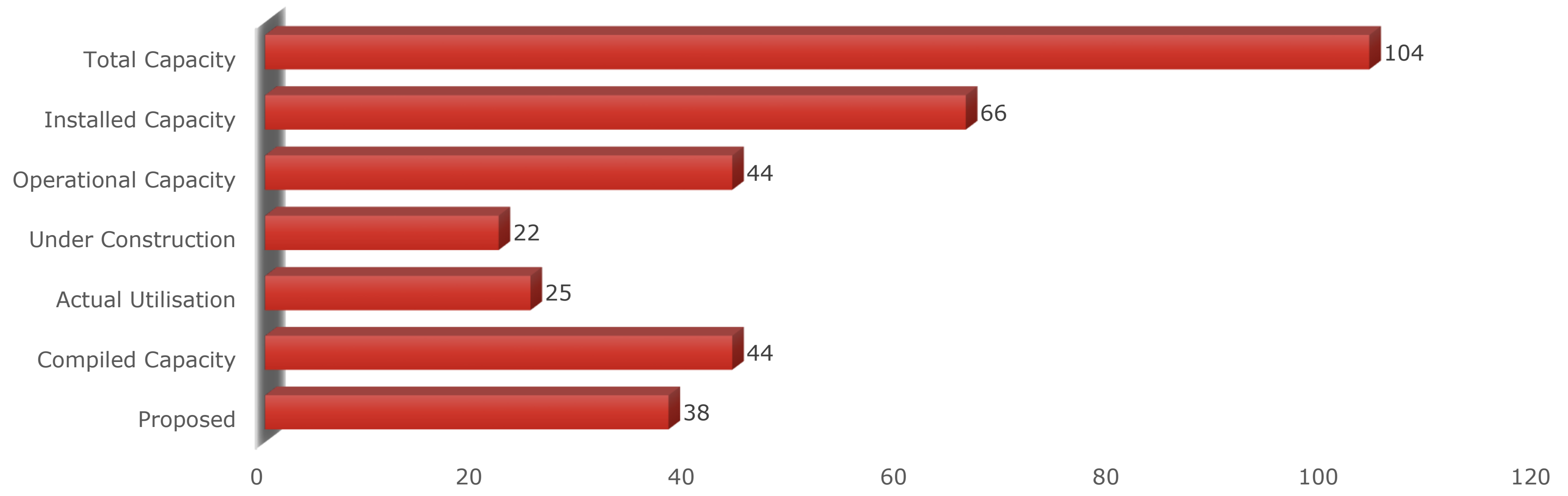
FIGURE 36. SEWAGE TREATMENT CAPACITY (MLD) – DAMAN DIU & DADRA NAGAR HAVELI



6.3.1.6. GOA

- The estimated sewage generating capacity for the state of Goa is 176 MLD, with a total capacity (including projected capacity) of 104 MLD (14 STPs).
- The installed capacity is 66 MLD (25%) of the sewage generating capacity of 176 MLD. It demonstrates a 110 MLD (62.5%) treatment capacity shortfall. The operationalized capacity is 44 MLD (66.67%) of the 66 MLD installed capacity developed.
- The actual used capacity is 25 MLD out of the 44 MLD operational capacity, and all STPs are in compliance with standards.

FIGURE 37. SEWAGE TREATMENT CAPACITY (MLD) – GOA

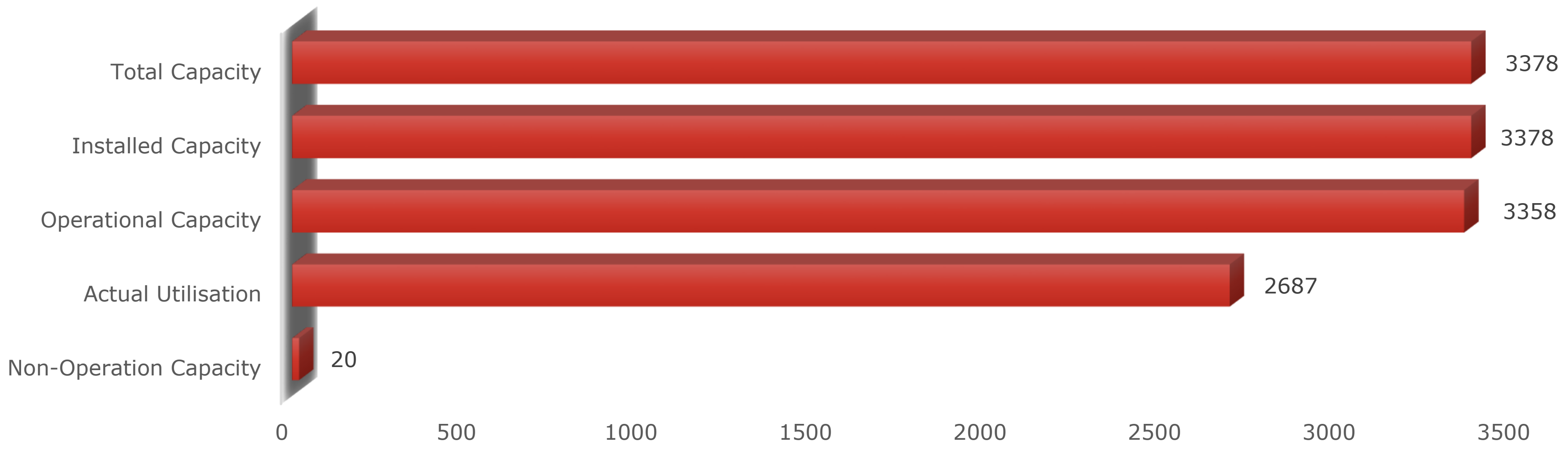


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.7. GUJARAT

- The estimated sewage generation for Gujarat is 5,013 MLD, with a total capacity (including projected) of 3,378 MLD (70 STPs).
- The installed capacity is 3,378 MLD (67.38%) of the sewage generating capacity of 5,013 MLD. It reveals that there is a treatment capacity shortfall of 1635 MLD (32.61%).
- The operational capacity is 3358 MLD (99.40%) of the installed capacity of 3378 MLD. The actual usable capacity is 2,687 MLD out of a total operating capacity of 3,358 MLD.
- In comparison to natural treatment systems, STPs based on SBR and ASP technology predominate.

FIGURE 38. SEWAGE TREATMENT CAPACITY (MLD) – GUJARAT

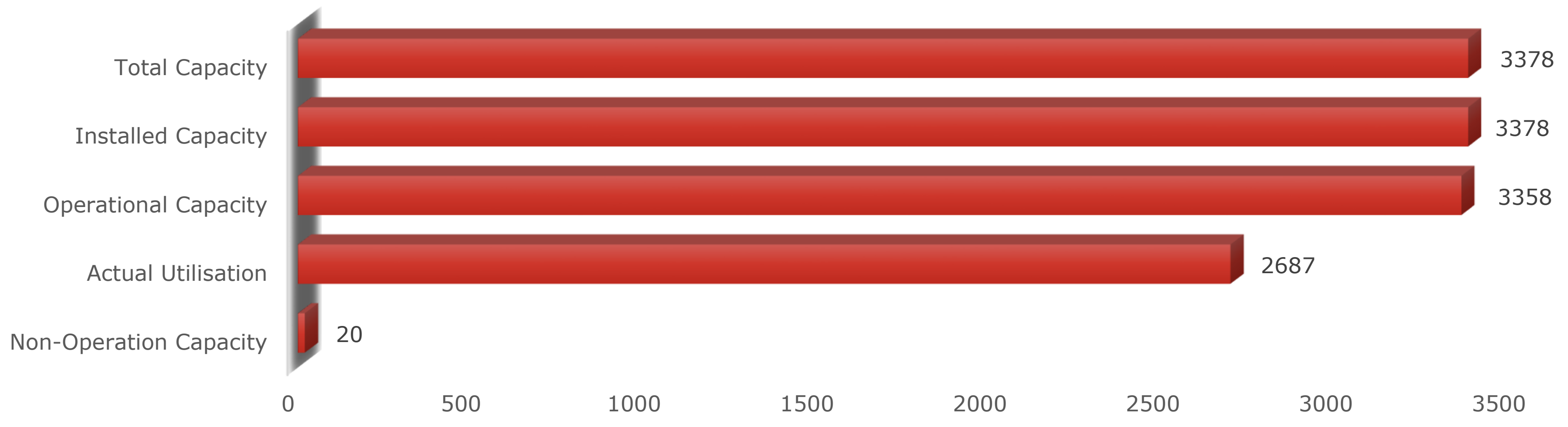


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.8. GUJARAT

- The estimated sewage generation for Gujarat is 5,013 MLD, with a total capacity (including projected) of 3,378 MLD (70 STPs).
- The installed capacity is 3,378 MLD (67.38%) of the sewage generating capacity of 5,013 MLD. It reveals that there is a treatment capacity shortfall of 1635 MLD (32.61%).
- The operational capacity is 3358 MLD (99.40%) of the installed capacity of 3378 MLD. The actual usable capacity is 2,687 MLD out of a total operating capacity of 3,358 MLD.
- In comparison to natural treatment systems, STPs based on SBR and ASP technology predominate.

FIGURE 39. SEWAGE TREATMENT CAPACITY (MLD) – GUJARAT

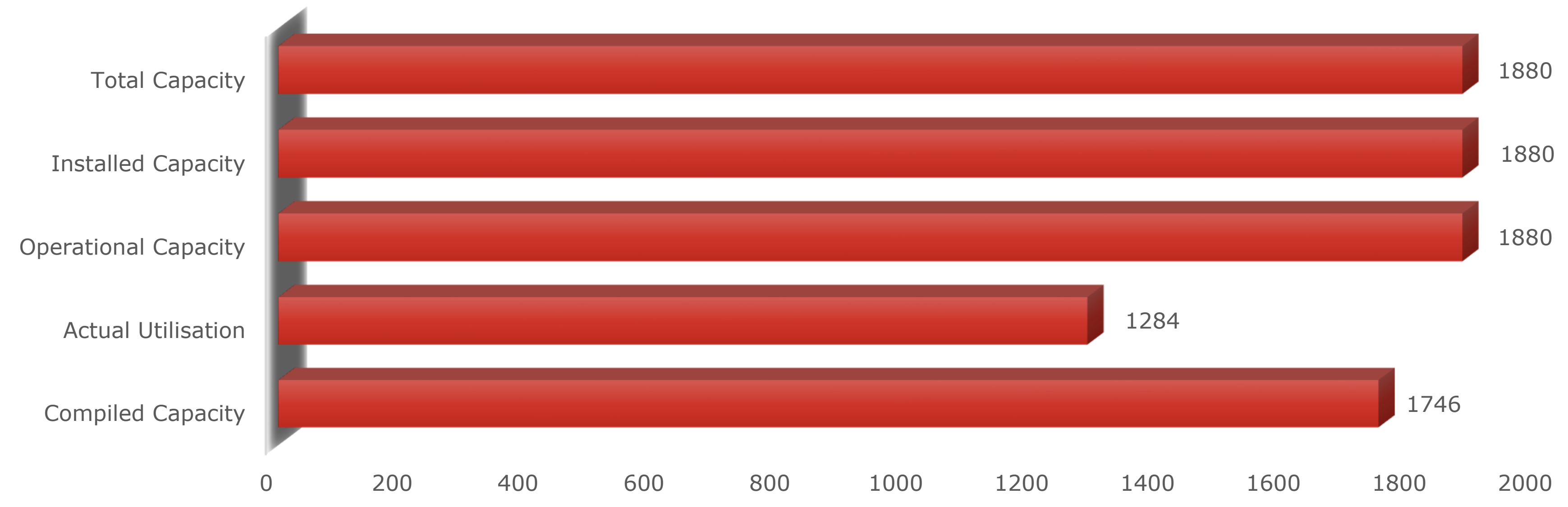


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.9. HARYANA

- Haryana's estimated sewage generation is 1816 MLD, while total treatment capacity (including projected) is 1880 MLD (153 STPs).
- The installed treatment capacity is 1880 MLD, with a sewage generating capacity of 1816 MLD. It demonstrates that the treatment capacity exceeds 64 MLD.
- All STPs are capable of operating at maximum capacity. However, real usable capacity is just 1284 MLD, and compliance STP capacity is only 1746 MLD. Haryana is dominated by STPs based on SBR and MBBR technology.

FIGURE 40. SEWAGE TREATMENT CAPACITY (MLD) – HARYANA

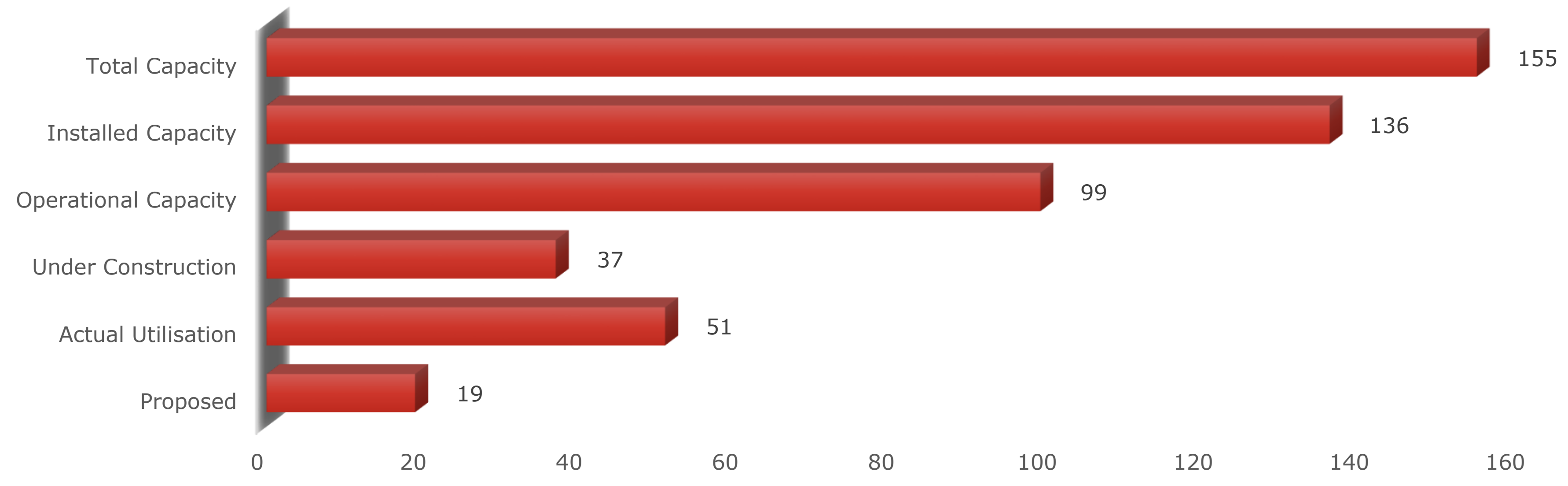


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.10. HIMACHAL PRADESH

- Himachal Pradesh's estimated sewage generation is 116 MLD, with a total capacity (including projected) of 155 MLD (86 STPs).
- The installed capacity is 136 MLD, with a sewage generating capacity of 116 MLD. It demonstrates that the treatment capacity exceeds 20 MLD.
- The operationalized capacity is 99 MLD (72.79%) of the 136 MLD installed capacity created, however the actual used capacity is just 51 MLD.

FIGURE 41. SEWAGE TREATMENT CAPACITY (MLD) – HIMACHAL PRADESH

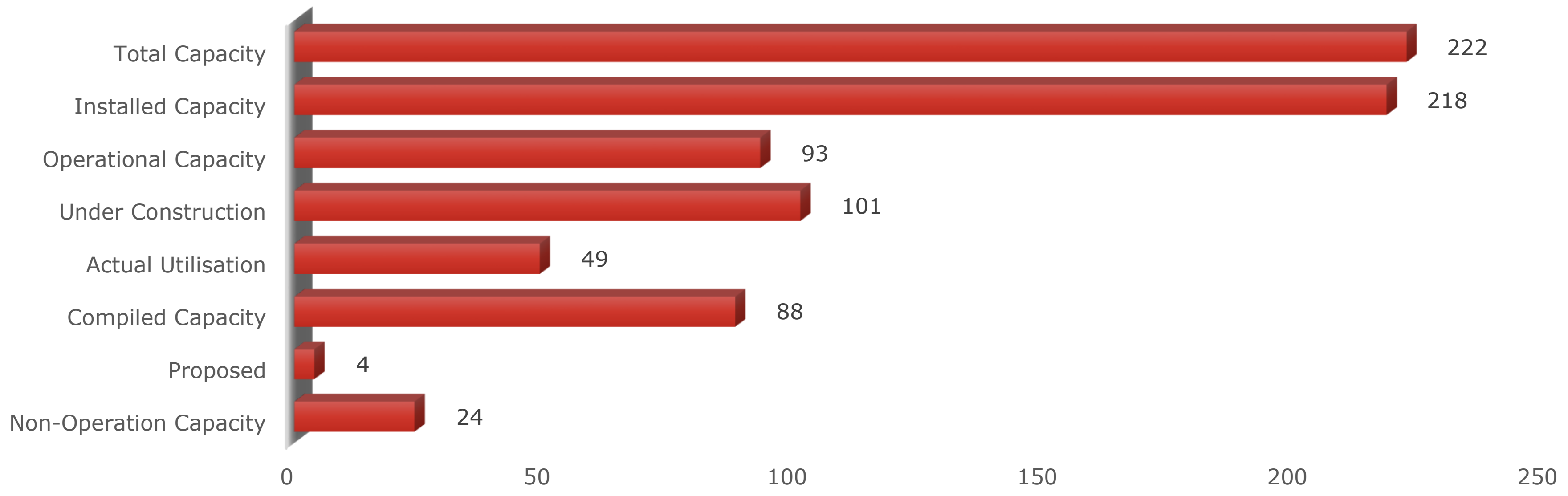


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.11. JAMMU & KASHMIR

- The estimated sewage generating capacity for the state of Jammu and Kashmir is 665 MLD, with a total capacity (including projected capacity) of 222 MLD (26 STPs).
- The installed capacity is 218 MLD (32.78%), with a sewage generating capacity of 665 MLD. It reveals a treatment capacity shortfall of 447 MLD (67.21%).
- The operationalized capacity is 93 MLD (42.66%) of the 218 MLD installed capacity developed. The actual used capacity is 49 MLD, while the capacity of the combined STPs is only 88 MLD.

FIGURE 42. SEWAGE TREATMENT CAPACITY (MLD) – JAMMU & KASHMIR

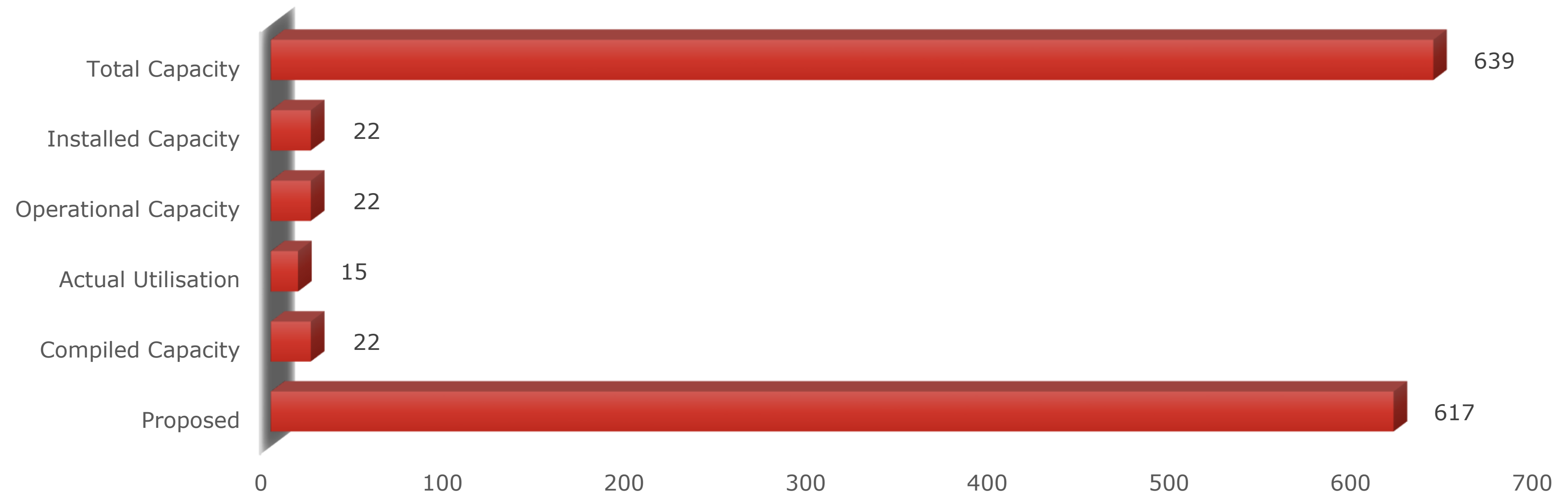


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.12. JHARKHAND

- Jharkhand's estimated sewage generation is 1510 MLD, with a total capacity (including projected) of 639 MLD (12 STPs).
- The installed capacity is 22 MLD (1.45%) of the sewage generating capacity of 1510 MLD. It demonstrates that there is a treatment capacity shortfall of 1488 MLD (98.55%).
- Installed STPs can run at full capacity. However, the actual utilized capacity is just 15 MLD, which meets the agreed-upon standards.

FIGURE 43. SEWAGE TREATMENT CAPACITY (MLD) – JHARKHAND



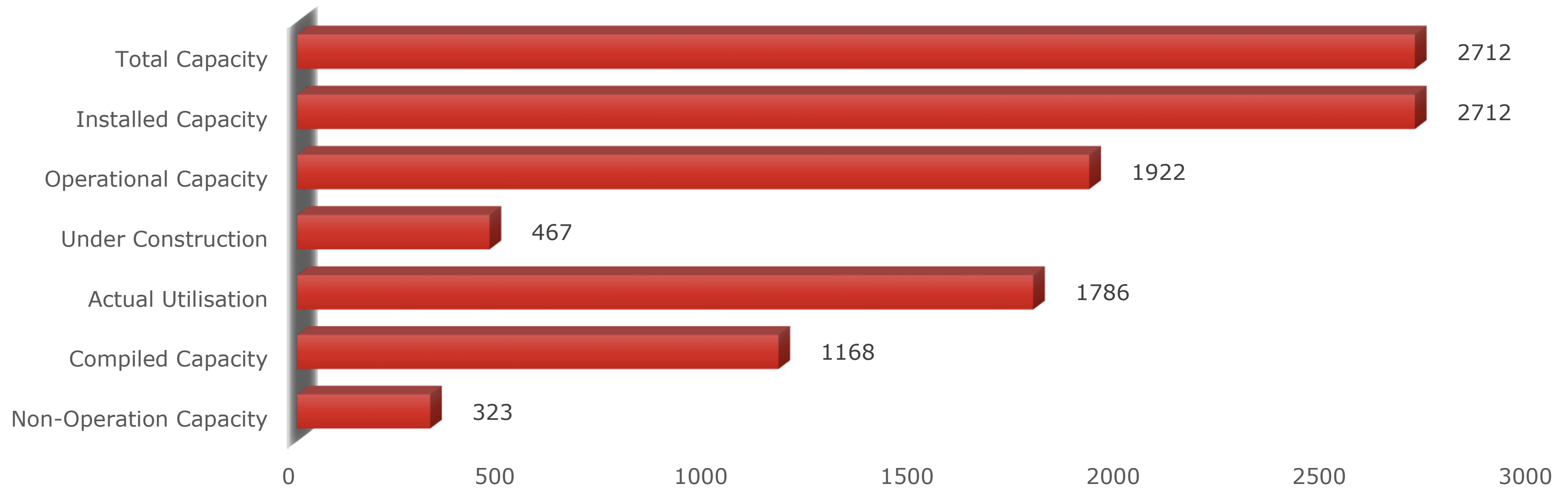
Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.13. KARNATAKA

- The estimated sewage generating capacity for the state of Karnataka is 4,458 MLD, with a total capacity (including projected capacity) of 2,712 MLD (140 STPs).
- In comparison to sewage generation of 4,458 MLD, installed capacity is 2,712 MLD (60.83%). It reveals a treatment capacity shortfall of 1,746 MLD (39.17%). The operational capacity is 1922 MLD (70.87%) of the installed capacity of 2,712 MLD.

- The actual used capacity is 1786 MLD (92.92%), with compliant STPs having a capacity of just 1168 MLD. STPs based on SBR, OP, and ASP technologies are the most common.

FIGURE 44. SEWAGE TREATMENT CAPACITY (MLD) – KARNATAKA

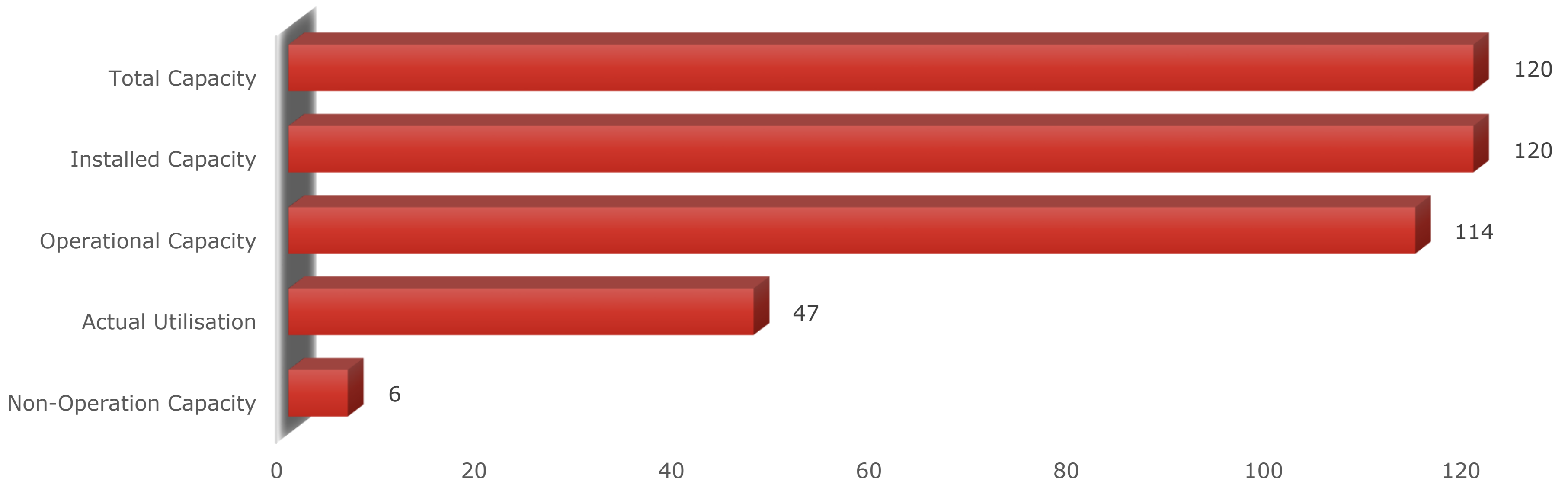


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.14. KERALA

- Kerala's estimated sewage generation is 4,256 MLD, with a total capacity (including projected) of 120 MLD (07 STPs).
- The installed capacity is 120 MLD (2.82%), with a sewage generating capacity of 4,256 MLD. It reveals that there is a treatment capacity shortfall of 4136 MLD (97.18%).
- The operationalized capacity of the 120 MLD installed capacity is 114 MLD (95%) and the actual used capacity is just 47 MLD.

FIGURE 45. SEWAGE TREATMENT CAPACITY (MLD) – KERALA



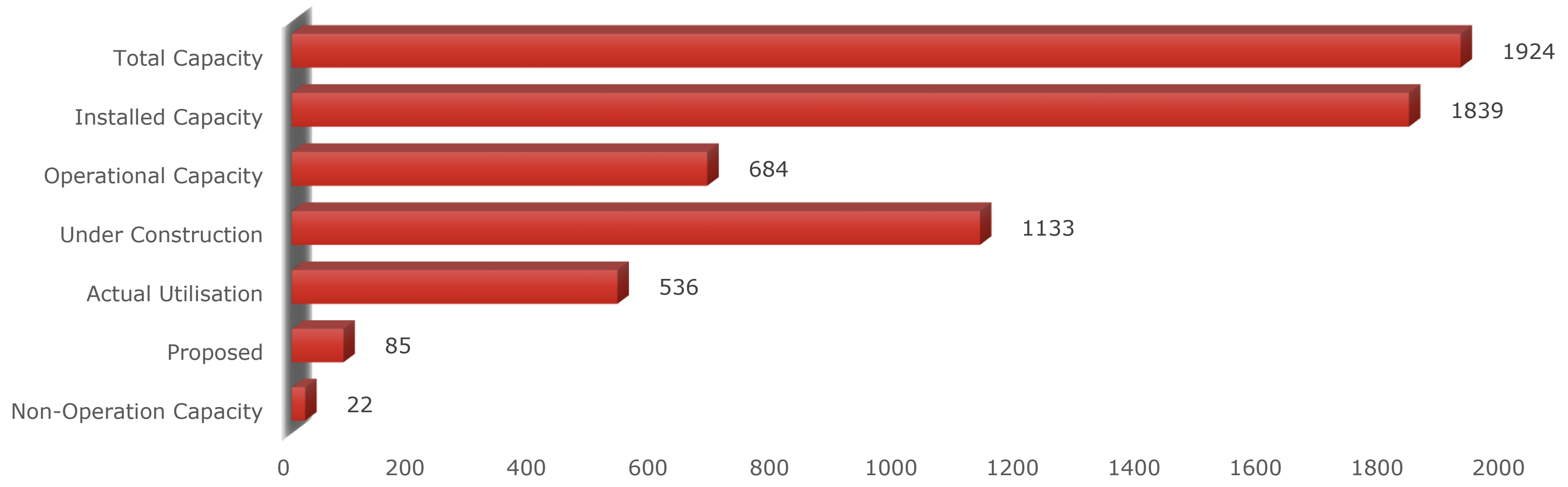
Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.15. MADHYA PRADESH

- Madhya Pradesh's estimated sewage generation is 3,646 MLD, with a total capacity (including projected) of 1,924 MLD (142 STPs).
- The installed capacity is 1,839 MLD (50.44%) of the total sewage generating capacity of 3,646 MLD. It reveals a treatment capacity shortfall of 1,807 MLD (49.56%).
- The operationalized capacity is 684 MLD (37.19%) of the 1839 MLD installed capacity created, while the actual used capacity is 536 MLD.

- MPPCB makes no mention of STP technology in relation to the 123 STPs. The remaining STPs are mostly based on SBR and WSP technology.

FIGURE 46. SEWAGE TREATMENT CAPACITY (MLD) – MADHYA PRADESH

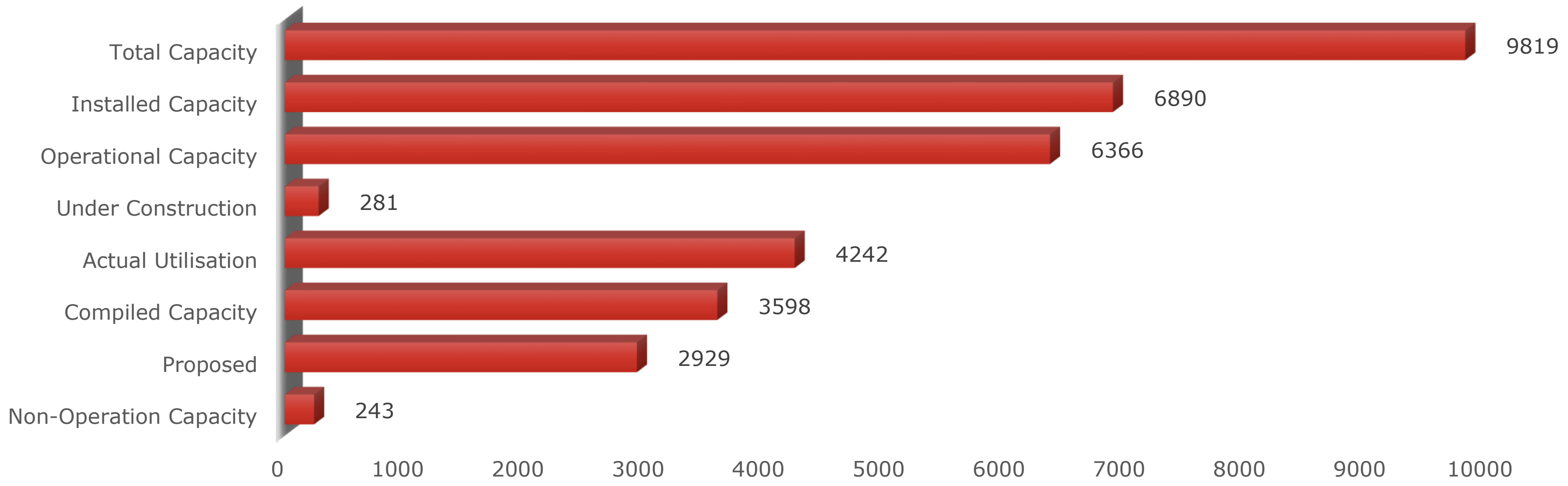


6.3.1.16. MAHARASHTRA

- The estimated sewage generating capacity for Maharashtra is 9,107 MLD, with a total capacity (including projected capacity) of 9,819 MLD (195 STPs).
- The installed capacity is 6,890 MLD (75.65%) of the sewage generating capacity of 9,107 MLD. It reveals a treatment capacity shortfall of 2217 MLD (24.35%).

- The operationalized capacity is 6,366 MLD (92.39%) of the 6,890 MLD of installed capacity created, while the actual used capacity is 4,242 MLD. Furthermore, the combined capacity of STPs is just 3598 MLD.

FIGURE 47. SEWAGE TREATMENT CAPACITY (MLD) – MAHARASHTRA

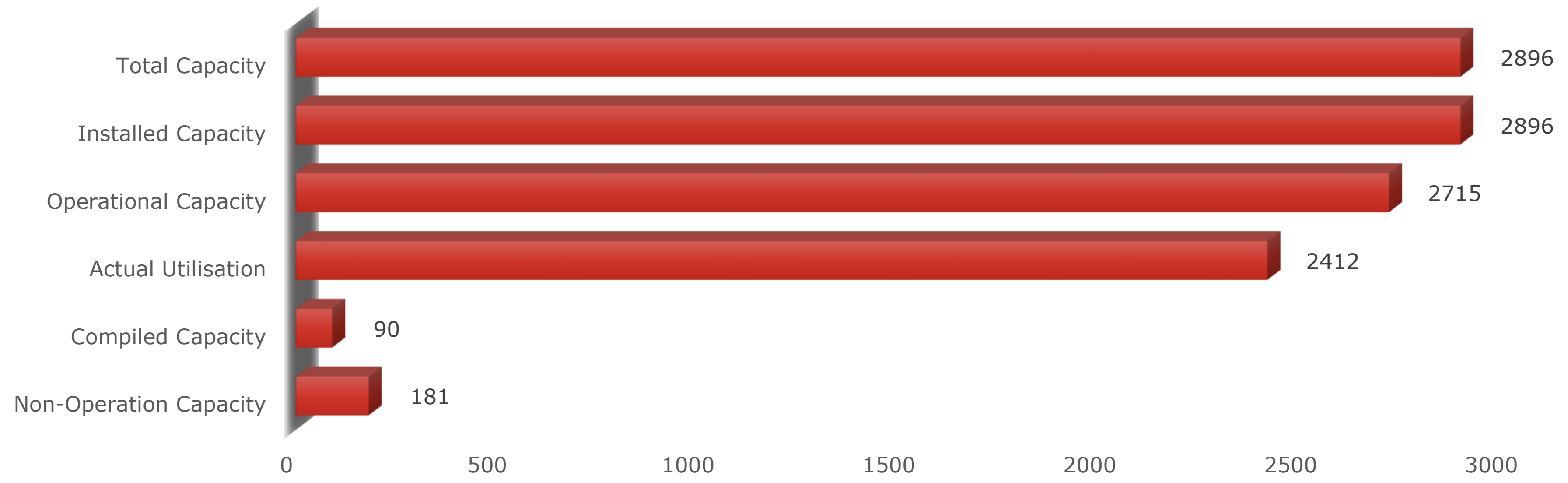


6.3.1.17. NCT DELHI

- The estimated sewage generation for NCT Delhi is 3,330 MLD, with a total treatment capacity of 2,896 MLD (38 STPs).
- The installed capacity is 2,896 MLD (86.96%) of the sewage generating capacity of 3330 MLD. It reveals a 434 MLD (13.04%) shortfall in treatment capacity.

- Out of the total installed capacity of 2,896 MLD, the operationalized capacity is 2715 MLD (35 STPs) (93.75%), the actual utilized capacity is 2412 MLD, and the additional capacity of complied STPs is only 90 MLD.

FIGURE 48. SEWAGE TREATMENT CAPACITY (MLD) – NCT DELHI

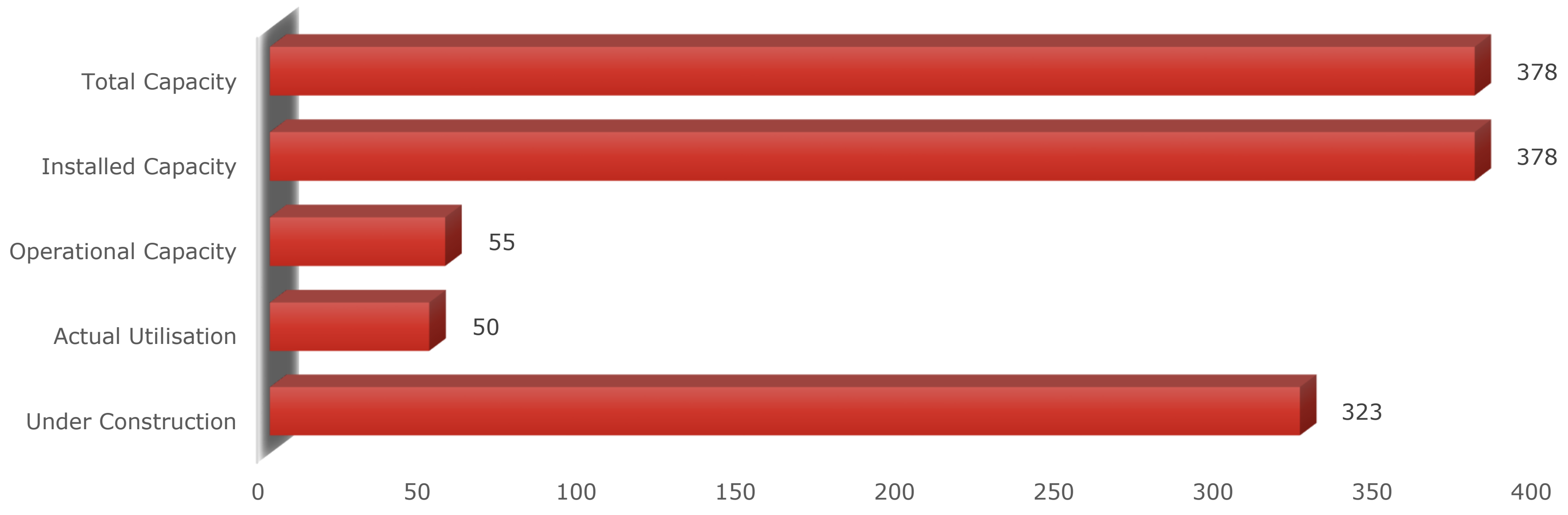


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.18. ODISHA

- Odisha's estimated sewage generation is 1,282 MLD, with a total treatment capacity of 378 MLD (14 STPs).
- The installed capacity is 378 MLD (29.48%), with a sewage generating capacity of 1,282 MLD. It reveals a treatment capacity shortfall of 904 MLD (70.51%).
- The operationalized capacity is 55 MLD (14.55% of the total installed capacity) while the actual used capacity is just 50 MLD.

FIGURE 49. SEWAGE TREATMENT CAPACITY (MLD) – ODISHA

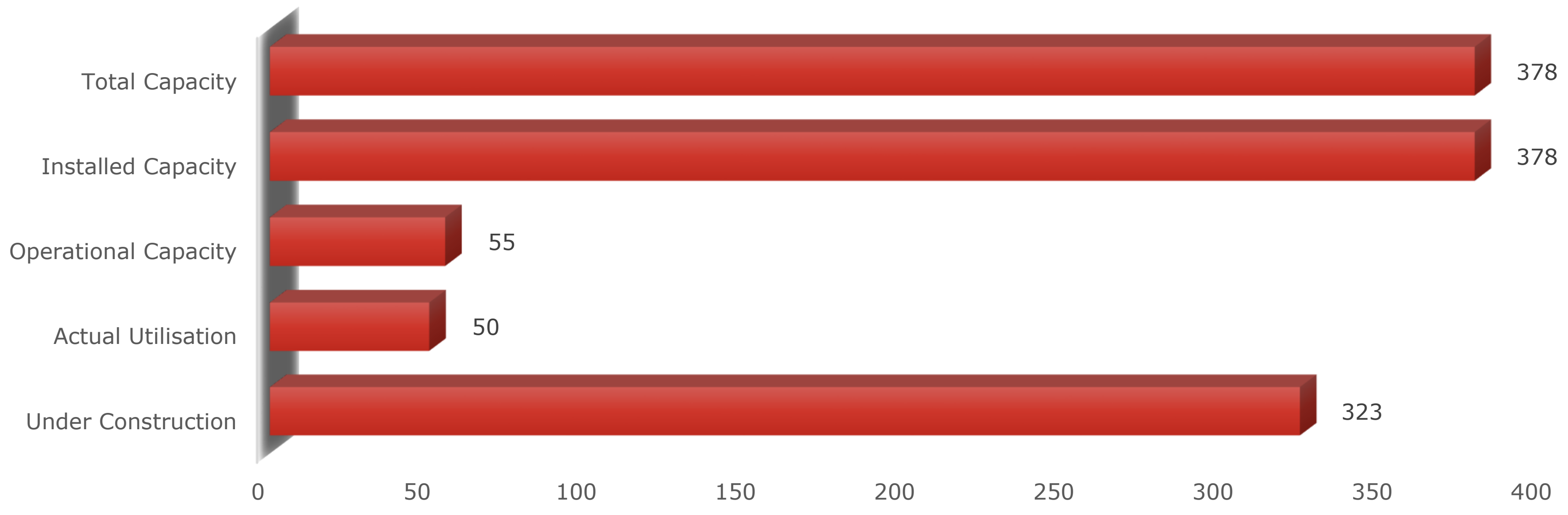


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.19. PUDUCHERRY

- The state of Puducherry's estimated sewage generation is 161 MLD, and total treatment capacity (including projected) is 59 MLD (04 STPs).
- The installed capacity is 56 MLD (34.79%), with a sewage generating capacity of 161 MLD. It reveals a treatment capacity shortfall of 105 MLD (65.21%).
- All of the STPs installed can function at maximum capacity, however the actual utilized capacity is just 30 MLD.

FIGURE 50. SEWAGE TREATMENT CAPACITY (MLD) – PUDUCHERRY

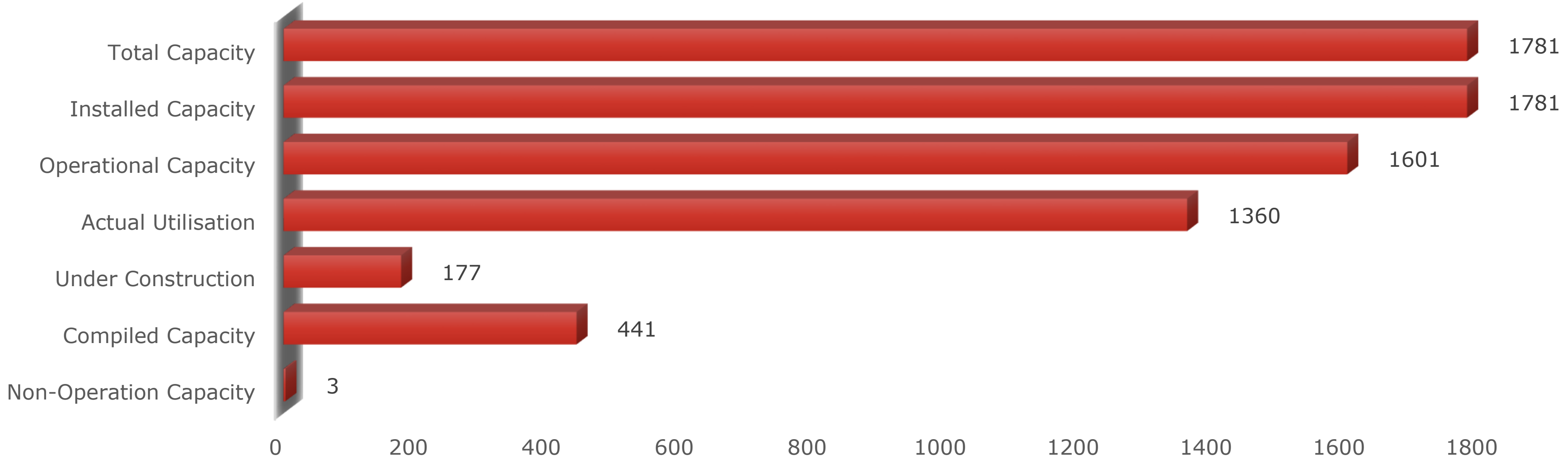


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.20. PUNJAB

- The estimated sewage generation for Punjab is 1,889 MLD, with a total treatment capacity of 1,781 MLD (119 STPs).
- The installed capacity is 1,781 MLD (94.28%), with a sewage generating capacity of 1,889 MLD. It reveals a treatment capacity shortfall of 108 MLD (5.72%).
- The operationalized capacity is 1601 MLD (89.89%) and the actual used capacity is 1,360 MLD (84.94%) of the total installed capacity of 1781 MLD. Furthermore, the combined capacity of the STPs is just 441 MLD.

FIGURE 51. SEWAGE TREATMENT CAPACITY (MLD) – PUNJAB

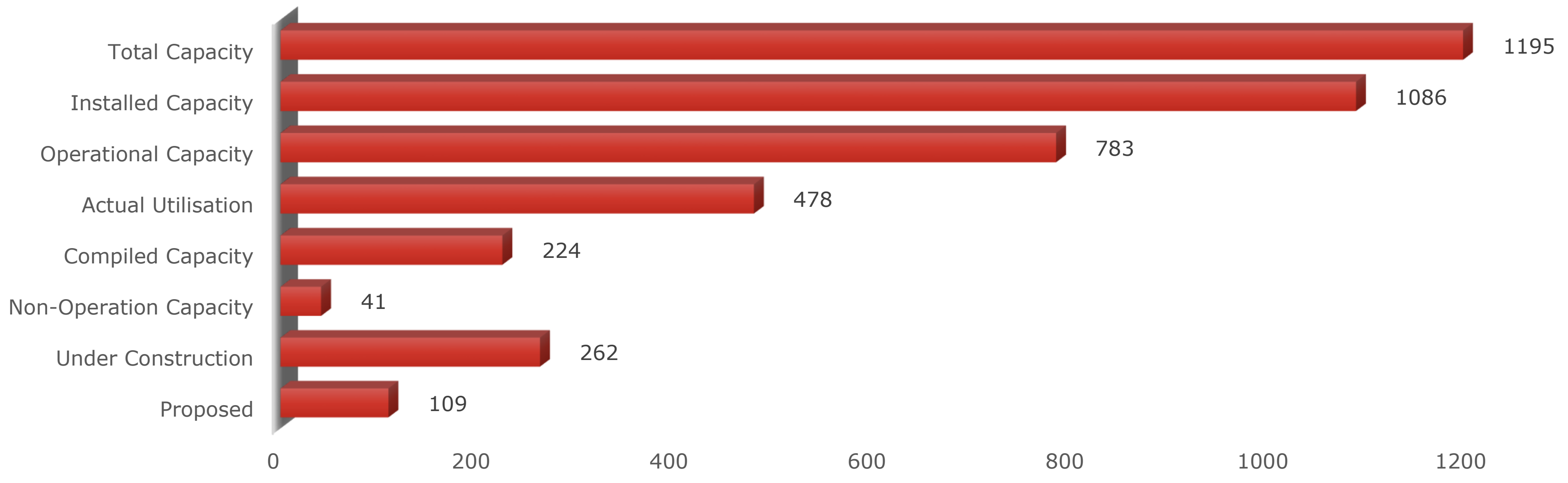


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.21. RAJASTHAN

- Rajasthan's estimated sewage generation is 3,185 MLD, while total treatment capacity (including projected) is 1,195 MLD (140 STPs).
- The installed capacity is 1,086 MLD (34.10%) of the sewage generating capacity of 3,185 MLD. It reveals a treatment capacity shortfall of 2,099 MLD (65.90%).
- The operationalized capacity is 783 MLD (72.09%) of the total installed capacity of 1086 MLD, while the actual used capacity is 478 MLD. Furthermore, the combined capacity of the STPs is just 224 MLD.

FIGURE 52. SEWAGE TREATMENT CAPACITY (MLD) – RAJASTHAN

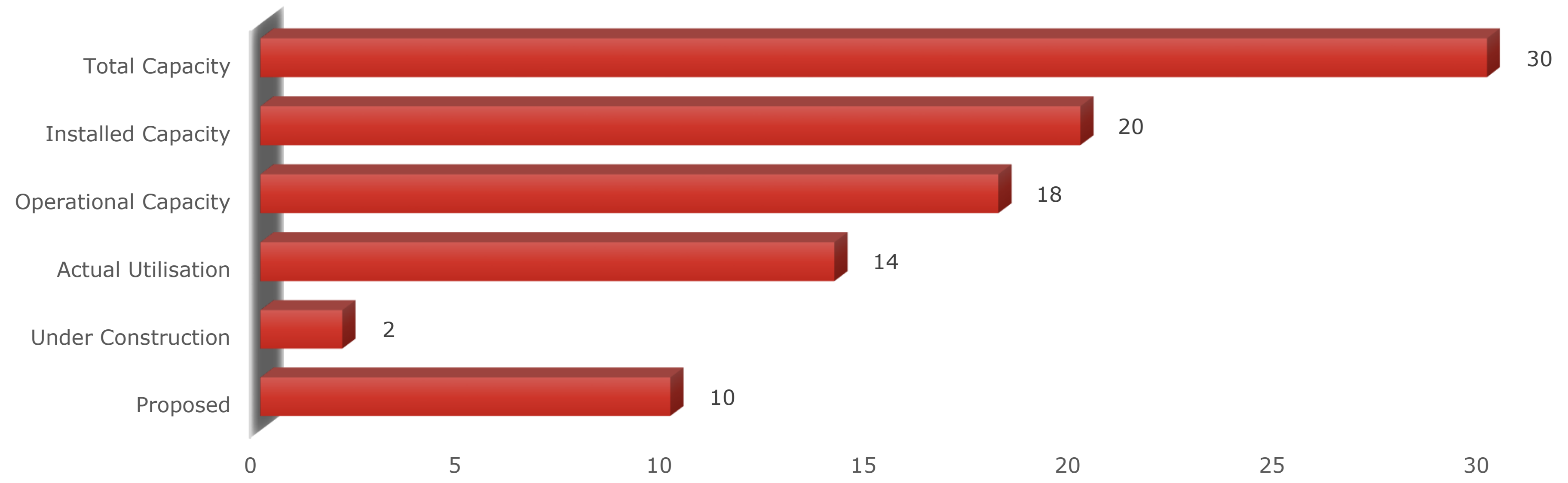


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.22. SIKKIM

- Sikkim's estimated sewage generation is 52 MLD, with a total treatment capacity (including projected) of 30 MLD (11 STPs).
- In comparison to sewage generation of 52 MLD, installed capacity is 20 MLD (38.46%). It reveals a treatment capacity shortfall of 32 MLD (61.54%).
- The operationalized capacity is 18 MLD (90% of the total installed capacity of 20 MLD).
- Similarly, actual used capacity is 14 MLD (77.77%) of operating capacity of 18 MLD.

FIGURE 53. SEWAGE TREATMENT CAPACITY (MLD) – SIKKIM

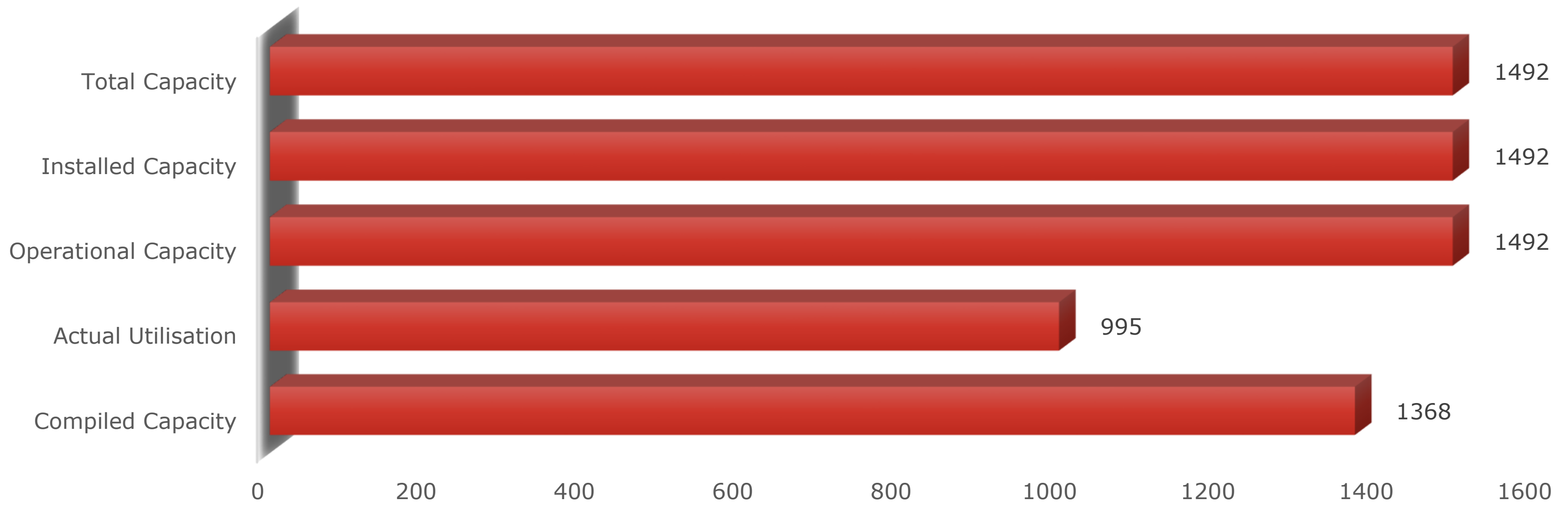


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.23. TAMIL NADU

- The estimated sewage generation for Tamil Nadu is 6,421 MLD, with a total treatment capacity of 1,492 MLD (63 STPs).
- The installed capacity is 1,492 MLD (23.23%), with a sewage generating capacity of 6421 MLD. It reveals a treatment capacity shortfall of 4,929 MLD (76.77%).
- The operationalized capacity is 1,492 MLD (100%) of the installed capacity of 1,492 MLD, while the actual used capacity is 995 MLD. Furthermore, the capacity of STPs that have been approved is just 1,368 MLD.

FIGURE 54. SEWAGE TREATMENT CAPACITY (MLD) – TAMIL NADU

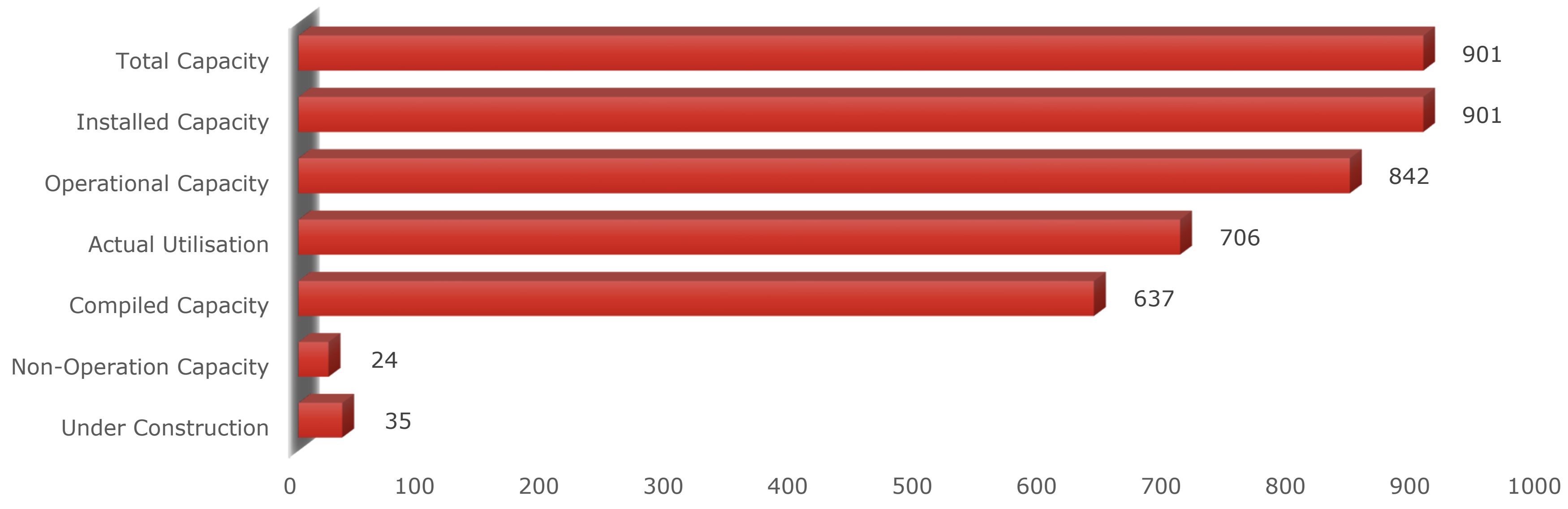


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.24. TELANGANA

- Telangana's estimated sewage generation is 2,660 MLD, while total treatment capacity (including projected) is 901 MLD (37 STPs).
- The installed capacity is 901 MLD (33.87%), with a sewage generating capacity of 2,660 MLD. It reveals a treatment capacity shortfall of 1,759 MLD (66.13%).
- The operationalized capacity is 842 MLD (93.45%) of the installed capacity of 901 MLD, while the actual used capacity is 706 MLD. Furthermore, the combined capacity of STPs is just 637 MLD.

FIGURE 55. SEWAGE TREATMENT CAPACITY (MLD) – TELANGANA

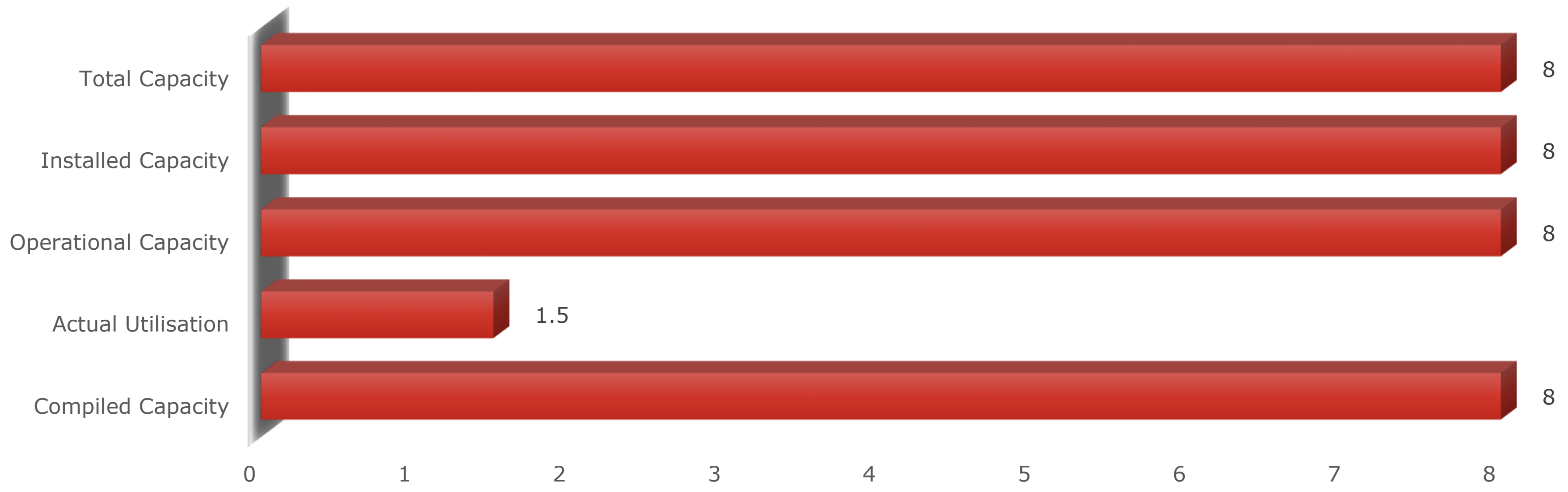


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.25. TRIPURA

- The estimated sewage generating capacity for the state of Tripura is 237 MLD, with a total treatment capacity of just 08 MLD (01 STP).
- According to data analysis, there is only one STP in the state that receives 1.5 MLD of sewage while achieving the agreed-upon standards.

FIGURE 56. SEWAGE TREATMENT CAPACITY (MLD) – TRIPURA

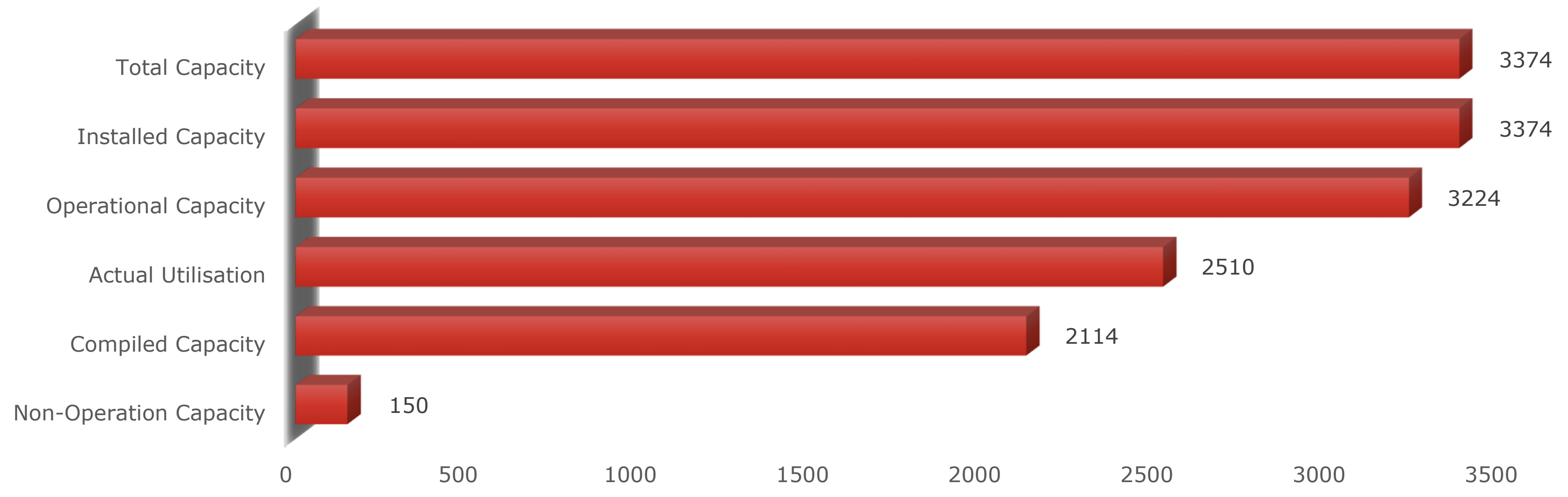


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.26. UTTAR PRADESH

- The estimated sewage generation in Uttar Pradesh is 8,263 MLD, with a total treatment capacity of 3,374 MLD (107 STPs).
- In comparison to sewage generation of 8,263 MLD, installed capacity is 3,374 MLD (40.83%). It reveals a treatment capacity shortfall of 4,889 MLD (59.17%).
- The operationalized capacity is 3,224 MLD (95.55%) and the actual used capacity is 2,510 MLD (77.85%) of the installed capacity of 3,374 MLD. Furthermore, the capacity of STPs that have been approved is just 2,114 MLD.

FIGURE 57. SEWAGE TREATMENT CAPACITY (MLD) – UTTAR PRADESH

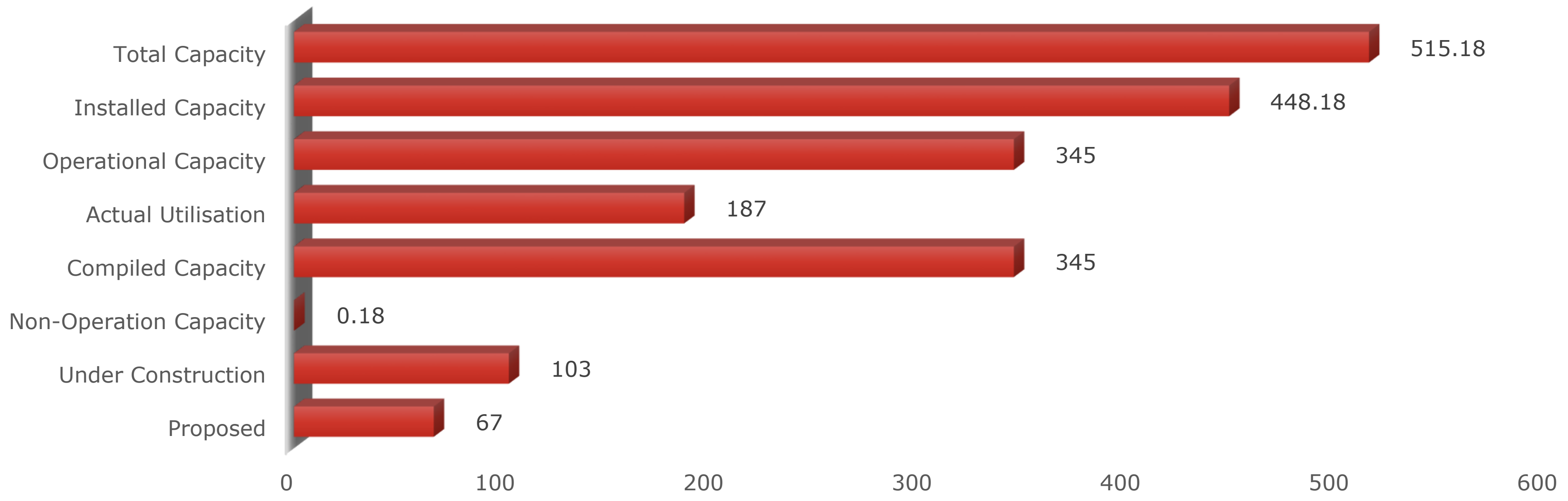


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.27. UTTARAKHAND

- The estimated sewage generation for Uttarakhand is 627 MLD, with a total capacity (including projected) of 515 MLD (81 STPs).
- The installed capacity is 448 MLD (71.45%) of the sewage generating capacity of 627 MLD. It reveals a treatment capacity shortfall of 179 MLD (28.55%).
- The operationalized capacity is 345 MLD (77%) of the 448 MLD of installed capacity created, while the actual used capacity is 187 MLD. Furthermore, the capacity of STPs that have been approved is just 345 MLD.

FIGURE 58. SEWAGE TREATMENT CAPACITY (MLD) – UTTARAKHAND

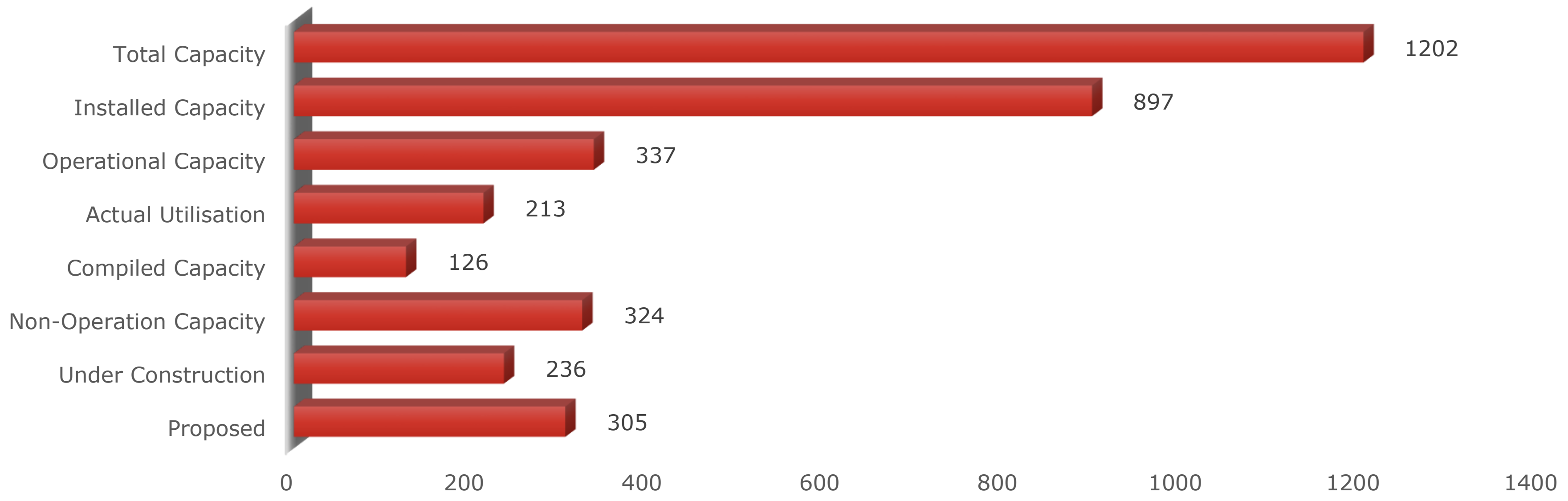


Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

6.3.1.28. WEST BENGAL

- The estimated sewage generating capacity for the state of West Bengal is 5,457 MLD, with a total capacity (including projected capacity) of 1,202 MLD (65 STPs).
- The installed capacity is 897 MLD (16.43%) of the sewage generating capacity of 5,457 MLD. It reveals a treatment capacity shortfall of 4,560 MLD (83.57%).
- The operationalized capacity is 337 MLD (37.56%) and the actual used capacity is 213 MLD (63.20%) of the 897 MLD installed capacity generated. Furthermore, the capacity of STPs that have been approved is just 126 MLD.

FIGURE 59. SEWAGE TREATMENT CAPACITY (MLD) – WEST BENGAL



Source: Central Pollution Control Board, National Inventory of Sewage Treatment Plants

The expected sewage generation is 72,368 MLD, whereas the existing treatment capacity is 31841 MLD (43.9%). The operationalized capacity is 26,869 MLD (84% of the total installed capacity of 31,841 MLD). Similarly, actual used capacity is 20,235 MLD (75%) of operating capacity is 26,869 MLD. This is due to a lack of conveyance infrastructure (household connection, sewer lines, and sewage pumping stations). States deploy STPs based on various treatment technologies ranging from conventional to sophisticated technology. STPs based on Sequential Batch Reactor (SBR) treatment technology have been erected and dominant in the majority of states and territories. This is followed by STPs based on ASP technology. In all, 490 STPs are planned to use SBR technology, with 321 STPs using the Activated Sludge Process (ASP). Upflow- Anaerobic Sludge Blanket (UASB) technique is used in 76 STPs. STPs based on natural treatment systems are being constructed around the country in addition to conventional treatment technologies.67 STPs are based on the Waste Stabilization Pond technology, whereas 61 STPs are Oxidation Ponds. The top five states with substantial sewage treatment facilities are Maharashtra, Gujarat, Uttar Pradesh, NCT of Delhi, and Karnataka. These five states provide a total of 19,250 MLD, or 60.5% of the country's total installed treatment capacity. In addition to the one mentioned above, the states of Haryana, Madhya Pradesh, Punjab, Tamil Nadu, and Rajasthan, totaling 86% (approx.) of total installed treatment capacity.

There are no sewage treatment plants in Arunachal Pradesh, Andaman and Nicobar Islands, Lakshadweep, Manipur, Meghalaya, or Nagaland. The compliance status of eight states and union territories (Gujarat, Himachal Pradesh, Kerala, Pondicherry, Sikkim, Chandigarh, Chhattisgarh, and Madhya Pradesh) has not been disclosed. Treatment capacity developed per capita is higher in Chandigarh (240 lpcd), Haryana (184 lpcd), NCT of Delhi (151 lpcd), Punjab (141 lpcd), and Maharashtra (115 lpcd). 29 states and territories have treatment capacities of less than 100 lpcd.

The state of Maharashtra has the most installed as well as compliant treatment capacity. However, the per capita installation capacity is highest in the UT of Chandigarh (240 lpcd), whereas Maharashtra has a per capita treatment capacity of 115 lpcd. The state of Haryana has the highest compliant per capita treatment capacity (142 lpcd), whereas Maharashtra has the lowest (58 lpcd). The NCT of Delhi has the fourth greatest treatment capacity of 2896 MLD and the third highest per capita treatment capacity of 151 lpcd, although the complying treatment capacity is only 4 lpcd.

6.3.1.29. OPPORTUNITIES IN SEWAGE TREATMENT

- Given the rising urbanization and sewage creation, there is an urgent need to close the existing sewage treatment gap. Aside from addressing the gap, there is also a need to coordinate future treatment capacity requirements.

- As it has been discovered that existing infrastructure is only being used at 75% of its operationalized treatment capacity, it is suggested that the sewerage conveyance system, which includes the laying of sewer lines and individual household sewer connections, be strengthened in order to meet current and future demand.
- In terms of compliance, it has been discovered that only 23% of treatment capacity meets the agreed-upon standards for SPCBs / PCCs. In light of this, it is also necessary to focus on the operation and maintenance of treatment facilities in order for STPs to fulfil the desired quality of treatment.
- ULBs must concentrate on the use of treated sewage for non-potable applications such as horticulture, irrigation, firefighting, industrial cooling, toilet flushing, non-contact impoundments, and washing (floors, roads, buses, trains, and so on).
- Treated sewage should also be given to industrial clusters / zones for further treatment and utilization as required by the industrial zone.

6.4. MARKET DROC ANALYSIS

FIGURE 60. DROC'S ANALYSIS

D

DRIVERS

- Growth of chemically treated water in various end use industries
- Stringent regulatory and sustainability mandates
- Increasing industrial water consumption and discharge

R

RESTRAINTS

- Lack of water and infrastructure management
- High installation, equipment and operation costs

O

OPPORTUNITIES

- Adoption of more sustainable approach through reduce, recycle and reuse
- New initiatives supporting market growth
- Collaborations between public and private sectors

C

CHALLENGES

- Groundwater depletion and untreated water discharge
- Limited funds may pose challenges in certain regions
- Lack of required techno-commercial awareness

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

6.4.1. MARKET DRIVERS' ANALYSIS

6.4.1.1. INCREASING DEMAND FOR CHEMICALLY TREATED WATER IN VARIOUS END-USE SEGMENTS

Water plays a crucial role in industrial production, whether for paper, textiles, electricity generation, mining, oil exploitation, or pharmaceutical drugs. Globally industries use almost twice the amount of water consumed by households, and this is mostly accounted for cooling during production of electricity. In addition, a sizable volume of water is used in food & beverage industries. Monitoring of water quality is essential for efficient operation and safety in a variety of industries such as pharmaceuticals, life sciences, semiconductors, food & beverages, and power plants. In industrial processes, water biofouling and scaling can result from contaminants present or accumulated in water. Increasing adoption of real-time monitoring of water quality instruments in such industries can help in providing continuous information to react and respond to water quality changes.

If the food and beverage industry is considered, water is essential for many processes. Water serves as not only a key ingredient in most food and beverage products, but also finds application for cleaning or rinsing products, sanitizing equipment, cooling systems, and packaging products. Thus, to ensure adherence to food safety norms and compliance with regulations, ingredient water and wash water must be treated to meet high quality standards. Cooling water should be treated to ensure cooling system is cooled efficiency and for preventing operational stresses such as scaling or fouling. In addition, wastewater produced by food and beverage production facilities must be treated before being discharged to the municipal sewage system.

Similarly, heat exchangers are extensively used in power plants, petrochemical industries, and heavy industries. Oil leakages at turbines, pumps, or within the heat exchanger are responsible for polluting the cooling water with oil. Detection of hydrocarbons through water monitoring can help in maintaining the cooling water in the Parts Per Million (PPM) and Parts Per Billion (PPB) levels in these systems and also help in identifying potential failures early on and save on incurring high operational, maintenance, and repair costs. In the case of cooling water, which is directly discharged into the environment, monitoring would help in ensuring compliance with environmental and other regulations. Industrial wastewater is likely to contain sediment, organic pollutants, nutrients, metals, bacteria, and viruses. More specifically, industrial processes, such as manufacturing of steel and chemical, are responsible for producing billions of gallons of wastewater daily. Hence, the importance of industrial wastewater monitoring is of high importance currently, and this creates high demand for various treatments, solutions, equipment, and manpower required for water monitoring.

6.4.1.2. STRINGENT REGULATORY AND SUSTAINABILITY MANDATES CONCERNING THE ENVIRONMENT

Rising demand for water for consumption as well as for agricultural and industrial purposes has been creating a surge in demand for water monitoring systems. Studies indicate that the current global water use can be segmented into three areas: urban water management, agriculture, and industrial production. Out of the total available water volumes, 10% flows into domestic use, 70% into agriculture, and 20% into industrial production. In recent years, all three sectors have witnessed an increase in demand. Currently, the world's population stands at approximately 7.3 billion people, and though the growth rates are expected to level off in the future, it will continue to increase over the next few decades. According to the UN, the global population is expected to reach 9.6 billion by 2050. Demand for water will, of course, increase purely in response to population growth. This will directly affect water demand from agricultural and industrial sectors. For instance: the combination of population growth and improving living standards will have an impact on food production, which will increase demand for water. The FAO expects demand for food to increase by 60% between 2006 and 2050. Surge in demand will be driven mainly by developing countries, and a growing middle-class section of society will increasingly have access to more water-intensive foods such as beef and other protein-rich products. Moreover, improving crop yields and efficient irrigation in these developing countries would be required to meet demand by increasing agricultural productivity. Increasing demand for water has also exerted pressure on regulatory bodies and governments of different countries to formulate regulations related to water quality monitoring.

In September 2015, heads of state and governments globally gathered in New York for adopting the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDG) that describe an ambitious plan of action for people, planet, and prosperity. The SDG Goals include a dedicated goal on water and sanitation (SDG 6) which aims to ensure availability coupled with sustainable management of water and sanitation. The UN-Water Integrated Monitoring Initiative for SDG 6 can be explained as a collaboration among UN agencies for supporting countries to monitor water and sanitation across sectors and to compile data, which would represent the global progress. The GEMI was established in 2014 as an inter-agency initiative composed of FAO, UNECE, UN Environment, UN-Habitat, UNICEF, UNESCO, WHO, and WMO. It focuses on integrating and expanding existing monitoring efforts on wastewater treatment and water quality, water use and scarcity, integrated water resources management including trans-boundary cooperation and water-related ecosystems. Countries globally have also adopted different regulations for monitoring water.

For instance, in the U.S., the Water Quality Standards Regulation (40 CFR 131) establishes the requirements for states and tribes to review, revise, and adopt water quality standards. The standard also establishes the procedures for Environmental Protection Agency (EPA) to review, approve, disapprove, and promulgate water quality standards pursuant to section 303 (c) of the Clean Water Act. In Europe, the Drinking Water Directive governs the quality of water intended for human consumption. As per the directive, total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly. Thus, adoption of regulatory standards and measures globally, is expected to boost adoption of water and wastewater treatment techniques, solutions, equipment, and systems.

6.4.1.3. INCREASE IN INDUSTRIAL WATER CONSUMPTION & DISCHARGE

Worldwide, about 80% of wastewater is released into the environment without adequate treatment or as per prescribed at UNESCO 2017. Approximately, 1.8 billion people use a source of drinking water contaminated with microorganisms, risking various diseases including cholera, dysentery, typhoid, and polio to name a few. Water wastage has become one of the significant challenges for both developed and developing economies with an increase in the manufacturing industry. Many government and non-governmental organizations are actively participating in initiatives to save fresh water and protect natural resources.

Based on statistics, average high-income countries treat about 70% of the wastewater generated, whereas 38% of wastewater is only managed in upper-middle-income countries, and 28% in lower-middle-income countries. In addition, as per the United Nations Educational, Scientific and Cultural Organization in 2017, only 8% of industrial and municipal wastewater undergoes treatment of any kind in low-income countries. Rise in consumers' awareness with regard to rapidly depleting natural resources, scarcity of freshwater in a number of developed countries, and surge in need for wastewater treatment chemicals from various industries are key factors expected to continue to drive revenue growth of the market over the forecast period.

Rapid industrialization and urbanization trends have driven an increase in demand for water as well as resulted in increased consumption of water and discharge of wastewater volumes across industries, as well as per household. Inadequate availability of freshwater resources is resulting in governments and other bodies exploring more stringent norms and regulations on water use and discharge. Industries and organizations are presently empowered to treat and recycle wastewater before discharge into natural water bodies. Different physical processes such as osmosis, ultraviolet radiation, and chemicals such as peroxides and chlorine derivatives are widely employed to treat sludge and wastewater. Furthermore, chemicals are preferred over physical processes on account of easy availability.

Rising concerns regarding health and environment impacts are leading to increasing usage of various treatments during water consumption and discharge.

6.4.2. MARKET RESTRAINTS ANALYSIS

6.4.2.1. LACK OF WATER AND INFRASTRUCTURE MANAGEMENT

Though there is a widespread consensus among governments and businesses for enhancing the economy of a country by development and investments in the infrastructure activities, the world on average continues to underinvest in the same. As aging infrastructure requires constant maintenance and follow-ups, and this results in need for additional investments., Reinvestments for similar or same type of projects would be one of the major obstacles for development of aging infrastructure, primarily in some developing and underdeveloped countries. Over the long lifecycle, materials used in these types of infrastructure are subject to wear and tear, effects of climatic conditions, and constant presence of moisture, among other challenges. Any failure of infrastructure can result in potential structural damage, losses, fatalities, injuries, and property damages, among others. Furthermore, increasing incidence of natural disasters have been resulting in need for reconstruction of such, and other infrastructure. However, in several underdeveloped countries, governments are still facing challenges to provide basic water infrastructure to the country owing to lack of skilled workforce, poor infrastructural decisions, and lack of technical knowledge. This is a key factor expected to inhibit construction or deployment of newer water treatment facilities, especially in some developing and underdeveloped countries over the forecast period. Furthermore, technological advancements in infrastructure and high cost for construction, equipment, workforce, and logistics for such projects are some other factors expected to hamper market growth to some extent over the forecast period.

6.4.2.2. HIGH INSTALLATION, EQUIPMENT AND OPERATIONS COSTS

High cost of water quality monitoring equipment is expected to act as a major restraint to growth of the market. The cost of ownership of water quality monitoring equipment includes the initial analyser purchase and the related operational costs associated with the systems, which includes consumables, spares, and maintenance charges to name a few. Consumable costs include cost of standard chemical solutions and reagent preparation. In addition, maintenance costs for analysers are the major contributor to overall expense of the equipment. Following calibration, the most significant instrument cost of ownership is the in-plant repair and administration, and spare part inventory management. These costs add to the total cost of production that in turn has a significant impact on the overall profit margin.

6.4.3. MARKET OPPORTUNITIES ANALYSIS

6.4.3.1. ADOPTING MORE SUSTAINABLE APPROACHES THROUGH REDUCE-RECYCLE-REUSE

Water quality controlling is often limited to the pattern of water resource allocation, availability, and efficiency. Quite often, buffer capacity, water circulation, or re-use of buffered water is not taken into consideration. 3R can contribute substantially to increasing the quantity and quality of water resources. The use and reuse of buffered water allows for increased availability of water, as it avoids water allocation conflicts through simply using and re-circulating the water. Investing in water reuse across various countries ensures that residents have safe drinking water supplies as a result of untreated water not being discharged into the environment, industries have sufficient water supply to expand and create jobs, farmers have water to grow food, the environment is less impacted, and our economic future is more secure. With more varied end-uses and application areas, water reuse can improve water security, allow some level of flexibility, and sustainability. In recent years, increasing number of countries have been incorporating water reuse into their respective water management strategies in order to ensure a drought-resistant, safe, reliable, and locally controlled water supply going ahead. Petrochemicals, power plants, oil & gas, chemical manufacturing, and food & beverage are some of the industries that can capitalize of wastewater reuse. Water that is treated can be used for industrial cooling towers, evaporative cooling process, and these do require large amounts of water. Thus, reuse can resolve water scarcity issues to some extent and can reduce costs by maximizing water recovery. These factors can also open up opportunities for industries to implement more sustainable approaches that could be on the market in future.

6.4.3.2. NEW INITIATIVES SUPPORTING MARKET GROWTH

In recent years, India has been witnessing a significant emergence of new initiatives aimed at bolstering the growth of the water and wastewater treatment market. With increasing urbanization, industrialization, and population growth, the demand for clean and accessible water has become a pressing concern. Consequently, both governmental and non-governmental entities have stepped up their efforts to address these challenges, leading to a surge in innovative initiatives that are reshaping the water and wastewater treatment landscape. One of the primary drivers of this transformation is the government's commitment to promoting sustainable water management practices. The Swachh Bharat Abhiyan (Clean India Mission) and the Namami Gange project are two noteworthy examples. The Namami Gange project, launched in 2014, focuses on cleaning and conserving the Ganges River, a lifeline for millions. The government's allocation of substantial funds towards these initiatives has not only enhanced wastewater treatment infrastructure but has also spurred investments in research and development of advanced technologies.

Moreover, the private sector has actively engaged in this domain, fostering innovation and competition. Startups and established companies alike are developing cutting-edge solutions for water and wastewater treatment. These range from decentralized and modular treatment systems to IoT-driven monitoring and management platforms. These initiatives are not only catering to the needs of urban areas but are also making inroads into rural communities that often lack access to clean water. Such diversification has broadened the market's scope and accelerated its growth.

The role of technology in transforming the water and wastewater treatment sector cannot be overstated. Advanced treatment methods such as membrane filtration, reverse osmosis, and ultraviolet disinfection are gaining prominence. These technologies are contributing to improved efficiency, reduced operational costs, and enhanced water quality. Partnerships and collaborations are also playing a pivotal role in this sector's evolution. Government bodies are partnering with international organizations and experts to leverage global best practices. Multilateral initiatives like the India-EU Water Partnership and joint ventures with international companies are fostering knowledge exchange and cross-border investments. These collaborations are instrumental in addressing complex challenges and facilitating the transfer of innovative solutions.

Furthermore, the growing awareness of water scarcity and pollution issues has mobilized civil society and non-governmental organizations to take proactive steps. Community-driven initiatives are empowering local communities to actively participate in water management, conservation, and treatment efforts. These initiatives have not only improved water quality but have also generated employment opportunities and enhanced socio-economic conditions in many regions.

6.4.3.3. COLLABORATIONS BETWEEN PUBLIC AND PRIVATE SECTORS

PPPs are increasingly being used to finance and implement water and wastewater treatment projects in India. This is because PPPs can help to bring in the expertise and resources of the private sector to address the country's water challenges. Private sector involvement brings in much-needed investment for developing and upgrading water and wastewater treatment facilities. The public sector often faces budget constraints, and private companies can contribute capital to build and maintain treatment plants, distribution systems, and infrastructure. Private companies often possess advanced technological know-how and expertise in water and wastewater treatment processes. Collaborations allow the public sector to leverage these advancements, leading to more efficient and effective treatment methods. Private sector collaboration fosters innovation through research and development initiatives. This can lead to the discovery of new treatment methods, improved equipment, and more sustainable solutions, enhancing the overall efficiency of water management. Private sector companies bring operational efficiency to water treatment processes. Their experience in project management, procurement, and operations can lead to streamlined processes, reduced costs, and optimized resource utilization.

Developing nations, confronted with the constraints of sustainability and financial viability as a result of the unavoidable reality of poor water supply and sanitation services and tight budgets, are exploring PPPs as a viable alternative to improve performance or create new sources. Water PPPs are increasingly being used by public utilities in a more focused manner, to manage a specific subset of activities or challenges, such as increasing energy efficiency and water availability through non-revenue water management, or development of a new water source, using lessons learned in the past and a better understanding of what PPPs in water can and cannot bring. The emphasis is on performance-based contracting, with payments made depending on outcomes.

Furthermore, the supply-demand imbalance for water and sanitation services is likely to grow in the near future: India's urban population is expected to exceed 600 million by 2031, more than double that of 2001 (HPEC, 2011). In light of lofty national goals, public and media pressure is increasing. The Indian Ministry of Urban Development has set a national service benchmark objective of continuous, around-the-clock water delivery services for all cities in India by 2031, demanding 100% coverage and a daily supply of 135 litres per capita for all households (Ministry of Urban Development 2008).

All cities will be equipped with underground sewerage systems, and 100% of wastewater will be collected and treated. Massive expenditures will be needed over the next 20 years to meet these lofty targets. Between 2012 and 2031, the total investment required in water supply and sewerage is anticipated to be over INR 563,598 crores (USD 90 billion) (HPEC, 2011). Expecting the public sector to fund such development wholly is patently unfeasible, and private-sector engagement will be one of the few viable alternatives open to Indian municipalities if service-level requirements are to be met. However, the growth of public-private partnerships (PPPs) for water and sanitation has been restricted and much slower than in other sectors such as transportation and energy. According to the World Bank's Public-Private Infrastructure (PPI) Database, between 1990 and 2012, India has just 13 PPP projects in the water and sanitation sector, accounting for less than 2% of all PPP projects (PPI Database, 2014). Water and sanitation received even less investment, accounting for 0.2% of overall PPP investments in India. However, the government has been launching various initiative such as Atal Mission for Rejuvenation and Urban Transformation (AMRUT), National Mission for Clean Ganga (Namami Gange) and among others are projected to improve the PPP investment in India in water and wastewater treatment market.

6.4.4. MARKET CHALLENGES ANALYSIS

6.4.4.1. GROUNDWATER DEPLETION AND UNTREATED WATER DISCHARGE

Although India has 16% of the world's population, it only has 4% of the world's freshwater resources. Not only is water limited in India, but groundwater exploitation has been increasing for decades. The government's backing for the "green revolution" to maintain food security has boosted demand for groundwater for agriculture since the 1960s. Rapid rural electrification, along with the availability of contemporary pump technology, has resulted in a rise in borewells to satisfy that demand. The number of borewells in India has increased from 1 million to 20 million in the previous 50 years, making it the world's greatest consumer of groundwater. According to the Central Groundwater Board of India, around 17% of groundwater blocks are overexploited meaning the rate at which water is withdrawn exceeds the rate at which the aquifer can recharge, while 5% and 14% are at critical and semi-critical phases, respectively.

The situation is especially concerning in three key regions: the northwestern, western, and southern peninsular. Groundwater contamination and the consequences of climate change, such as unpredictable rainfall in dry places, put further strain on groundwater resources, which supply roughly 85% of rural home water supply, 45% of urban water supply, and more than 60% of irrigated agriculture. Current levels of overexploitation endanger livelihoods, food security, climate-driven migration, long-term poverty alleviation, and urban growth. Groundwater extraction has helped rural people to minimize their susceptibility in the short term, but it may come with trade-offs that raise the risk of depletion and, ultimately, vulnerability in the long run. Increased access to and extraction of groundwater resources enables families to enhance agricultural productivity in the short term. Many farm households with wells said that their vulnerability has decreased, owing in part to income increase and diversification, as well as buffers provided by social safety nets. However, if aquifers are not adequately regulated or replenished, greater access to and use of groundwater for agriculture may result in dropping water tables and growing water shortages, thus aggravating long-term vulnerability. As groundwater becomes scarcer and less reliable, the demand for surface water sources (rivers, lakes, reservoirs) increases. Water treatment plants designed for surface water may need to be expanded or new facilities constructed to meet the growing demand. In summary, groundwater depletion and untreated water discharge are critical issues that can significantly impact the India Water and Wastewater Treatment Market. The market may respond with technological advancements, policy changes, increased investments, and a greater focus on sustainable water management practices.

6.4.4.2. LIMITED FUNDS MAY POSE CHALLENGES IN CERTAIN REGIONS

India is a country with 28 states and 8 union territories and as India is developing nation some of the states in the country are still underdeveloped. Even by developing-country standards, India's regional growth has been notably unequal. Since the 1960s, India's regional growth has been polarized, with a high-income club and a low-income club. Gujarat, Maharashtra, Punjab, and Haryana are among the wealthy states, with Tamil Nadu, Uttar Pradesh and Karnataka joining recently. Orissa, Bihar, Rajasthan, Jharkhand, Assam, Arunachal Pradesh and Madhya Pradesh are among the states in the low-income club. Worryingly, the makeup of these clubs has essentially stayed consistent over the previous four decades. The central government allocates limited funds to low-income club states. There are a number of reasons for allocation of limited funds in these states which include geographical location, geopolitical scenario, availability of natural resources and among others. Therefore, the rate of industrial development in these states is very low. In addition, the abovementioned low-income states have low population compared to high income states therefore, while allocating funds to these states the central government consider the population of each state.

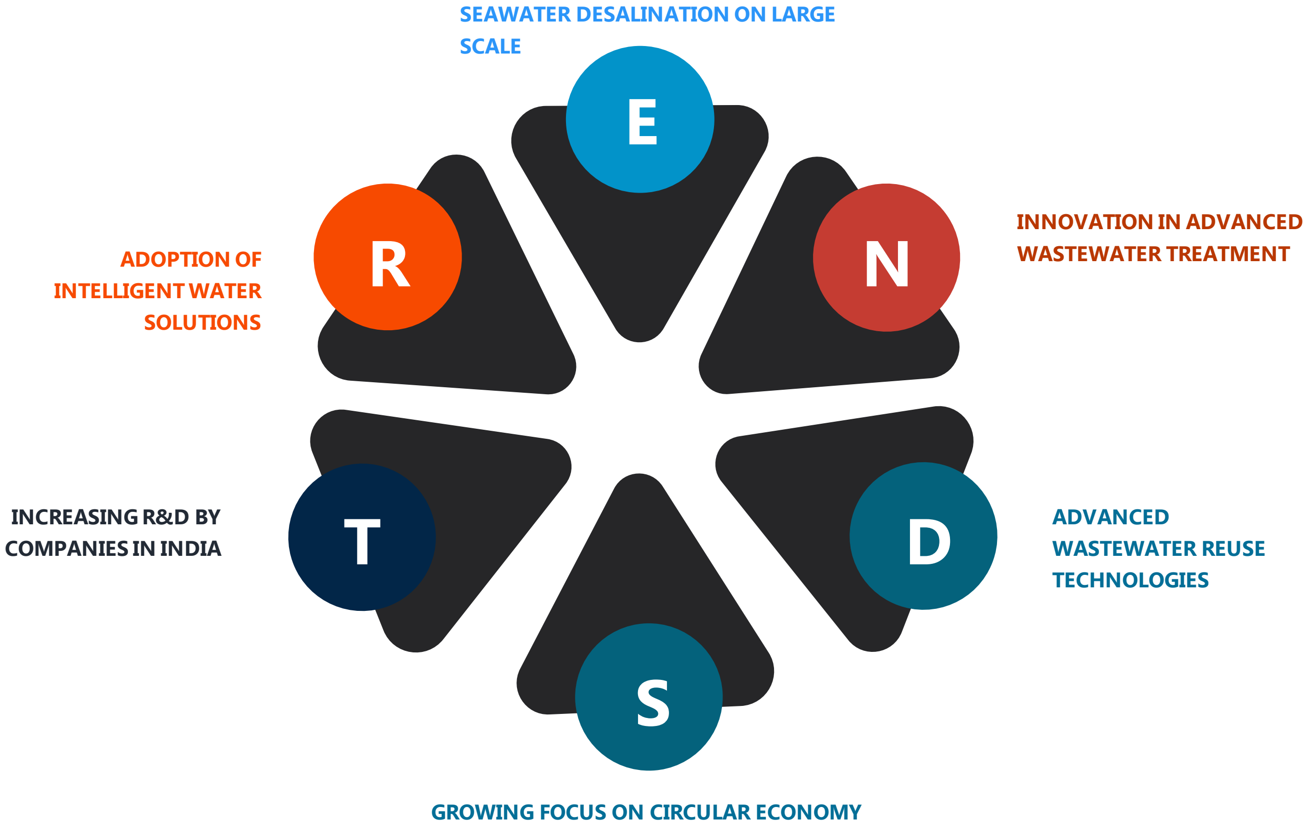
Water and wastewater treatment facilities require substantial investment for the construction, operation, and maintenance of treatment plants, pipelines, and distribution networks. Limited funds can hamper the development of new infrastructure and upgrades to existing facilities, leading to inadequate treatment capacity and inefficient operations. Advanced water and wastewater treatment technologies often come with higher costs. Limited funds can hinder the adoption of innovative technologies that could improve treatment efficiency and reduce environmental impacts. Without access to cutting-edge solutions, regions may struggle to address water quality and scarcity issues effectively. These states use allocate funds to fulfill basic needs of people and to provide adequate infrastructure. Therefore, the water and wastewater treatment market face significant challenge in the low income states. Due to lack funds pose a significant challenge for water and wastewater treatment market as the initial investment for the water and wastewater treatment is very high.

6.4.4.3. LACK OF REQUIRED TECHNO-COMMERCIAL AWARENESS

To keep up with industrial and societal changes, water treatment technologies must be constantly innovated and improved to stay ahead of the competition. This necessitates the continual acquisition of new technological skills and information. Reliability engineering faces significant problems in the present technological landscape, which includes strong digitization and connectivity at all levels of cyber-physical systems and across all industrial sectors, as well as new avenues and opportunities for improvement. Water treatment equipment are advanced in in a number of aspects and require skilled personnel for operations. This equipment is increasingly being mandated or being voluntarily deployed in almost every end-use industry, which is a challenge for small, as well as medium scale companies or organizations. The process and handling require appropriate monitoring and usage to ascertain accurate measurements and results. Even online and at-line technology requires qualified resources to understand the operation and data, among others. Moreover, water and wastewater treatment are required in various sectors, including pharmaceuticals, power, food, and beverages, as well as petroleum, among others. It is critical to maintain standards and have professionals analyse if the system requires maintenance or repairs. Quality control issues such as non-zero blanks and preservation also require proper monitoring. Limitations in operator competence and understanding of Natural Organic Matter (NOM) might prevent compliance monitoring from reaching the degree of precision and desired accuracy. Furthermore, lack of skilled labor is a key factor that could hamper growth of the market to some extent during the forecast period.

6.5. KEY TREND ANALYSIS

FIGURE 61. KEY MARKET TREND ANALYSIS



6.5.1. INCREASING R&D BY COMPANIES IN INDIA

India's water and sewage industries have seen significant development from private players due to available funds and grants for new entrepreneurship. The Startup India program, initiated by the Government in 2016, offers mentors and grants to over 74,750 organizations. Multinational water treatment companies like Evoqua Water Technologies have expanded their presence in India. Evoqua's Indian headquarters in Chennai, established in 2019, includes a Global Engineering and Technology Centre focused on pollution treatment. Major companies like Denta Water & Infrastructure Ltd, Thermax Ltd., Voltas Ltd., GE Water and Process Technologies, and VA Tech WABAG Ltd. offer commercial water filtration solutions. VA Tech WABAG Ltd. partners with the Namami Gange Program to provide clean water solutions. Thermax Ltd. develops resin filtration technologies including products like Tulsion ADS 540 and Tulsion CH 92 for removing radioactive elements and contaminants in sewage and effluent treatment plants.

Nanotechnology research is gaining traction, utilizing nanoparticles to attract pure water and repel impurities. Companies like Voltas Ltd. provide nanofiltration cartridges. Evoqua Water Technologies also offers nanofiltration membranes, useful in desalination projects. Bhabha Atomic Research Center developed an energy-efficient filtration system for water purification in the Punjab region. IIT Madras incubates companies like InnoNano Research Pvt. Ltd., Innodi Water Technologies Pvt. Ltd., Aqueasy Innovations Pvt. Ltd., and VayuJal Technologies Pvt. Ltd. These startups focus on water technology research. InnoNano Research Pvt. Ltd. developed a nanotechnology-based treatment system for anion and metal removal, implemented in multiple Indian villages. Hydromaterials Pvt. Ltd. uses IoT to monitor nanotechnology-enabled arsenic and iron removal. EyeNetAqua Solutions Pvt. Ltd., incubated by the International Centre for Clean Water, employs IoT for smart water sensors that monitor pH levels, nitrate, chlorine, and fluoride. These sensors optimize filtration resources based on water quality. The product aligns with the Jal Jeevan Mission's norms, promoting commercial viability.

Private companies contribute significantly to water treatment technology development in India, partnering with educational institutions and government programs. This drives advancements in solutions for industries, factories, and municipalities. The expanding role of private enterprises is expected to fuel further progress in the field.

6.5.2. ADOPTION OF INTELLIGENT WATER SOLUTIONS

In India, this global initiative has gained significant importance due to the country's growing water-related challenges. Moreover, the rapid advancements in Artificial Intelligence (AI) and Internet of Things (IoT) technologies are finding applications in various sectors, including manufacturing and production. These technologies, along with the concepts of Industry 3.0 and Industry 4.0, are playing a crucial role in the evolution of the Indian water and wastewater treatment sector. As the demand for efficient water management solutions rises, there is a notable shift towards the adoption of intelligent water systems. These systems prioritize sustainability, energy efficiency, and reduced carbon footprint. For instance, global companies like Hitachi Ltd. have introduced intelligent water systems that integrate smart monitoring controls and data management with water treatment processes. In India, Hitachi has collaborated with the government to implement smart water systems in villages, such as those in the Bhilwara district of Rajasthan, using IoT and Operational Technology (OT) devices.

India faces a pressing need for innovative solutions due to its significant water contamination issues, with around 70% of surface water being contaminated. To address this, companies like Xylem Water Solutions India have developed wastewater management equipment that optimizes energy usage and treatment processes, leading to substantial energy savings. International collaborations are also shaping the Indian water management landscape. Germany's Fraunhofer-Institut für Grenzflächen- und Bioverfahrenstechnik IGB has been working with Indian cities to implement actionable wastewater management plans driven by intelligent integrated networks. In Coimbatore, Tamil Nadu, a smart city project has led to sustainable monitoring and visualization of wastewater management results.

AI-driven solutions are gaining ground in India's water sector. Companies like Greenvironment Innovation & Marketing India are developing AI-based water treatment systems. IoT sensor-based water quality detection is being encouraged, and startups like EyeNetAqua Solutions have emerged, focusing on advanced water quality monitoring. India's abundant sunlight is being harnessed for innovative water purification methods, such as photocatalysis. Gujarat's municipalities are adopting photocatalytic technologies to treat wastewater, with significant budget allocations. Additionally, advanced techniques like automatic variable filtration (AVF) are being embraced by companies like Eureka Forbes Ltd. and Oxive Environment Management Pvt. Ltd., especially for small-scale wastewater management in residential and commercial areas. The Indian water sector is also witnessing the application of biotechnology. Bio-augmentation methods, which involve the introduction of specific microorganisms to chemically transform pollutants, are being employed. Unitech Water Technologies Pvt. Ltd. has developed a product called the Microbial Accelerator, which uses dried microorganisms to treat wastewater. This eco-friendly solution balances oxygen and pH levels and has received support from the India Water Portal, a project by Arghyam.

6.5.3. INNOVATION IN ADVANCED WASTEWATER TREATMENT

37.7 million people are being affected by waterborne diseases such as cholera and typhoid each year in the country, according to a UNICEF report in 2019. The need for more advanced and effective water treatment techniques and approaches are becoming extremely necessary, in order to prevent outbreaks of diseases epidemics, and to secure public health. Advanced waste water treatment can be defined as processes to reduce impurities in water, either through traditional procedures or via biological methods. These methods are focused more on enhancing the efficiency of conventional procedures. Moreover, the effluents of water and waste water treatment plants can be further recycled to conserve water. India's escalating challenges in wastewater management, driven by rapid urbanization, industrialization, and population growth, have necessitated a fundamental shift towards innovation in advanced wastewater treatment.

Traditional methods have proven insufficient in tackling the escalating pollution crisis, resulting in dire environmental consequences and health hazards. Acknowledging this urgency, there is a growing momentum towards embracing advanced treatment solutions, signifying a pivotal trend in the country's approach to wastewater management.

Government statistics from the Ministry of Jal Shakti paint a stark reality—over 70% of India's surface water resources are currently contaminated to varying degrees. This alarming scenario has galvanized the Indian government to take proactive measures, prominently represented by flagship initiatives like the "Namami Gange" (Clean Ganga) program and the "Swachh Bharat Mission." These endeavors underscore the pressing need to prioritize wastewater management and pave the way for innovative approaches. The emergence of innovation in advanced wastewater treatment holds immense promise for India. A series of discernible trends has emerged, each poised to address specific challenges in the sector. Firstly, decentralized treatment systems have garnered attention for their ability to effectively manage wastewater at the source. Technologies such as constructed wetlands, biofiltration, and decentralized wastewater treatment plants (DEWATS) offer cost-effective solutions that mitigate pollution before it reaches vulnerable water bodies, thus easing the burden on centralized facilities.

Advanced oxidation processes (AOPs) constitute another influential trend. These processes deploy chemical reactions to degrade organic and inorganic pollutants that often defy conventional treatment methods. Technologies like ozone treatment, ultraviolet (UV) irradiation, and photochemical oxidation are being harnessed to break down persistent pollutants, showcasing their potential to significantly enhance treatment efficacy. Membrane filtration technologies have taken center stage in achieving high-quality wastewater treatment. Employing methods like ultrafiltration, nanofiltration, and reverse osmosis, these approaches excel in eliminating suspended solids, pathogens, and dissolved contaminants. The outcome is treated water that meets stringent quality benchmarks, and in some instances, is even suitable for non-potable reuse, thereby conserving precious water resources.

Biological nutrient removal represents yet another pioneering innovation. By utilizing processes such as sequencing batch reactors (SBRs) and membrane bioreactors (MBRs), this trend simultaneously addresses organic matter and nutrient removal from wastewater. This is particularly crucial in preventing nutrient pollution, which can contribute to harmful algal blooms and oxygen depletion in water bodies.

6.5.4. ADVANCED WASTEWATER REUSE TECHNOLOGIES

As per the United Nations Environment Program (UNEP), reusing water is economically as well as ecologically very important, since it is beneficial in relieving water scarcity and enabling waste water management. In addition, India has a limited supply of this resource, with a total of 4,000 billion Cubic Meter (BCM) of water being acquired per year, of which, up to 500 BCM capacity is used in manufacturing industries and factories. Despite supply being limited, demand for this critical resource continues to rise exponentially, and reusing water is an appropriate solution for industries, sectors, farmers, residents, and citizens. The Jal Jeevan Mission by the government of India has also reported to set a target of 20% of total available water coming from its reused version, as of 2021.

Moreover, the state government of Gujarat had launched the Policy for Reuse of Treated Waste Water in 2018, which aims to complete a full reuse of treated water till the year 2030. According to the Government of India, the country possesses 5% of the world's fresh water sources; however, it hosts 16% of the global population, putting major pressure on limited water available. Thus, advanced waste water reuse technologies are being developed and innovation is being supported due to the aim of water conservation. The technique known as advanced oxidation is being implemented in the country to clean the water of Ganga River. Developed by the Energy and Resources Institute (New Delhi, India), this product has been supported by the Government of India Department of Science and Technology. The product has been reported to achieve a zero liquid discharge, which works on ultraviolet light technology. Compared to tertiary purification systems of Reverse Osmosis (RO) as well as multi effect evaporators, the advanced oxidation technique, also called as TERI Advanced Oxidation Technology (TADOX) has proved to leave a lesser carbon footprint. This technology is viable to be installed in decentralized wastewater treatment systems in large infrastructure and construction projects which require purified water for longer periods of time. In addition, this system has been ready for commercial use since April 2021.

Furthermore, Indirect Potable Reuse (IPR) process involves the usage of a buffer medium such as the soil or a lake before the recycling treatment of waste water, whereas, Direct Potable Reuse (DPR) is characterized by not involving any environmental buffer. The inclusion of these two methods before recycling of used water is crucial in the reuse process. IPR is also being applied in Bangalore, Karnataka, India, and its pilot was conducted in 2006, after which systems have been working to prepare industrial and agricultural grade purified water in the city, as per the Ministry of Urban Development. The second procedure after these two methods is the activated sludge system, which is a biological treatment method to purify water. Protozoa, bacteria, and algae are removed from waste water through oxidation with the help of microorganisms in the presence of an oxygen environment. A newer modification of this process is the Nereda technology, wherein the sludge is given a granular texture with the help of slow growth of glycogen collecting micro-organisms. Such activated sludge systems have been extensively applied at the Titagarh sewage treatment plant in the vicinity of Kolkata city.

Categorized as a secondary treatment method, Kelvin Water Technologies Pvt. Ltd. (India) is working towards making this procedure affordable across the country. The company is known to provide multiple reactors activated processes along with cyclic sludge processes, which is regarded as highly efficient for water recycling, since it removes suspended particles. Furthermore, this water reuse technique is economical and efficient since the volume of waste water can be controlled easily. Moreover, in 2021, Chennai implemented tertiary treatment reverse osmosis methods by establishing two large plants at Koyambedu and Kodungaiyur, which are utilizing this method to provide recycling at a city level scale while catering to industries in the areas of Oragadam and Sriperumbudur in Tamil Nadu. Since the maximum capacity of the plants is 45 million liters per day, these are proving to be beneficial to make the city self-sufficient in terms of water reuse. This Tertiary Treatment Reverse Osmosis (TTRO) solution applies the membrane-based technique of impurity removal and is also beneficial in agricultural water refining. Being a tertiary treatment level, it is regarded as very advanced, and is prominently used to remove minerals and salts. It can involve flocculation, carbon adsorption, de-chlorination as well as ultra-filtration. Such tertiary treatment plants are also present at the Bamroli sewage treatment plant in Surat, Gujarat, as well as in Kolhapur, in Maharashtra. As a result, recycling has been in the limelight in terms of new innovations taking place along with advanced recycling solutions being made operational in urban cities. Hence, techniques such as IPR, TADOX advanced oxidation, activated sludge systems, and Nereda technology along with biological membrane filtration are being provided as commercial solutions by private companies. Deployment is also being supported by various departments of the Indian government to drive growth of this industry.

6.5.5. SEAWATER DESALINATION ON LARGE SCALE

India, surrounded by the Arabian sea to the west, the Bay of Bengal in the east, and the Indian ocean to the south, has immense water reserve of sea water. However, since seawater desalination requires much energy due to the strong bonds salt minerals form with water molecules. As a result, it cannot be utilized for agriculture, for which the resource is required in large quantities. Hence, with the pressing need for increased crop yields in order to provide for the large population of India, desalination is a very viable solution if energy and cost-efficient techniques are developed. Thus, the Department of Science and Technology, Government of India (GoI), has called for desalination project proposals in 2021. The proposals included are based on futuristic technologies pertaining to thermal and membrane-based desalination. The Indian Desalination Association also regards thermal processes viable for the purpose. With the inclusion of vaporization and distillation, multiple boiling containers are involved, wherein gypsum and carbonates are removed via these procedures. Since these methods are considered inefficient for small scale use, such as in factories.

However, India has been developing economically viable large-scale plants based on the low temperature thermal desalination. For instance, the National Institute of Ocean Technology (NIOT) at Chennai has developed the world's first low temperature thermal desalination plant established at Lakshadweep islands. Cold water, located at a depth of 400-600m can be desalinated on large scale in the plant. Other such plants are being set up in Amini, Chetlat and Kalpeni islands among other places, with a capacity of 1.5 lakh liter per day. Plans for a 10 million liters per day (MLD) projects are also under consideration. Similarly, the National Institution for Transforming India (NITI) Aayog has been setting up various purification projects along the coastline, especially near Chennai. The Minjur plant is India's largest desalination project, operational since the past decade. This plant contains up to 8,600 reverse osmosis membranes and 23 pressure exchangers.

In addition, it has the capacity to produce 100 MLD together. IVRCL Infrastructure and Projects Ltd. (India) has also contributed to the construction of this significantly large desalination project. Furthermore, Multi Stage Flash Distillation (MSF) is being utilized in the country to purify sea water of dissolved minerals and salts. The Desalination and Membrane Technology Division of the Bhabha Atomic Research Center (BARC) of India has been working on promoting this technique throughout the nation. The Kalpakkam based Nuclear Desalination Demonstration Plant uses this procedure coupled with the reverse osmosis (RO) method to produce a capacity of 1.8 MLD. This plant supplies pure water to the Madras Atomic Power Station. MSF includes up to 30 stages of methods, in which portions of water are flashed into steam through heat exchangers and condensers. These stages are known to have different atmospheric pressure requirements, which are simulated via vapor compression. MSF plants are even provided by private commercial manufacturers such as Shree Vinayak Jal Pvt. Ltd. (India) and Doosan Power Systems India Pvt. Ltd. (India), among others. Large scale projects have been proposed to be instituted in Kutch, Dawrka, Bhavnagar and other places in Gujarat. Other companies engaged in this sector in India are Genesis Water Technologies Inc. (The U.S.), Landmark Aquatec Pvt. Ltd. (India), and Ionex Engineers (India) along with other firms. Another advanced procedure is the Multiple Effect Desalination (MED), which works on the reuse of energy from the previous stage and is resistant to corrosion. This method can operate at lower concentration of minerals, along with a low temperature, making it easy to maintain and operate efficiently. As a result, this procedure is becoming popular in the water treatment industry.

A plant functional using this technique has been implemented by the Bhabha Atomic Research Center (BARC), combined with a vapor compression process. The plant supplies clean water for nuclear research, by reusing sea water from the Arabian sea shore near Mumbai. IDE Technologies (Israel) has been delivering clean water to the oil refining wing of Reliance Industries Ltd. (India) since the past two decades, in Jamnagar city in Gujarat. Improving awareness regarding eco-friendly technologies, this plant can refine up to 168,000 m3 per day. Also, the Indian subsidiary of Alfa Laval AB (Sweden) also provides multiple effect desalination equipment on a commercial level to be used in power plants. Its products have the ability to generate pure water of up to 10,000 m3 per day, with the plant being lightweight and applicable offshore, land-based, and marine installations. As a result, large scale desalination projects are being implemented in the country for the past decade; however, newer and larger plants have been receiving government funding as of 2021. Furthermore, technologies such as multiple effect desalination, multi stage flash distillation, reverse osmosis, and vapor compression are proving to be the sought-after methods in this field.

6.5.6. GROWING FOCUS ON CIRCULAR ECONOMY

The circular economy model lays emphasis on production and consumption cycles which is more sustainable, including recycling, reusing, refurbishing, as well as optimizing available resources. The United Nations Environment Program regards circular economy as the economic system which aims to minimize pollution, resource wastage as well as to create sustainable jobs and preserve the overall environment. Similarly, the Indian Government has also been promoting this philosophy pertaining to the energy, infrastructure and production sector. For instance, the NITI Aayog has taken multiple initiatives such as the international conference on Sustainable Growth through National Recycling as well as the formation of 11 committees to prepare action plans regarding the country’s transition to a circular economy. Construction and Demolition Management rules, Metals recycling policy, as well as plastic waste management rules are the examples of other initiatives taken up by the government. Furthermore, the Ellen McArthur Foundation suggests that circular economy is to bring a benefit of up to USD 624 billion to the Indian economy. Closely linked with the United Nations Sustainable Development Goals, this concept has started to be applied at the local governance level in India. As per the Ministry of Housing and Urban Affairs, recycling of plastic waste along with treatment of waste water for reuse has been at the forefront of this field. Hence, intermediate targets have been set for the recycling of waste water which aim to achieve 25% reuse of by 2026, 35% and 50% by 2050. Moreover, the country has the ability to recycle a total of 20,000 MLD, in which most water treatment plants are observed to not run at full capacity. Hence, since 60% of India's industries are being affected by the lack of water reuse efficiency, circular economy has been gaining importance in the context of water and waste water recycling. According to a research paper published by the American Chemical Society in 2021, carbon and nitrogen removal from waste water are some of the major issues pertaining to the water industry, which need to be addressed. The waste water reuse system adopted by the Surat Municipal Corporation was presented at the United Nations Conference of Parties (COP26) in 2021, which is a conference working towards environment protection through the mandate of Paris Agreement, which legally binds UN member nations to adhere to environment protection laws. The Surat Municipal corporation highlighted their reuse model of waste water, in which the city has been generating USD 6.25 crore by selling 115 MLD recycled water. Being applauded for this circular economy progress, such Indian cities are proving to create an ideal for India in terms of advancing the waste water treatment sector, in order to spread the idea of circular economies. Indian industries located in water scarce regions tend to lose revenue due to hindrances in production due to the lack of pure water. Hence, the focus on financing waste water treatment projects has been the core aim of governmental agencies and ministries. Decentralization of such programs, accurate management strategies along with massive community participation is required in order to make these plans successful in the long term. A study by the Council of Energy, Environment and Water of India regarded large scale interventions, technology access and good public perception about water treatment plants as some of the prominent reasons to drive the circular economic growth of the country pertaining to the water sector. India’s trajectory towards circular and sustainable water industry highly revolves around water recycling technologies such as reverse osmosis purification, bio-augmentation, multiple effect desalination, multi stage flash distillation and vapor compression. Additionally, given the rapid urbanization of India, the 6 R rule beneficial to urban water conservation is the rule consisting of reduce, reuse, recycle, reclaim, recovery and restore water. Indian rivers are receiving half treated waste water, which is leading to complex issues in water treatment efficiency and loss of purification time. For instance, the Musi River has been getting partially treated waste water from the city of Hyderabad. Hence, although having the presence of a process of trying to shift to a circular economy, efficacy and management of such procedures needs to be enhanced. As a result, owing to the growing global awareness pertaining to the hazardous effects of a linear economy, government funding for circular economy is increasing. Additionally, many Indian cities are commencing with water recycling plants in order to propel water circular economy and make India sustainable in terms of its water resources. Prevalence of water technology companies in the country such as Thermax Ltd. (India), Evoqua Water Technologies (The U.S.), Voltas Ltd. (India) and GE Water and Process Technologies (The U.S.) are enhancing the working of this industry and aiding in the growth of this sector.

6.6. GOVERNMENT POLICIES AND REGULATORY FRAMWORK IN INDIA

According to Provisions of Environment (Protection) Act, 1986 and Water (Prevention & Control of Pollution), Act 1974, the industries must implement Effluent Treatment Plants (ETPs) and should treat respective effluents as per environmental standards before releasing it into rivers and water bodies. Thus, State Pollution Control Boards/Pollution Control Committees usually inspects the industries with respect to effluent discharge standards and also takes action for non-compliance under provisions of these Acts.

The IS 10500: 2012 DRINKING WATER — SPECIFICATION by Bureau of Indian Standards, aims to prescribes the requirements and the methods of sampling and test for drinking water.

The guidelines by WHO for drinking water specifications is prepared through a vast global consultative process involving WHO member states (India is the member state), national authorities and international agencies, in consultation with the WHO Expert Advisory Panel.

Primary Water Quality Criteria for Bathing Waters by the Ministry of Environment and Forests (MoEF): In a water body or its part, water has several types of uses. Relying on the water applications and activities, thus the water quality criteria have been specified to determine its suitability for a particular purpose. Among the various types of uses there is one use that demands highest level of water quality or purity and that is termed as "Designated Best Use" in that stretch of water body. Based on this, water quality requirements have been specified for different uses in terms of primary water quality criteria.

According to Central Pollution Control Board of India the standard such as, WATER QUALITY STANDARDS FOR COASTAL WATERS MARINE OUTFALLS, in a coastal segment marine water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose. Among the various types of uses there is one use that demands highest level of water quality/purity and that is termed a "designed best use" in that stretch of the coastal segment. Based on this, primary water quality criteria have been specified into five designated best uses.

As per Central Pollution Control Board of India the standard Designated Best Use Water Quality Criteria includes certain criteria for drinking water source without conventional treatment but after disinfection, outdoor bathing (organized), drinking water source after conventional treatment and disinfection, propagation of wild life and fisheries and irrigation, industrial cooling, controlled waste disposal.

6.6.1. MINISTRY OF JAL SHAKTI

Historical Overview

The Ministry of Jal Shakti was established in May 2019 under the Government of India. Two ministries namely the Ministry of Water Resources, River Development & Ganga Rejuvenation, as well as the Ministry of Drinking Water and Sanitation, were merged together to form the Ministry of Jal Shakti.

The organizational history of the Department of Water Resources, River Development, and Ganga Rejuvenation:

- The origin of "Irrigation & Power" dates back to 1855, when it was given to the Department of Public Works, which had just been established at the time.

- In 1923, the Public Works Department and the Department of Industry amalgamated, becoming the Department of Industries and Labor, which was responsible for irrigation and power. In 1927, a Central Board of Irrigation was also established.

- In 1937, the Department of Industry and Labour was bifurcated into the Department of Communication and Department of Labour.

- The Ministry of Works, Mines, and Power relinquished control of the topic of "Irrigation and Power" to the newly established Ministry of National Resources and Scientific Research in 1951.

- In order to handle the issue of irrigation, a separate Ministry of Irrigation and Power was established in 1952. A Flood Control Board was established during severe floods to evaluate flood control initiatives at the highest level.

- In 1969, an Irrigation Commission was set up to go into the matter of future irrigation development programs in the country in a comprehensive manner.

- In January 1980, the new Ministry of Energy and Irrigation included the Department of Irrigation. In order to have a coordinated and complete perspective of the whole irrigation sector, the then Ministry of Energy and Irrigation was split into two on June 9, 1980, and the former Department of Irrigation was elevated to the rank of Ministry. In addition to major and medium irrigation, the Ministry of Irrigation was given control over the large irrigation sector, including both surface and ground irrigation as well as Command Area Development Programme.

- The following items of work were transferred from the Ministry of Agriculture (Department of Agriculture & Cooperation) to the Ministry of Irrigation with effect from in July 1980: -
    a. Irrigation for agricultural purposes
    b. Minor and emergency irrigation; and

c. Ground water exploration

- In January 1985, the Ministry of Irrigation was once again combined under the Ministry of Irrigation and Power. However, in the re-organization of the Ministries of the Central Government in September 1985, the then Ministry of Irrigation and Power was bifurcated, and the Department of Irrigation was re-constituted as the Ministry of Water Resources.

- In light of this new viewpoint, which mandated comprehensive planning and coordination of all areas of the country's water resource development, it was deemed necessary to create a National Water Policy, outlining, among other things, priority for different uses of water.

- Under the leadership of the Honorable Prime Minister, the National Water Resources Council was established to look into this issue. The National Water Resources Council (NWRC) adopted the National Water Policy in September 1987. The National Water Board was established in September 1990 with the Secretary of the Ministry of Water Resources as its Chairman, the Chief Secretaries of all the States and UTs, the Secretaries of the relevant Union Ministries, and the Chairman of the Central Water Commission serving as its members. Its duties include reviewing the status of the National Water Policy's implementation for the purpose of reporting to the NWRC and also launching effective initiatives for the systematic development of the nation's water resources.

- Accelerated Irrigation Benefits Programme (AIBP): The AIBP was established by the Central Government in 1996–1997 to provide Central Assistance to major/medium irrigation projects across the nation with the goal of accelerating the implementation of those projects that were either beyond the States' capacity for resources or at an advanced stage of completion. Priority was given to initiatives that were launched during the Pre-Fifth and Fifth Plans, as well as those that benefited tribal groups and areas vulnerable to drought. The program provided benefits for the twenty-five States. 99 projects with a combined potential of 76.03 lakh hectares have been prioritized under PMKSY (AIBP) for completion by December 2019. The entire amount of money needed to finish these 99 projects, including CAD&WM work, is expected to be INR. 77,595 Crore. For AIBP works estimated cost is INR. 48,546 Crore with Central Assistance (CA) of INR. 16,818 Crore.

- The National Water Resources Council adopted the revised **'National Water Policy2002'** and passed a resolution to this effect in its 5th meeting held on 1st April 2002 at New Delhi under the Chairmanship of Hon'ble Prime Minister. Thereafter, the National Water Board considered the further revised Draft National Water Policy 2012.

- **The Centrally Sponsored Scheme - Rationalization of Minor Irrigation Statistics (RMIS)** was launched in 1987-88 and is being implemented by Minor Irrigation (Stat.) Wing of the Department through State Governments. It is now renamed as "Irrigation Census" which is a Centrally Sponsored Scheme with 100% Central funding. The major activities under the Scheme are: (i) conduct of 6th Minor Irrigation Census with reference year 2017-18 and (ii) conduct of a Census of Water Bodies which is taken up for the first time.

- For comprehensive improvement of water bodies, two schemes - **Repair, Renovation and Restoration (RRR) of Water Bodies**, one with external assistance and the other with domestic support for implementation during XI Plan Period was approved by the Government. The scheme of RRR of water bodies includes the catchment area treatment, command area development, capacity building of stakeholders and increased availability of drinking water.

- The R & D activities undertaken in the **R&D Programme in Water Sector** Scheme are essential for the management and development of water resources of the country. The activities taken up under this Scheme are:
    a. R&D activities through Apex Research Organizations at National level: Central Water and Power Research Station (CWPRS), Pune; Central Soil and Material Research Station (CSMRS); National Institute of Hydrology (NIH), Roorkee; and Central Water Commission (CWC), New Delhi.
    b. Sponsoring and Coordinating Research in water sector through Educational Institutions, Indian Research Institutes, NGOs and Indian Private Institutes in collaboration with Government Institutes.
    c. Dissemination of research findings and technology transfer and International Collaborations
    d. Evaluation of R&D Activities and Consultancies

i. **National Action Plan on Climate Change**: The Government of India launched National Action Plan on Climate Change (NAPCC) on 30th June 2008, Ministry of Water Resources has set up National Water Mission with the main objective of "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management" Comprehensive Mission Document" of the NWM on 6.4.2011 with following five goals: -
    a. Comprehensive Water Data Base in Public Domain and Assessment of Impact of Climate Change on Water Resources.
    b. Promotion of Citizen and State Action for Water Conservation, Augmentation and Preservation.
    c. Focused Attention on Vulnerable Areas including Over-Exploited Areas.
    d. Increasing Water Use Efficiency by 20%.

e. Promotion of Basin Level and Integrated Water Resources Management

- **Flood Management and Border Areas Programme (FMBAP):** The Flood Management Programme (FMP) and River Management Activities and Works related to Border Areas (RMBA) under operation during XII Five Year Plan by Department of Water Resources, RD & GR merged as Flood Management and Border Areas Programme (FMBAP) for the period 2017-18 to 2019-20 and later extended up to March, 2021. The outlay of FMBAP is INR 3342 Crore comprising of FM component of INR 2642 Crore and RMBA component of INR 700 Crore for the period 2017-18 to 2019-20 under the Scheme. There were 83 ongoing Schemes under FMBAP out of which 39 Schemes have been physically completed / foreclosed by the State Governments.

- **Dam Rehabilitation and Improvement Project (DRIP):** to address comprehensively various dam safety challenges in India, the Ministry of Jal Shakti initiated the World Bank assisted Dam Rehabilitation and Improvement Project (DRIP), in 2012, The initial project cost was INR 2,100 Cr. (Loan share: USD 279.3 M), which was revised to INR 3,466 Cr (Loan Share: USD 416 M) in 2018. Now revised budget outlay is INR 2,642 Cr after surrendering of loan amounting to USD101 during COVID19. In the year 2018, the Project was also extended by Govt of India and World Bank from June 2018 to June 2020. This timeline was further extended by nine months i.e., up to 31 March 2021, to compensate the loss of time due to COVID pandemic and also facilitate the partner agencies to complete the balanced rehabilitation activities. The cumulative expenditure as on 31 March 2021, is INR 2,525 Cr. The loan disbursed by World Bank (up to December 2020) is USD 293.42 M (93%) out of USD 315.3 Million.

- **Under Dam Safety Institutional Strengthening, achievements include the following:**
  a. Preparation of Tier-I Inundation mapping and Dam Break Analysis (197 dams).

b. Preparation of two dam-specific important protocols viz Operation and Maintenance Manuals (194 dams) as well as Emergency Action Plan (182 dams).
c. Stakeholder Consultation program (101 Nos).
d. Publication of 14 Guidelines and Manuals in various areas of dam safety.
e. 186 nos. customized training benefitting 5442 officials, along with capacity building of 8 Academic Institution and 2 Central Agencies.
f. Implementation of Dam Health and Rehabilitation Monitoring Application (DHARMA)-a web-based asset management tool in 18 States with 1100 users containing preliminary information of about 5,000 dams wherein health data in respect of about 1,500 dams have been entered: and
g. Organization of three (3) National and two (2) International Dam Safety Conferences with 2469 participants and 471 technical papers.

- **DRIP Phase II and Phase III** Based on the success of DRIP, the Ministry of Jal Shakti initiated another externally funded Scheme DRIP Phase II and Phase III. This new Scheme has nineteen (19) States, and three Central Agencies on board. The budget outlay is INR 10,211 Cr (Phase II: INR 5,107 Cr; Phase III: INR 5,104 Cr) with rehabilitation provision of 736 dams. The Scheme is of 10 years' duration, proposed to be implemented in two Phases, each of six years' duration with two years overlapping. Each Phase has external assistance of USD 500 M. The Union Cabinet has approved the Scheme on October 29, 2020.

- In July 2014, the Ministry was renamed as "Ministry of Water Resources, River Development & Ganga Rejuvenation". The following additional items of work have been assigned to the Ministry: -

a. National Ganga River Basin Authority including the Mission Directorate, National Mission for Clean Ganga, and other related matters of Ganga Rejuvenation.
b. Conservation, development, management, and abatement of pollution in river Ganga and its tributaries.

OBJECTIVE

This ministry has been formed with the primary objective of tackling India's persistent battle against mounting water challenges and water resource-related issues that the country has been facing over the past few decades. Initially, the ministry was created with the intention of cleaning up the Ganges River. It is now operating to include any regional or national conflicts between inter-state water sources and rivers that India and other neighboring countries share with each other. A special project called "Namami Gange" was initiated to clean up Ganga and its tributaries to provide safe drinking water for the region's citizens. The ministry has also initiated unique social media programs to raise awareness of water conservation among the citizens of the country. WAPCOS is an Indian multinational government undertaking and consultancy firm wholly owned by the Ministry of Jal Shakti, Government of India.

TABLE 9. BUDGETARY ALLOCATION FOR MINISTRY OF JAL SHAKTI

MINISTRY OF JAL SHAKTI	
Established in	May, 2019
Budget allocated for 2022-2023	INR 86,189 crore

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

ROLE OF MINISTRY OF JAL SHAKTI:

The Ministry of Water Resources is responsible for laying down policy guidelines and programs for the development and regulation of the country's water resources.

The Ministry has been allocated the following function: -

- Overall planning, policy formulation, coordination, and guidance in the water resources sector.
- Technical guidance, scrutiny, clearance, and monitoring of the irrigation, flood control, and multi-purpose projects (major/medium).
- General infrastructural, technical, and research support for development.
- Providing special Central Financial Assistance for specific projects and assistance in obtaining External Finance from World Bank and other agencies.
- Overall policy formulation, planning, and guidance in respect of Minor Irrigation and Command Area Development, administration and monitoring of the Centrally Sponsored Schemes, and promotion of Participatory Irrigation Management.
- Overall planning for the development of Ground Water Resources, the establishment of utilizable resources and formulation of policies for exploitation, overseeing of and support to State level activities in groundwater development.
- Formulation of national water development perspective and the determination of the water balance of different basins/sub-basins for consideration of possibilities of inter-basin transfers.
- Coordination, mediation, and facilitation in regard to the resolution of differences or disputes relating to Inter-State Rivers and in some instances overseeing of implementation of inter-state projects.

- Operation of the central network for flood forecasting and warning on inter-state rivers, provision of central assistance for some State Schemes in special cases, and preparation of flood control master plans for rivers Ganga and Brahmaputra.
- Talks and negotiations with neighboring countries, with regard to river waters, water resources development projects, and the operation of the Indus Water Treaty.
- Ensure effective abatement of pollution and rejuvenation of the river Ganga by adopting a river basin approach to promote inter-sectoral coordination for comprehensive planning and management.

BUDGETARY ALLOCATION

The Ministry of Jal Shakti is responsible for the development, maintenance, and efficient use of water resources in the country and for the coordination of drinking water and sanitation programs in rural areas. The Ministry was created in 2019 by integrating the Ministries of:

a) Water Resources, River Development, and Ganga Rejuvenation, and
b) Drinking Water and Sanitation

TABLE 10. ALLOCATION UNDER THE OBJECT HEAD GRANTS FOR THE CREATION OF CAPITAL ASSETS

(In INR Crores)

MINISTRY/ DEPARTMENT	2022-2023 BUDGET ESTIMATES
Ministry of Jal Shakti	**86,189.00**

a) Department of Water Resources, River Development, and Ganga Rejuvenation	***18,967.88***
b) Department of Drinking Water and Sanitation	***67,221.12***

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

TABLE 11. FURTHER ALLOCATION TO THE DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT, AND GANGA REJUVENATION

(In INR Crores)

PROJECTS/SCHEMES	2022-2023 BUDGET ESTIMATES
a) Major Irrigation Projects	***210.98***
b) Namami Gange Mission-II	***2,800.00***
c) River Basin Management	***97.00***
d) Water Resources Management	***2,112.88***
e) Pradhan Mantri Krishi Sinchai Yojna	***10,954.44***

f) Others	***2792.58***
<u>TOTAL</u>	**<u>18967.88</u>**

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

TABLE 12. FURTHER ALLOCATION TO THE DEPARTMENT OF DRINKING WATER AND SANITATION

(In INR Crores)

SCHEMES	BUDGET 2022-2023 (INR CRORE)
Jal Jeevan Mission (JJM) / National Rural Drinking Water Mission	**60,000**
Swachh Bharat Mission (Gramin)	**7,192**
Others	**29**
<u>Total</u>	**<u>67,221</u>**

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

The work assigned to the Department of Water Resources, River Development, and Ganga Rejuvenation:

A. GENERAL

a) Development, conservation, and management of water as a national resource; overall national perspective of water planning and coordination in relation to diverse uses of water and interlinking of rivers.

b) National Water Resources Council.

c) General Policy, technical assistance, research and development training, and all matters relating to irrigation, including multi-purpose, major, medium, minor, and emergency irrigation works; hydraulic structures for navigation and hydro-power; tube wells and groundwater exploration and exploitation; protection and preservation of groundwater resources; conjunctive use of surface and groundwater, irrigation for agricultural purposes, water management, command area development; management of reservoirs and reservoir sedimentation; flood (control) management, drainage, drought proofing, water logging, and sea erosion problems; dam safety;

d) Regulation and development of Inter-State rivers and river valleys. Implementation of Awards of Tribunals through Schemes, River Boards.

e) Water laws, legislation.

f) Water quality assessment.

g) Cadre control and management of the Central Water Engineering Services (Group A).

h) Conservation, development, management, and abatement of pollution of rivers.

B. INTERNATIONAL ASPECTS

a) International organizations, commissions, and conferences relating to water resources development and management, drainage, and flood control.
b) International Water Law.
c) Matters relating to rivers common to India and neighboring countries; the Joint Rivers Commission with Bangladesh, the Indus Waters Treaty 1960; the Permanent Indus Commission.
d) Bilateral and external assistance and cooperation programs in the field of water resources development.

Presently, the following Attached & Subordinate Offices, Statutory Bodies, Registered Societies, and Public Sector Undertakings are working under the control of the Department of Water Resources, RD & GR: -

Attached Offices

1. Central Water Commission (CWC)
2. Central Soil & Materials Research Station (CSMRS)

Subordinate Offices

3. Central Ground Water Board (CGWB)
4. Central Ground Water Authority (CGWA)
5. Central Water & Power Research Station (CWPRS)
6. Bansagar Control Board (BCB)
7. Ganga Flood Control Commission (GFCC)

8. Farakka Barrage Project (FBP)
9. Farakka Barrage Project Control Board
10. Sardar Sarovar Construction Advisory Committee
11. Upper Yamuna River Board (UYRB)
12. National Water Information Centre (NWIC)

Statutory Bodies

13. Tungabhadra Board (TB)
14. Betwa River Board (BRB)
15. Brahmaputra Board (BB)
16. Godavari River Management Board (GRMB)
17. Krishna River Management Board (KRMB)

Corporate Bodies

18. Narmada Control Authority (NCA)
19. Cauvery Water Management Authority

Registered Societies/ Autonomous Bodies

20. National Water Development Agency (NWDA)
21. National Institute of Hydrology (NIH)
22. North Eastern Regional Institute of Water and Land Management (NERIWALM)

23. National Mission for Clean Ganga (NMCG)
24. National River Conservation Directorate
25. National Water Informatics Centre (NWIC).
26. Polavaram Project Authority (PPA)

Public Sector Undertakings

27. National Projects Construction Corporation Limited (NPCC Ltd.)
28. Water & Power Consultancy Services Limited (WAPCOS Ltd.)

Various Programs and Schemes under the Ministry of Jal Shakti

- Ganga Rejuvenation
- Interlinking of Rivers
- CADWM program
- Flood Management Wing Program
- R and D Programme in Water Sector
- Dam Rehabilitation and Improvement Programme
- PMKSY - Pradhan Mantri Krishi Sinchayee Yojna
- HRD / Capacity Building
- Atal Bhujal Yojana
- National Hydrology Project
- Farakka Barrage Project

- Namami Gange
- Implementation of National Water Mission
- River Basin Management
- Flood Forecasting
- Development of Water Resources Information System
- Ground Water Management and Regulation
- Infrastructure Development
- Assistance for Sutlej Yamuna Link Canal Project
- Flood Management Programme
- River Management Activities and Works Related to Border Areas
- Minor Irrigation Census
- National Ground Water Management Improvement Scheme
- Pancheshwar Multipurpose Project
- Polavaram Project Authority
- National Water Framework Bill
- Policy on Sediment Management

6.6.2. KEY GOVERNMENT PLANS

TABLE 13. BUDGETARY ALLOCATION FOR KEY GOVERNMENT PLANS

SR.NO	SCHEME	LAUNCHED IN	BUDGET ALLOCATION
1	The Atal Mission for Rejuvenation And Urban Transformation 2.0 (AMRUT 2.0)	October, 2021	INR 2,99,000 crore (Budget allocation for five years)
2	Jal Jeevan Mission (JJM)- Har Ghar Jal	August, 2019	INR 3.60 lakh crore
3	Namami Gange Programme	June, 2014	INR 2,800 crore (Budget allocated in 2022-2023)
4	Swajal	February, 2018	INR 700 crore

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

TABLE 14. ABBREVIATIONS FOR KEY GOVERNMENT PLANS

Parameters	Description
A&OE	Administrative and Other Expenses
ACA	Admissible Central Assistance
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AMRUT 2.0	Atal Mission for Rejuvenation and Urban Transformation 2.0
ATR	Action Taken Report
CA	Central Assistance
CMMUs	City Mission Management Units
CPSU	Central Public Sector Undertaking
CSR	Corporate Social Responsibility
CWAP	City Water Action Plan

CWBP	City Water Balance Plans
DDP	Desert Development Programme
DPAP	Drought Prone Area Programme
DPR	Detailed Project Report
JE-AES	Japanese Encephalitis-Acute Encephalitis Syndrome
FHTC	Functional Household Tap Connection
GP	Gram Panchayat
HADP	Hill Area Development Programme
HRD	Human Resource Development
IEC	Information, Education and Communication
IMIS	Integrated Management Information System
INR	Indian rupee

IRMA	Independent Review and Monitoring Agency
IWMP	Watershed Management Programme
JJM	Jal Jeevan Mission
lpcd	liters per capita per day
M&E	Monitoring and Evaluation
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MIS	Management Information System
MLD	Million Liters per Day
MoF	Ministry of Finance
MoHUA	Ministry of Housing and Urban Affairs
MRTS	Mass Rapid Transit System
NCDWSQ	National Center for Drinking Water, Sanitation and Quality

NMCG	National Mission for Clean Ganga
NRDWP	National Rural Drinking Water Programme
NRDWP	National Rural Drinking Water Programme
PDMC	Project Development and Management Consultant
PFMS	Public Financial Management System
PIB	Press Information Bureau
PIU	Project Implementation Units
PMAY	Pradhan Mantri Awas Yojna
PMU	Project Management Unit
PPP	Public Private Partnership
R&D	Research and Development
RLB	Rural Local Bodies

SAGY	Sansad Aadarsh Gram Yojana
SBM	Swachh Bharat Mission
SC	Scheduled Caste
SHPSC	State High Powered Steering Committee
SMMU	State Mission Management Unit
SNA	Single Nodal Agency
ST	Scheduled Tribes
STP	Sewage Treatment Plant
SWAP	State Water Action Plan
UC	Utilization Certificate
ULB	Urban Local Body
UT	Union Territory

WQMS	Water Quality Monitoring System

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Ministry of Jal Shakti, Jal Jeevan Mission (JJM), National Mission for Clean Ganga, Press Information Bureau (PIB), Union Budget of India

6.6.3. THE ATAL MISSION FOR REJUVENATION AND URBAN TRANSFORMATION 2.0 (AMRUT 2.0)

On October 1, 2021, the Government of India launched the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0, as a continuation of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) launched in 2015 by the Ministry of Housing and Urban Affairs, with additional incorporation of the circular economy of water, through influencing water source conservation, rejuvenation of bodies of water and wells, recycling and reuse of treated used water, and rainwater harvesting, to make cities water secure and self-sustainable. It has introduced Pey Jal Survekshan as a challenge process under AMRUT 2.0 to assess the compliance of service level benchmarks with respect to the quality, quantity, and coverage of water supply in a city, with the first phase covering 500 cities. This will also evaluate the steps taken to reduce non-revenue water through water clusters, water body rejuvenation, and skill development. The extension of the project will include a robust technology-based portal that will be used to monitor the mission through geo-tags which have been installed at the project sites. Moreover, through the technology sub-mission, it will also bring in the world's leading technologies in the water sector since entrepreneurs and new businesses will be encouraged to participate and bring in reforms in the water ecosystem. The mission involves cities to monitor their assessment of water sources, consumption, future needs, and water losses through the use of a city water balance plan. A public information, education, and communication (IEC) campaign will also be launched to raise public awareness about the importance of water and the need for conservation. The results of the projects would be translated into effective city water action plans which will be compiled into the State Water Action Plan and approved by the Ministry of Housing and Urban Affairs.

The mission puts key emphasis on water demand management, water quality testing, and water infrastructure operations which will be handled by women Self-Help Groups (SHGs) to ensure recruitment of women and youth into the program to obtain crucial feedback on the progress. These women would be trained through a programme led by the Public Health Engineering Department (PHED) or water and sewerage boards, with oversight from the State's urban development department, to test water quality and develop detailed City Water Balance Plans (CWBPs) and City Water Action Plans (CWAPs) based on the prevailing situation. It proposes some key function outcomes which would be put special focus on during implementation. Providing universal piped water supply with household water tap connection is one component which is being worked on by ensuring freshwater treatment, proper water distribution systems in uncovered areas, augmentation of existing water distribution system, sustainability of quality and quantity of water supply, and reuse of treated used water, amongst other measures. Another crucial objective is providing universal sewerage and septage management coverage in the cities and promoting the circular economy of water which requires construction of necessary interception and diversion (I&D) infrastructure and sewage treatment plants (STPs), management of faecal sludge and septage, sewerage system provision and rehabilitation with end-to-end treatment and reuse, and identification of the bulk users of recycled used water to facilitating the sale of used water to potential users. Furthermore, rejuvenation of water bodies for supplementing water and increasing amenity value along with the development of green spaces is another fundamental intent the mission aims to achieve through desilting, embankment strengthening, and stone packing for revitalization of wetlands and water bodies, diversion of polluting drains to treatment plants, strengthening of aquifers and community wells, and creation and better facilitation of storm water drains around water bodies.

The operation also includes an Urban Aquifer Management Plan (UAMP) which prioritizes the preservation of positive groundwater balance in urban aquifer systems. The development of this roadmap will ensure that cities strategize groundwater recharge augmentation for improving rainwater harvesting within city limits. Moreover, it encourages cities to map aquifers in order to identify recharge and discharge zones and integrate aquifer management into urban planning to further create an annual groundwater balance report to determine current and future groundwater availability. UAMP also aligns with the aim to make every city achieve universal coverage and become water secure. Another crucial objective is reduction of non-revenue water, which is the water lost before reaching the end user, to less than 20%. This can be accomplished by regularizing illegal connections and reducing pipe damage leakage in the distribution system through timely detection and resolution of complaints. Furthermore, measuring stations at the source, storage, and distribution have evaluation criteria which have to be adhered to for every metered connection. A proactive approach is being undertaken to train plumbers and infrastructure managers to ensure minimal disruptions and a functional and easy to use mobile application for pipe reporting is being developed. These proceedings will boost the operation of supply projects oriented towards 24x7 supply in the regions. The project puts emphasis on recycling of used treated water to meet at least 20% of total city water demand by following institutionalization mechanisms for checking the quality, treatment capacity of sewage treatment plants (STP), treated recycled water used, and sector specific percentage of recycled water usage. These steps propose a remarkable reduction in sewage and septage. It also targets water availability 24x7, with sufficient improvement in the quality to provide the option of drinking from the tap in designated wards. The continual supply will further be evaluated specifically for quality, accessibility, and availability of water to the citizens. The incentive-based reforms implemented for achieving the desired targets of restoration of urban water bodies, reduction of non-revenue water, installation of rainwater harvesting systems in all institutional buildings, and reuse of treated wastewater are expected to bolster the program’s progress by making the alternatives look more lucrative, encouraging wide adoption.

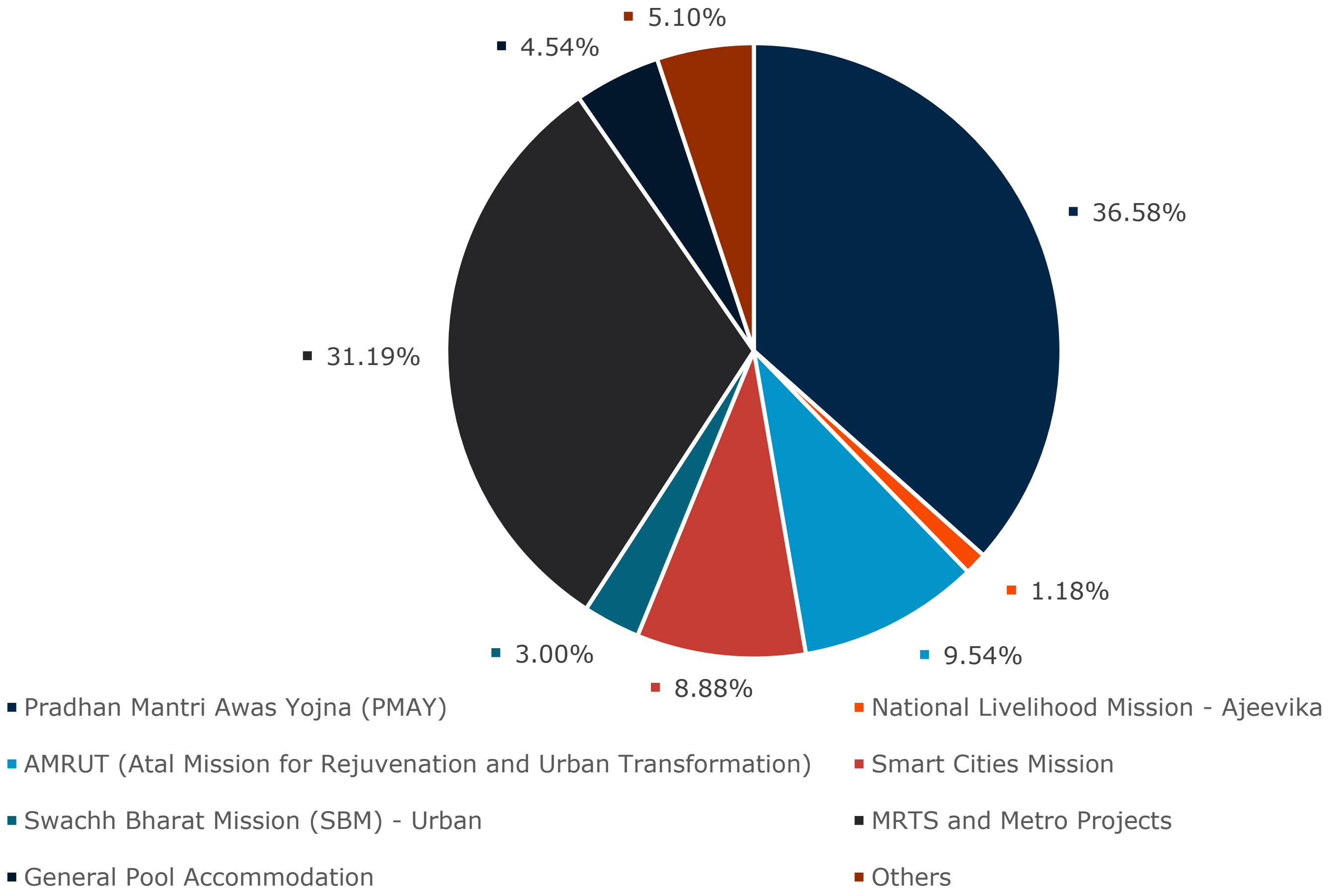
Governance reforms are an elementary part of the whole proceeding. They work towards easing the procedure of obtaining water and sewer connections simple for households by reducing the documents required and dropping the incurred costs. The Pey Jal Survekshan initiative will incentivise cities to keep improving and updating the existing system by fostering healthy competition between cities on the parameters of water supply management, innovative practices, compliance of water supply service level benchmarks, reduction in non-revenue water, operational efficiency of sewage and water treatment plants, rejuvenation of water bodies and wells, and evaluation of collection, treatment, and reuse of treated used water. Frequent feedback collection from citizens and municipal officials, and laboratory testing of water samples will ensure effectiveness of the initiative. Furthermore, it supports developing synergies between the rural and urban regions for better project facilitation. The co-treatment of sewage from villages close to each other in excess capacity would be investigated for installation of STPs to improve water security in rural regions and speed up the reutilization of treated water. It further extends to establish urban-urban synergies to make the procedure viable for the urban local bodies (ULBs) which have populations of less than 10,000 people. Water supply projects for such ULBs are made techno economically sustainable by forming clusters of adjacent ULBs, which share a common intake line from a distant water source, which makes accomplishing the sustained water supply initiative more feasible and financially practical. A capacity building convergence between urban and rural areas is also widely encouraged in the mission.

AMRUT 2.0 recognises the importance of wells and aquifers, owing to the heavy reliance of the urban population on these systems. It intends to prioritize urban aquifer system management in its pursuit of water-secure cities by developing sound groundwater resource management strategies, with a particular emphasis on groundwater dependence, key characteristics of the city's aquifer systems and the availability of recharge potential within city limits. Moreover, it promotes and encourages citizen participation in groundwater management in cities. The urban local bodies would be required to enhance their technical capacities to facilitate a scientific approach to groundwater aquifer system management and would be responsible for monitoring groundwater usage, identifying aquifer potential, and identifying recharge opportunities. The mission essentially plans to develop protocols for running a scientific routine around data collection on groundwater resources to aid in the development and refinement of an aquifer management plan. It intends to start a behavioural change communication (BCC) through information dissipation, education, and persuasion of people to raise awareness about water conservation practises, municipal services such as the new water connection, optimal water usage and waste reduction, and established markets for treated used water in rural and peri-urban areas. Additionally, it will instil a sense of ownership of water supply infrastructure in citizens to encourage proper conduction of the proposed measures. It is an effective approach applied to improve water quality, ensure a constant water supply, provide sewerage facilities and septage management, install effective drainage systems to reduce flooding, and enhancing city amenity value by creating and upgrading green spaces to enhance the living conditions and extend basic requirements to households in the AMRUT cities which will show progress in terms of water security and improve the quality of life for all urban dwellers, especially the poor and the disadvantaged.

6.6.3.1. BUDGETARY ALLOCATION FOR AMRUT 2.0

The Ministry of Housing and Urban Affairs is engaged in policy developments, manages the operations of numerous organisations at the state and municipal level, and oversees programmes for urban development. Additionally, it offers financial support to states and urban local bodies (ULBs) through a number of centrally backed programmes. The total expenditure of Ministry of Housing and Urban Affairs' projected budget for 2022–2023 is estimated to be **INR 76,549 crore**. Various centrally sponsored schemes, and a few central sector schemes are being carried out by the Ministry. Some of these include Pradhan Mantri Awas Yojna (PMAY), National Livelihood Mission – Ajeevika, AMRUT (Atal Mission for Rejuvenation and Urban Transformation), Smart Cities Mission, Swachh Bharat Mission (SBM) – Urban, Mass Rapid Transit System (MRTS), and Metro Projects and General Pool Accommodation, among others.

FIGURE 62. BUDGETARY ALLOCATION FOR MINISTRY OF HOUSING AND URBAN AFFAIRS FOR 2022-2023



Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

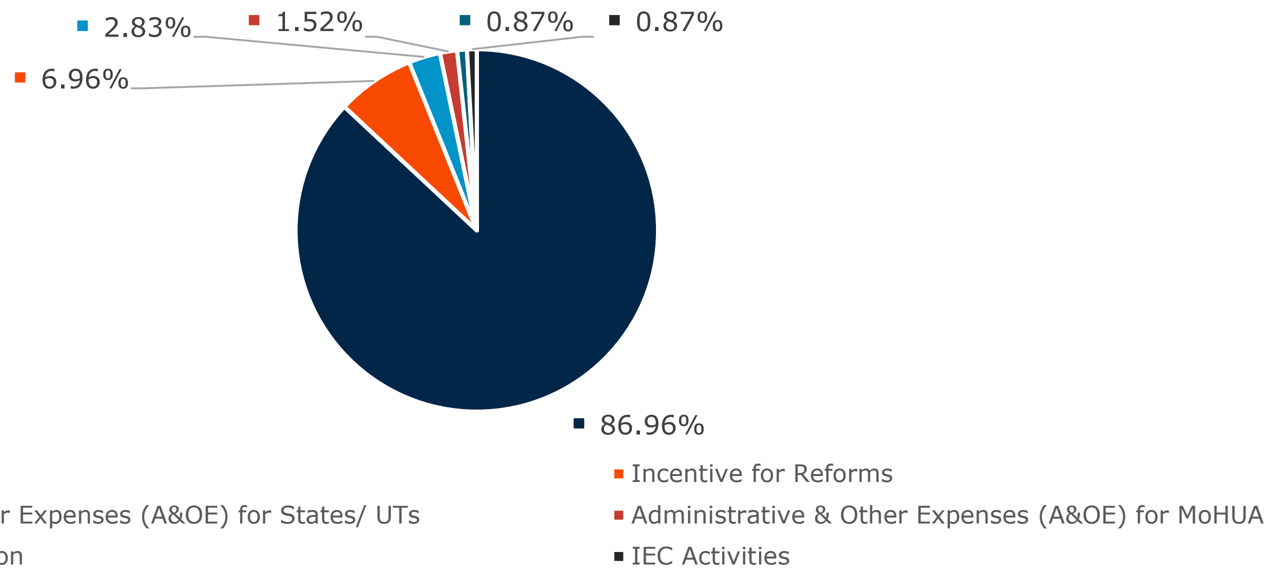
TABLE 15. BUDGETARY ALLOCATION FOR MINISTRY OF HOUSING AND URBAN AFFAIRS FOR 2022-2023

SR.NO	SCHEMES	BUDGET 2022-2023 (INR CRORE)	SHARE IN %
1	Pradhan Mantri Awas Yojna (PMAY)	28,000	36.58%
2	National Livelihood Mission - Ajeevika	900	1.18%
3	AMRUT (Atal Mission for Rejuvenation and Urban Transformation)	7,300	9.54%
4	Smart Cities Mission	6,800	8.88%
5	Swachh Bharat Mission (SBM) - Urban	2,300	3.00%
6	MRTS and Metro Projects	23,875	31.19%
7	General Pool Accommodation	3,474.01	4.54%
8	Others	3,900.45	5.10%
Total		**76,549.46**	**100%**

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

The total outlay for the AMRUT 2.0 is **INR 2,99,000 crore**. This budget allocation includes **INR 22,000 crore** for the ongoing AMRUT Mission for two years from FY 2021-22 to FY 2022-23 and the rest of amount would be utilized for five years. In this budget the central share is of **INR 86,760 crore** which comprises of **INR 10,000 crore** for AMRUT projects. The ongoing projects of AMRUT would be funded up to 31st March 2023 by the central assistance. Some of the major components of AMRUT 2.0 consists of projects, administrative & other expenses (A&OE), reforms, technology sub-mission, information, education and communication (IEC), Pey Jal Survekshan, community participation with focus on woman self- help groups, outcome-based funding, evidence based evaluation and public private partnership.

FIGURE 63. THE CENTRAL BUDGETARY ALLOCATION FOR VARIOUS MISSION COMPONENTS



Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

TABLE 16. THE CENTRAL BUDGETARY ALLOCATION FOR VARIOUS MISSION COMPONENTS

SR.NO	MISSION COMPONENT	CENTRAL ALLOCATION (INR CRORE)	SHARE IN %
1	Projects	66,750	86.96%
2	Incentive for Reforms (8% of project CA allocation)	5,340	6.96%
3	Administrative & Other Expenses (A&OE) for States/ UTs (3.25% of project CA allocation)	2,169	2.83%
4	Administrative & Other Expenses (A&OE) for MoHUA (1.75% of project CA allocation)	1,168	1.52%
5	Technology Sub-Mission (1% of project CA allocation	667	0.87%
6	IEC Activities (1% of project CA allocation)	667	0.87%

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

Under the AMRUT the approved plan size for Union Territory (UT) of Puducherry is of **INR 64.91 crore** that is entirely funded by the Central share through the entire mission period. Through the AMRUT scheme a total three cities of UT of Puducherry are being covered. Thus, for the project implementation **INR 44.09 crore** have been releases over which Utilization Certificates (UCs) being received is of **INR 32.68 crore**. For the UT of Puducherry 24 project of worth **INR 60.52 crore** have been assigned through the AMRUT initiative in which 15 projects of **INR 19.41 crore** had been completed, 6 projects are under implementation of **INR 25.03 crore** and 3 projects are being under tendering that worth of **INR 16.08 crore**. Hereby, the work of **INR 36.65 crore** is physically completed for this UT of Puducherry.

TABLE 17. STATE-WISE CENTRAL FUND ALLOCATION UNDER AMRUT - 2.0 (INR CRORE)

STATE/UT	CENTRAL FUND ALLOCATION FOR PROJECTS	CENTRAL FUND ALLOCATION FOR A&OE (ADMINISTRATIVE & OTHER EXPENSES)
Andaman and Nicobar Islands	35	1.14
Andhra Pradesh	3,158	102.62
Arunachal Pradesh	225	7.31
Assam	770	25.02
Bihar	2,620	85.14
Chandigarh	170	5.52
Chhattisgarh	1,294	42.05
Dadra - Nagar Haveli & Daman – Diu	30	0.97

Delhi	2,880	93.58
Goa	85	2.76
Gujarat	4,500	146.22
Haryana	1,494	48.55
Himachal Pradesh	252	8.19
Jammu and Kashmir	856	27.82
Jharkhand	1,178	38.28
Karnataka	4,615	149.96
Kerala	1,372	44.58
Ladakh	124	4.03
Lakshadweep	2	0.06
Madhya Pradesh	4,045	131.44

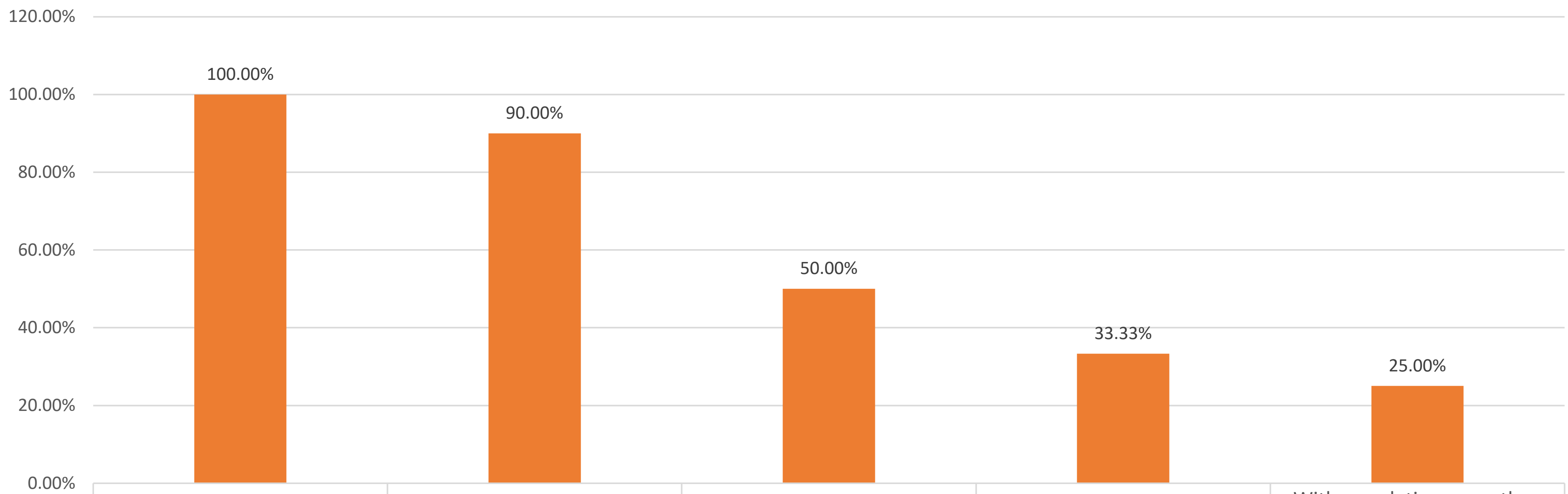
Maharashtra	9,285	301.71
Manipur	169	5.49
Meghalaya	110	3.57
Mizoram	142	4.61
Nagaland	175	5.69
Odisha	1,363	44.29
Puducherry	150	4.87
Punjab	1,833	59.56
Rajasthan	3,530	114.71
Sikkim	40	1.30
Tamil Nadu	4,935	160.36
Telangana	2,780	90.33

Tripura	156	5.07
Uttar Pradesh	8,145	264.67
Uttarakhand	582	18.91
West Bengal	3,650	118.6
Grand Total	**66,750**	**2,169.00**

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

The Centre, States/ UTs and ULBs will share the funding for the projects.

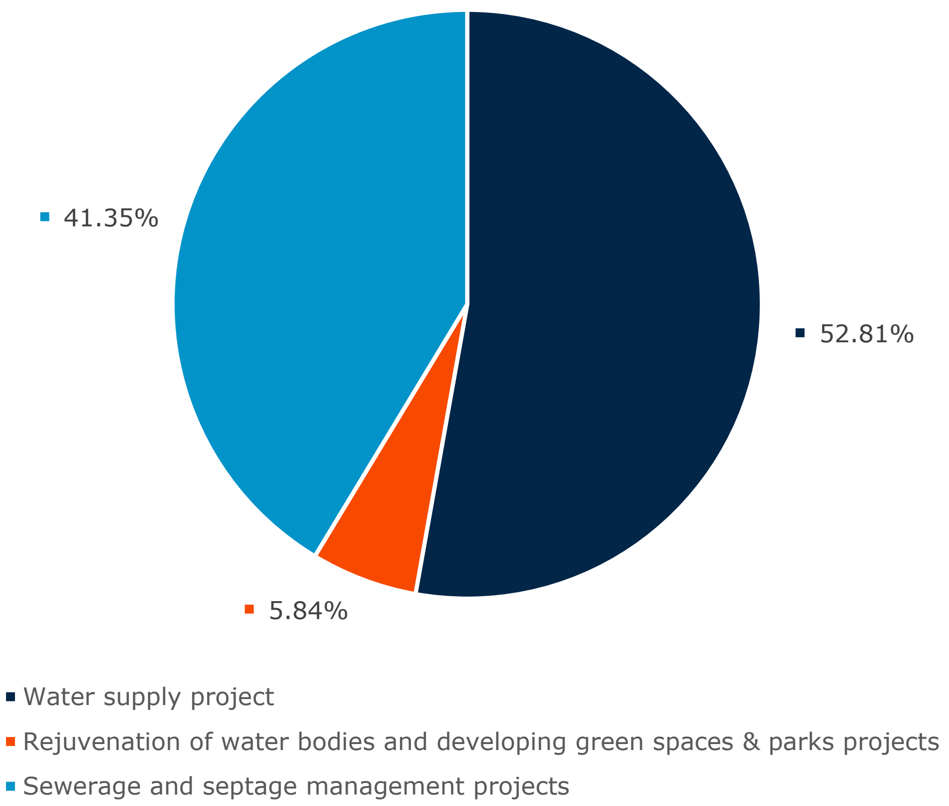
FIGURE 64. CENTRAL SHARE FOR VARIOUS CLASSES OF ULBS (URBAN LOCAL BODIES)



	Union Territories	North eastern States and Himalayan States	With less than one lakh population	With population one lakh to ten lakh (both included)	With population more than ten lakh (except for projects taken up under PPP mode)
Central share	100.00%	90.00%	50.00%	33.33%	25.00%

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

FIGURE 65. TENTATIVE DISTRIBUTION OF CENTRAL FUND ALLOCATION AMONG PROJECT COMPONENTS OF MISSION



Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

TABLE 18. TENTATIVE DISTRIBUTION OF CENTRAL FUND ALLOCATION AMONG PROJECT COMPONENTS OF MISSION

SR.NO	DESCRIPTION	CENTRAL SHARE (INR CRORE)	SHARE IN %
1	Water supply projects	35,250	52.81%
2	Rejuvenation of water bodies and developing green spaces & parks projects	3,900	5.84%
3	Sewerage and septage management projects	27,600	41.35%

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

If universal water supply is attained at the city level, then other components that are acceptable can be utilized to accomplish mission goals. As top priority, the State Mission Directorate needs to ensure that all cities have access to universal water supply and sewage/sewage treatment.

➢ **Release of Funds**

1. General conditions for release of project funds

- The central assistance would be conducted through online claims and settlement system that would be developed from the actual progress, which is updated on portal through various parameters including, physical/ financial data, videos and photos that can be collected through third-party assessment and citizen feedback.

- In this mission the fund flow would be followed by the instructions provided by the Ministry of Finance OM No. F. No. 1(13) PFMS |FCD/2020, dated 23 March 2021.
- The central fund that is being allocated to the States/UTs for project would be performed by distributing entire central project funds which is of **INR 66,750 crore** among these States/UTs in which weightage will be given to the urban population and area of States/ UTs in ratio 90:10.
- Through the AMRUT 2.0 states need to ensure that the further allocation to the cities must be in-line with accomplishing for all ULBs with universal coverage of water supply and universal coverage of sewerage/ septage management in 500 AMRUT cities. In the case where if city has already obtained universal coverage of water and sewerage then it will be considered into City Water Balance Plans (CWBP) and through AMRUT 2.0 further initiatives can be taken for enhancing the city water secure. Whereas the city in which the supposed outcomes are fulfilled by any other funding sources rather than AMRUT 2.0, that must be distinctly stated in the format offered for the same purpose in City Water Action Plan (CWAP).
- The functional outcomes that are being obtained above the baselines such as, 1st of November 2021 that are being funded by the other sources rather AMRUT/AMRUT 2.0 would also get grant of funding. These other sources may include, State Funds, XV Finance Commission grants, ULB funds and funds offered by the external agencies.
- On the basis of total amount of State Water Action Plan (SWAPs) submitted and the application proportion for the category of the State/City the Admissible Central Assistance (ACA) will be determined.
- The total project fund release through all the instalments to a State/ UT would not surpass the central fund allocation.
- For specific tranche of State Water Action Plan (SWAP), the Central Assistance (CA) released would be used for the employment of the permitted projects of another tranche. As per physical/ financial progress of the projects States/ UTs may use CA for projects in any of the ULBs.

2. Release of project funds (other than PPP)

The Central Assistance (CA) for the States/ UTs can be categorized into two components such as, Component-1 and Component-2.

- **Component-1**

Component-1 consists of CA for projects that are granted through State Water Action Plan (SWAPs) that can be offered in three instalments of 20:40:40.

- **First instalment under component 1**

This would count for 20 percent of CA admissible over the SWAP provided by the State/ UT and which is also approved the Apex Committee.

This can be claimed into three almost equal tranches over the submission and approval of individual tranches of SWAP.

- **Second Instalment under component 1**

It would count for 40 percent of total CA for the State/UT.

The projects under the AMRUT 2.0 that are being awarded contracts would be authorized for the consideration for release of second instalment.

For the working out instalment, the approved cost of projects is considered as basis. This cost may be lesser than appraised cost and contract award cost.

The following factors need to be gained before claiming second instalment:

- The projects that have been gained 15 percent physical and financial progress would be applicable for the second instalment. And the work for the project needs to be initiated on site.
- For the submission of City Aquifer Management Plan, the criteria for the states would be minimum 20 percent AMRUT cities of that state with first tranche of SWAP, 30 percent AMRUT cities with second tranche and rest 50 percent AMRUT cities with third tranche of SWAP. The states that have less than ten AMRUT cities need to provide City Aquifer Management Plan with third tranche.
- Need to submit Utilization Certificate (UC) of Administrative and Other Expenses (A&OE) grants and reform incentive.
- Need to submit IRMA's (Independent Review and Monitoring Agency) evaluation of AMRUT 2.0 that need to be appointed by Ministry of Housing and Urban Affairs (MoHUA) and State/ UT need to submit Action Taken Report (ATR) and IRMA’s compliance report.
- Consideration of citizen feedback.

- **Third instalment under component 1**

Third instalment under component-1 would count for 40 percent of admissible central assistance (ACA) to the State/UT which can be completely released after the expected functional outcomes achieved through AMRUT 2.0 projects.

TABLE 19. THIRD INSTALMENT UNDER COMPONENT-1

SR.NO	OUTCOME	FORMULA FOR WORKING OUT 3RD INSTALMENT
1	Tap connections (both new and serviced through augmentation)	(0.4) X (ACA for water supply projects) X (WA/ WT)
2	Sewer/ septage connection (both new and serviced through augmentation)	(0.4) X (ACA for sewerage/ septage projects) X (SA/ ST)
3	Water body rejuvenation projects	(0.4) X (ACA for Water body rejuvenation projects) X (WBA/ WBT)
4	Parks & green spaces	(0.4) X (ACA for Parks & green spaces projects) X (PA/ PT)

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

TABLE 20. DESCRIPTION OF TERMS IN THE ABOVE TABLE

SR.NO	OUTCOMES	ACHIEVEMENT THROUGH AMRUT 2.0	CUMULATIVE TARGET UNDER AMRUT 2.0
1	Number of new household water tap connections provided + number of tap connections serviced through augmentation + tap connections provided with 24x7 water supply as per real outcomes.	WA	WT

2	Number of new household sewer connections provided + sewer connections serviced through new sewerage network + households covered with septage management + households covered with tertiary treatment	SA	ST
3	Number of water body rejuvenation projects completed under AMRUT 2.0	WBA	WBT
4	Number of parks projects completed under AMRUT 2.0	PA	PT

Sources: Ministry of Housing and Urban Affairs (MoHUA), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Press Information Bureau (PIB), Union Budget of India

Sum of all above will be the admissible amount of third instalment. This is an illustration. Actual apportionment of third instalment for projects will be based on achievement of actual outcomes pertaining to those projects.

The admissible amount of third instalment would be sum of all above. This is only for illustration purpose, on the basis of actual results related to those initiatives, the third instalment's actual distribution will be determined.

Three authorized tranches of SWAPs may be used to claim the third instalment.

- **Component-2**

Each additional household water tap connection installed in ULBs above the baseline as of 1st November 2021 will get funding at a rate of **INR 3,000 (three thousand)**.

Also, financing will be paid at a rate of **INR 3,000 (three thousand)** for each new household sewer connection installed in all 500 AMRUT ULBs over the baseline as of 1st November 2021.

For the aforesaid funding, only new connections that are not supported by AMRUT and AMRUT 2.0 will be taken into consideration.

After the baseline is established, funds for these outcomes may be claimed once every three months in tranches.

After careful verification using citizen feedback and third-party sources, funds will be disbursed.

The State/ UT/ ULB need to utilize the funds that are being offered through component-2 on components of AMRUT 2.0 only.

3. Funds for projects implemented in PPP (Public Private Partnership) mode.

The State/ULB would create an adequate financial model and determine the viability gap for projects that are slated for implementation under the PPP model in cities having a population of more than ten lakhs. A project's overall viability gap cannot be greater than 60 percent of the total cost. The viability gap of 50 percent which is not exceeding over the 30 percent of project cost would be allowed to be funded as CA.

As with non-PPP projects, the CA developed for such projects will be made available in three instalments. Following the completion of the PPP project's financial model and DPR (Detailed Project Report) approval, the first instalment, of 20 percent of the allowable CA, will be released.

On reaching 15% of the project's physical and financial progress, a second instalment of 40 percent of the allowable CA for PPP projects will be released. When functional results are reached, the third instalment will be made available. The State/ULB will pay the annuity over the specified time period in accordance with the financial model. States may enable ULBs to establish escrow accounts for assuring smooth fund flow in order to boost confidence in PPP contracts.

4. Administrative and Other Expenses (A&OE) for States & MoHUA

The States/UTs will receive 3.25 percent of the annual budget allotment. As per urban population and area in the ratio 90:10 of States/ UTs/ ULBs, the State A&OE funds will be distributed accordingly.

At the initial stage of the mission, the state will receive A&OE funds. The state will also receive some fundings for the set-up State Mission Management Units such as, Project Development and Management Consultant (PDMC). The state will receive INR 20 lakhs for each AMRUT City to enable ULBs for the preparation of City Water Balance Plans (CWBPs), which will be distributed to each AMRUT ULB based on their claim in SNA account, and INR 10 lakhs to the remaining ULBs. This further can also be utilized to create separate unit for the management of missions in ULBs. For initializing mission states need to take immediate initiatives to bring resources on board to aid the cities and parastatals.

The states and UTs need to submit A&OE action plan along with SWAPs. here will be two instalments of the annual A&OE allocation given to a State or ULB. Following receipt of the A&OE action plan, the first instalment for the first year will be released. Upon receipt of online claims and UC worth at least 75 percent of the central aid already issued, the second instalment will be made available. In the following years, the first instalment will be issued on receipt of action plan and UC count of 75 percent for the previous yearly A&OE fund issued. The amount of eligible A&OE funding will be limited based on the proportion of actual spending.

The state A&OE funds can be spent for several factors as mentioned below:

- Capacity building, preparation of CWBPs, Programme Management/ Implementation Unit (PMU/ PIU)
- Project Development and Management Consultant (PDMC), State Mission Management Unit (SMMU)
- City or City cluster Mission Management Unit (CMMU)
- Preparation of Detailed Project Reports (DPRs)
- Publications like e-Newsletter, guidelines, brochures etc., promotional activities for Mission
- Display of the logo and tagline of AMRUT 2.0 prominently on all projects
- Reform implementation

The North-Eastern and Himalayan States would require additional handholding for effective project execution owing to smaller size and lower number of ULBs. MoHUA may send out extra support/ experts/ institutions upon written request to enhance capabilities. In the PDMCs/PMUs, representatives from local technical institutions, universities and colleges may be employed.

Hydrogeologists and data analysts can also be part of Mission management units at the State, regional, and city levels along with water sector experts. If there is need for model guidance document for hiring of these members, then that will be provided by the MoHUA.

At the National Mission Directorate level, the A&OE funds for MoHUA will be used for the following:

- Capacity building
- Convening national & regional workshops,
- Conferring awards and recognition, up-scaling and replication of best practices & smart solutions
- Commissioning of research and applied studies through Center of Excellence and other institutions
- Independent Review and Monitoring Agency (IRMA) to be positioned at State/ Substate/ regional level.

- Feedback using gig economy model.
- International cooperation for capacity building and technology development, among others.
- Pey Jal Survekshan components

The indicative list of inadmissible components under A&OE includes:

- Purchase of land for projects or project related works
- Regular staff salaries of State Governments/ULBs
- Any other purpose not oriented towards achieving Mission objectives

5. Reform incentives

For reform incentive the total fund of **INR 5,340 crore** has been set aside. The States/UTs will receive reform incentive of 8 percent of the annual budget each year for accomplishment of Reforms from second year of mission onwards. Incentives for reforms carried out in a year are given in the next fiscal year. Along with SWAPs, States/UTs need to submit a reform roadmap.

A marking system toolkit will be released prior to the start of the fiscal year. This toolkit will comprise of description of the process for evaluating reforms and creating incentives for the States and UTs.

In-line with accomplishing of mission objectives as an untied fund, the incentive may be utilized in mission cities on AMRUT 2.0 components that are admissible. The utilization of incentive amount will be determined by the State High Power Steering Committee (SHPSC).

As per Ministry of Finance requirements (MoF), UCs against disbursed incentives need to be submitted on time. The funds which were not utilized will be transferred to the project fund each year.

6. Fund flow

For the submission of CWBPs there would be need of adopting Public Financial Management System recommended by the Ministry of Finance. According to the revised procedure for fund release outlined in Department of Expenditure (GoI)'s OM No. F. No. 1(13) PFMS |FCD/2020, dated 23rd March 2021, as updated from time to time all transactions to receive funds under AMRUT 2.0 must be made through Single Nodal Agency (SNA) by using EAT as applicable.

6.6.4. JAL JEEVAN MISSION- HAR GHAR JAL

The Jal Jeevan Mission (JJM) was initiated on August 15, 2019, by the Government of India with the intention to provide Functional Household Tap Connections (FHTC), which have access to safe and adequate drinking water, to every rural household in the country by 2024. The programme also includes mandatory source sustainability measures such as recharge and reuse through gray water management, water conservation, and rainwater harvesting to incorporate a community-based approach to water, accounting for expansive knowledge, education, and communication as vital components. JJM hopes to establish water as a priority for everyone. The vision of the program is bringing in improvement in rural communities' living standards by assuring every rural household to receive adequate quantities of drinking water of prescribed quality on a daily basis for an extended time period at affordable service delivery charges. It is focused on assisting, empowering, and facilitating states and union territories to develop a participatory rural water supply strategy to ensure long-term potable drinking water security for every rural household and public institution, such as gram panchayat buildings, government schools in villages, Anganwadi centers, health centers, wellness centers, and other government establishments.

Moreover, it will assist in the construction of the necessary water supply infrastructure required for development of functional tap connections for sufficient water supply to households on a regular basis to fulfil the plan's objectives. The gram panchayats and the local rural communities will be responsible for planning, implementing, managing, owning, operating, and maintaining the in-village water supply systems for their corresponding villages. It also empowers states and union territories to plan for drinking water security for a sustained usage for a longer time and promotes for the development of strong institutions focused on service delivery and financial sustainability in the sector. Furthermore, it plans on building stakeholder capacity and raising community awareness about the importance of water in improving quality of life to ensure a smooth operation.

The mission has put forth broad objectives as the foundation to ensure implementation of tap water connections, and a regular and long-term access to adequate and good quality drinking water. Its implementation was followed after the National Rural Drinking Water Programme reported, on March 31, 2019, only 18.33% households having tap water connections, signalling the dire need of an initiative to expand provisioning of tap water connections. It follows a holistic and integrative approach of involving the gram panchayat and its sub-committees along with the local community and stakeholders in the critical steps of planning, implementation, management, operation, and maintenance of water supply within villages by effectively recognising the lack of reach of the state government department to the bottommost level for management of water supply to every household, making it more inclusive of the community with better recognition of problems are potential solutions existing on ground. Moreover, it allows for the formation of a separate technical cadre for planning and implementation to ensure necessary involvement of the local community and the gram panchayat in operations and maintenance (O&M), cost recovery, and good governance to see the desired results. It plans on a community-led collaboration with states to be an effective strategy for achieving JJM objectives as communities can take up the onus of ensuring every rural household has FHTC delivering water at least 55 litres per capita per day, which has been set as the adequate minimum quantity required. Local action and inclusion of the state government as true facilitators will make the approach viable in the long-term.

Rural women and adolescent girls spend a significant amount of time and energy in obtaining water for daily use which results in their lesser participation in income-generating activities, gender discriminated school enrolment ratios, and poor health. The plan identifies these issues and targets to have a multitude of impacts which will play an important role in bringing ease of living to the rural community, particularly women. It promotes women to lead with the initiative in their villages to better incorporate their problems and ensure equitable benefits are obtained. It has designed FHTC to be provided in every household with three delivery points through taps, including kitchen, washing and bathing area, and toilet, with only one tap funded, to keep water clean and prevent misuse. It has structured the rural water supply infrastructure built over the years to be dovetailed, retrofitted, and renovated to provide functional FHTCs. It has provisioned for the same local water source to be used in villages with sufficient groundwater availability of prescribed quality within the village boundary owing to the availability of technologies for providing safe water from contaminated groundwater sources with the government department. In villages with functional hand pumps, it allows for a depth deepening to meet the service delivery level and safeguard the basic water needs. On account of the development and increased application of new technologies, the mission stimulates exploration and prioritization of gravity and solar power-based water supply schemes with low O&M expenditure in tribal regions, and hilly and forested areas. Moreover, spring water is another reliable source of drinking water widely present in hills and mountains which will be optimally utilized with technological advancement for requirement fulfilment. The utilization of solar energy for water procurement in hot regions and deserts will also be surveyed with a possibility of technology intervention.

The plan also emphasizes on the specifics pertaining to each region, increasing outreach to more rural areas. It proposes the use of in-situ suitable treatment technology in villages with sufficient groundwater availability but quality issues. In villages which have water quality issues and a lack of suitable surface water sources in the nearby area, it recommends conjunctive use of multiple sources of water. Similarly, for villages in drought-prone areas, a combined implementation of multiple sources of water such as ponds, lakes, rivers, groundwater, supply from a long distance, rainwater harvesting, and artificial recharge will be considered. In water-scarce states with insufficient rainfall, it is developing regional water supply schemes covering both urban and rural areas by sourcing water from a single perennial source. Furthermore, it is working on planning a new water supply scheme in peri-urban sectors and large villages in water-scarce areas with a dual-piped water supply system, covering fresh water in one and treated wastewater in the other pipe in order to save precious fresh water. The wastewater pipe would contain treated water which will be suitable for non-potable needs, such as gardening, and use for toilet flushing and cleaning. The households will be prompted to use faucet aerators to save significant amounts of water within their homes, lessening the burden. It also mentions provisioning of potable water, on priority, in water quality-affected habitations, specifically with arsenic and fluoride contaminants to avoid poisoning. It accounts to the gradual and time-taking procedure of planning and implementation of a piped water supply scheme based on a safe water source and recommends establishing Community Water Purification Plants (CWPPs) as an interim measure to provide 8-10 LPCD potable water to meet the drinking and cooking needs of every household residing in such villages and habitations, keeping in mind the safety of the residents.

For source recharging it indents to adopt dedicated bore well recharge structures, and rainwater recharging systems, while focusing on rejuvenation of existing water bodies using watershed and springshed principles, in collaboration with other schemes such as MGNREGS, IWMP, Finance Commission grants, State schemes, MPLAD, and MLALAD, amongst others. In order to enhance recharging of aquifers, especially in arid and semi-arid areas, the state government will be required to strengthen and further extend existing canal networks to transfer surplus flood waters from dams and reservoirs to ponds, lakes, rivers and other water bodies which will refill groundwater and also prevent waterlogging during the monsoon season. Program arrangements will be made at all levels, with links and convergence with other organizations, such as the State Water and Sanitation Mission (SWSM), and the District Water and Sanitation Mission (DWSM) for superior outcomes. The collaborative approach will be included in the State Action Plan (SAP) and District Action Plan (DAP) to target long-term water security. These policies include an appropriate incentive and disincentive mechanism to discourage water waste while also meeting recurring expenditures on bulk water transfer, treatment, distribution network, and household level supply. Furthermore, the state government and UT Administration will assist the village level committee in making decisions on user charges for providing household connection as well as water supply by contemplating to achieve the lowest possible cost of water supply systems. The department monitors water quality through laboratory tests, while the community monitors water quality through Field Test Kits (FTKs) and sanitary inspection, ensuring proper sanitation guidelines are being followed. Provisioning of 24 X 7 water supply is the preference, but the mission provides states the ability to consult with Gram Panchayats for any requirement of individual household storage tanks. All efforts are anticipated to increase community ownership and trust and raise awareness about responsible use. The vision and impetus to this mission is assured availability of potable water, establishment of a functional household tap connection, increased participation by local communities especially women, in water ownership and resource management, improved water transfer and treatment, enhanced water distribution systems and a bottom-up approach to accomplish the desired objectives.

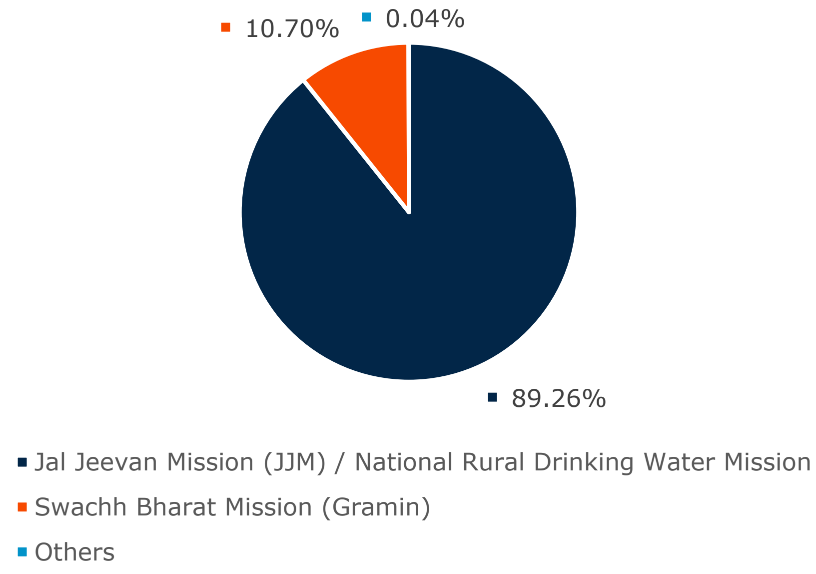
6.6.4.1. BUDGETARY ALLOCATION FOR JAL JEEVAN MISSION (JJM)-HAR GHAR JAL

The Department of Drinking Water and Sanitation was allocated for **INR 67,221 crore** in the 2022-2023 budget. This department mainly consists of Jal Jeevan Mission (JJM) / National Rural Drinking Water Mission and Swachh Bharat Mission (Gramin).

Since August 2019, the Indian government is engaged with States to implement Jal Jeevan Mission (JJM). The mission that aims to offer regular and long-term access to potable water to every rural household through a tap water connection at a service level of 55 liters per capita per day (lpcd), of the required quality (BIS:10500), by 2024. The anticipated outlay of the mission is of **INR 3.60 lakh crore** in which **INR 2.08 lakh crore** is of Central share.

More than **INR 40,000 crore** in grants have been given to States/ UTs for fiscal year 2021-2022 depending upon performance for offering of household tap water connections and using the available Central grant with a corresponding State share. The Central government has increased the budget for Jal Jeevan Mission to **INR 60,000 crore** for the fiscal year 2022-2023, highlighting the significance of the Har Ghar Jal' programme.

FIGURE 66. BUDGETARY ALLOCATION FOR DEPARTMENT OF DRINKING WATER AND SANITATION FOR 2022-2023



Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

TABLE 21. BUDGETARY ALLOCATION FOR DEPARTMENT OF DRINKING WATER AND SANITATION FOR 2022-2023

SCHEMES	BUDGET 2022-2023 (INR CRORE)	SHARE IN %
Jal Jeevan Mission (JJM) / National Rural Drinking Water Mission	60,000	89.26%
Swachh Bharat Mission (Gramin)	7,192	10.70%
Others	29	0.04%
Total	**67,221**	**100.00%**

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

TABLE 22. THE FUND DISTRIBUTION UNDER JAL JEEVAN MISSION (JJM) BETWEEN CENTRE AND STATES/ UTS

SR.NO	AREAS	FUND DISTRIBUTION
1	Union Territories without legislature	100%
2	North Eastern & Himalayan States and UTs with legislature	90:10
3	Rest of the States	50:50

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

TABLE 23. THE FUND DISTRIBUTION FOR SUPPORT AND WATER QUALITY MONITORING SYSTEM (WQMS) OPERATIONS

SR.NO	AREAS	FUND DISTRIBUTION
1	Union Territories	100%
2	Himalayan & North Eastern States	90%
3	Other States	60%

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

On the basis of balance households to be offered Functional Household Tap Connection (FHTCs) as per 'per household cost' for various scheme types, the fund requirement for capital expenditure for JJM would be determined. The balance households to be offered with FHTCs were chosen as per data provided by States on Integrated Management Information System (IMIS). For each household the average number of persons is considered as five. This was done solely to arrive at total outlay for the Jal Jeevan Mission and would not be utilized to approve schemes.

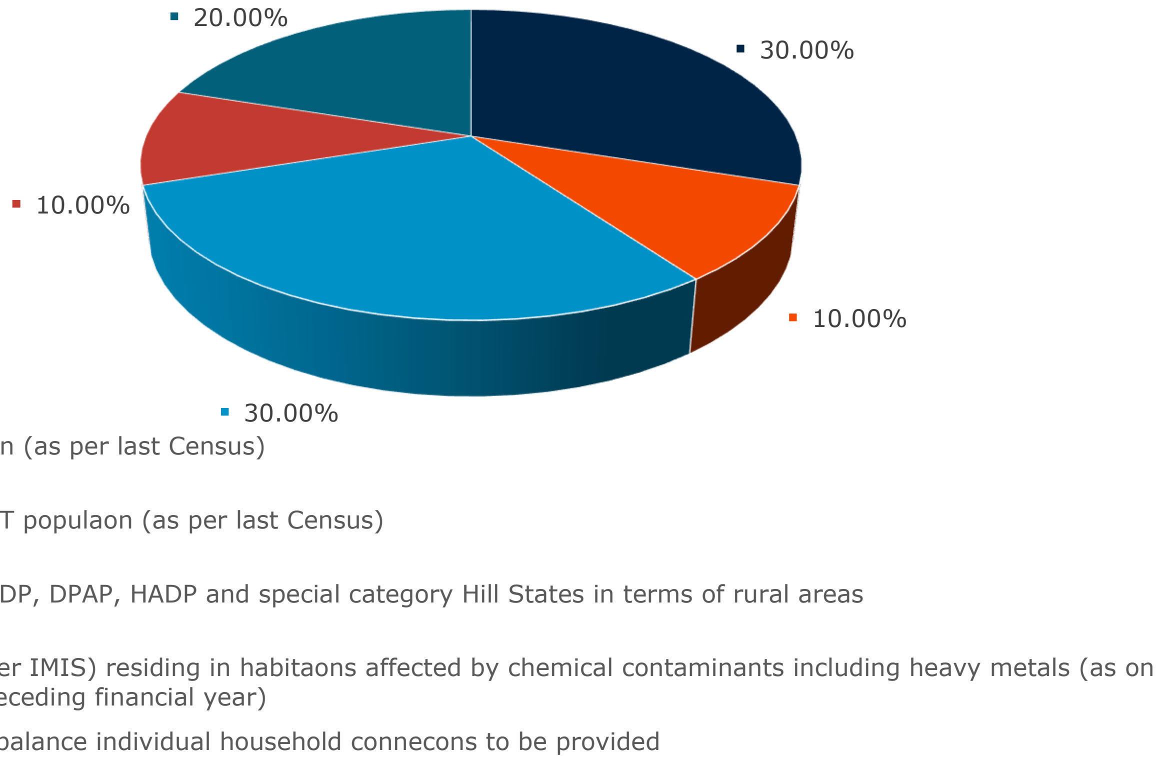
Through this mission, difficult terrains such as those covered by the Desert Development Programme (DDP) and the Drought Prone Area Programme (DPAP) are provided with 30 percentage of weightage, while population living in SC/ST dominated areas are offered with 10 percentage of weightage, aiding on prioritize coverage in these areas. Additionally, villages in drought-prone and desert areas, villages with a SC/ST majority, villages in Aspirational and JE-AES impacted districts, and Sansad Aadarsh Gram Yojana (SAGY) villages have been prioritized for tap water supply connections.

Furthermore, provisions have been made under JJM for pursing the augmentation and strengthening of local & ancient drinking water sources in convergence with other village-level schemes including, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), 15th Finance Commission tied grants to Rural Local Bodies (RLBs), District Mineral Development Fund, community contribution, Integrated Watershed Management Programme (IWMP) and CSR funds, among others.

Criteria for allocation of fund

For fund distribution under the Jal Jeevan Mission (JJM) there must need to follow certain criteria and weightage for both budgetary and extrabudgetary resources.

FIGURE 67. CRITERIA FOR ALLOCATION OF FUND



Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

Various sub-missions and sub-components which were part of erstwhile National Rural Drinking Water Programme (NRDWP) would also get funding. This projects also get up to 2 percent of Annual Allocation that would be set aside for the various activities at the Department/ National Mission level including, administrative and capital expenditure related to National Center for Drinking Water, Sanitation and Quality (NCDWSQ) and Department/ National Mission activities including, third party functionality assessment, program management unit (PMU), information, education and communication (IEC) & capacity building, research and development (R&D), workshops, conferences, centre of excellence, action research, professional services, human resource development (HRD), seminars, monitoring and evaluation (M&E), exhibitions and computerizing & management information system (MIS), among others.

TABLE 24. STATE-WISE DETAILS OF FUNDS ALLOCATED, RELEASED AND UTILIZED UNDER JJM IN FY 2021-22 (AS ON APRIL 4, 2022) IN INR CRORE

STATE	CENTRAL SHARE				STATE SHARE EXPENDITURE
	OPENING BALANCE	FUND ALLOCATION	FUND DRAWN	REPORTED EXPENDITURE	
Andaman & Nicobar Islands	0.52	8.26	2.06	1.01	0
Andhra Pradesh	146.65	3,182.88	791.06	230.21	228.57
Arunachal Pradesh	9.98	1,013.53	1,555.53	1,044.69	96.3
Assam	123.78	5,601.16	4,200.87	2,474.38	309.31
Bihar	58.95	6,608.25	0	4	340.45
Chhattisgarh	168.52	1,908.96	477.24	486.74	477.09

Dadra & Nagar Haveli and Daman & Diu	0	0	0	0	0
Goa	3.21	45.53	22.77	14.03	17.99
Gujarat	150.28	3,410.61	2,557.96	2,124.23	2,225.63
Haryana	32.24	1,119.95	559.98	258.41	252.43
Himachal Pradesh	226.42	1,262.78	2,012.78	1,420.05	146.73
Jammu & Kashmir	113.96	2,747.17	604.18	94.31	6.75
Jharkhand	137.93	2,479.88	512.22	382.89	451.88
Karnataka	177.16	5,008.80	2,504.40	1,390.35	1,512.03
Kerala	40.07	1,804.59	1,353.44	957.44	1,059.57
Ladakh	66.52	1,429.96	340.68	102.11	0
Madhya Pradesh	191.61	5,116.79	3,837.59	2,195.77	2,418.87
Maharashtra	268.99	7,064.41	1,666.64	354.66	451.72

Manipur	15.62	481.19	601.19	359.24	40.27
Meghalaya	15.06	678.39	1,078.39	667.64	76.06
Mizoram	27.17	303.89	303.89	250.98	32.31
Nagaland	28.52	444.81	333.61	345.14	27.88
Odisha	10.93	3,323.42	2,492.56	1,305.25	1,288.80
Puducherry	1.18	30.22	7.47	2.32	0.1
Punjab	110.36	1,656.39	402.24	244.5	158.62
Rajasthan	863.53	10,180.50	2,345.08	1,763.79	1,497.57
Sikkim	8.29	124.79	194.79	90.12	11.57
Tamil Nadu	377.48	3,691.21	614.35	436.8	473.82
Telangana	55.15	1,653.09	0	9.35	41.27
Tripura	61.51	614.09	714.09	599.82	65.13

Uttar Pradesh	466.56	10,870.50	5,435.25	2,930.07	3,525.40
Uttarakhand	111.22	1,443.80	1,082.85	594.09	66.96
West Bengal	757.58	6,998.97	1,404.61	1,523.90	710.62
Total	**4,826.95**	**92,308.77**	**40,009.77**	**24,658.29**	**18,011.70**

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

6.6.5. NAMAMI GANGE PROGRAMME

Namami Gange Programme is an integrated preservation program that was approved as a flagship programme in June 2014, by the Union Cabinet chaired by the Prime Minister to achieve the twin goals of conservation and restoration of the National River Ganga along with effective pollution abatement. It makes a transition to an integrated basin-based approach while continuing work on the principles set forth for cleaning of the river previously, including the GAP-I (Ganga Action Plan) of 1985, GAP-II (Ganga Action Plan) of 1993, NRCP (National River Conservation Plan) from 1995, and NGRBA (National Ganga River Basin Authority) formed in 2009. It is being implemented in a phased manner with divisions of entry-level activities for immediate visible impact, medium-term activities to be implemented within five years, and long-term activities to be implemented within 10 years. The initiative was implemented on account of the significant economic, environmental, and cultural value associated with the river Ganga, in India. Moreover, the river flows more than 2,500 kilometres through the plains of north and eastern India, and the Ganga basin accounts for 26% of India's landmass, making it a consequential component of the nation and a source of water for many citizens. The project covers 8 states, 47 towns, and 12 rivers, comprising the main river and its tributaries. Its elementary objectives include improving the quality of life of the people settled on the rivers' banks, setting up a river-centric urban planning process to improve citizen connections through interventions at Ghats and riverfronts, expansion of sewerage infrastructure coverage in 118 urban habitations along the Ganga's banks, creation of the Ganga Knowledge Center for increasing awareness of the people, development of efficient irrigation methods and rational agricultural practises, and making rural regions free of open defecation. The project was launched by the Water Resources Ministry in collaboration with several ministries, working on sustainable environments, urban development, shipping, tourism, and rural development.

It has identified municipal wastewater containing sewage, industrial pollution, solid waste and non-point sources, such as agricultural run-off, open defecation, pious refuse, partially cremated bodies, and associated materials, as the main contaminants of the river which are being effectively handled to achieve the desired results. The project has undertaken industrial sector development for pollution control. Common Effluent Treatment Plants (CETPs) have been provided to the tannery industries along the river bank to transition to cleaner processes and reduce water consumption. The paper and pulp sector have achieved advancements in process technology which has resulted in lower fresh water consumption and overall waste water discharge and a remarkable zero black liquor discharge. Additionally, in molasses-based distilleries, zero liquid discharge is obtained, making the industry cleaner. The switch to charter implementation in sugar production and process technology upgrades have resulted in lower fresh water consumption, effluent generation, and BOD load in sugar industries. Furthermore, the upgradation of the CETP system and the installation of flow meters at various unit processes has resulted in a reduction in the pollution load of textiles. Hybrid Annuity Models (HAM) have been introduced to incentivise quick construction of the required infrastructure for satisfactory performance of sewage infrastructure for longer time periods. To combat the problem of solid waste, the project is supporting Ghat Cleaning activities in cities along the bank of Ganga, including Haridwar, Bithoor, Kanpur, Prayagraj, Mathura, Vrindavan, and Varanasi. Furthermore, increased emphasis is being put on river surface cleaning with trash skimmers being deployed to clean the surface of Yamuna Stretch in Delhi. To accomplish rural sanitation, the initiative management is assisting the Department of Drinking Water and Sanitation in ensuring sanitation in Ganga villages. Growing awareness and stringent implementation has resulted in all 4465 Ganga bank villages being given the open defecation free (ODF) status.

The program plans to restore the wholesomeness of the river defined in terms of ensuring continuous flow termed as 'Aviral Dhara', unpolluted flow termed as 'Nirmal Dhara', geologic and ecological integrity termed as 'Jan Ganga' and climatic and spatial understanding termed as 'Gyan Ganga'. As a part of its Nirmal Dhara, it is working on building and improving sewerage infrastructure, inhibiting industrial pollution, wastewater reuse, rural sanitation recycling and solid waste management for availability of good quality water. Under the Aviral Dhara it is focused on wetland mapping and conservation, floodplain protection, sustainable agriculture, afforestation, biodiversity conservation and small river rejuvenation for achieving an uninterrupted flow in water bodies. As a part of Jan Ganga, it is developing riverfront, ghat and crematoriums, enhancing community engagement, organizing activities such as Ganga Run, Ganga Amantran (rafting expedition) and Ganga Utsav, and encouraging participation in the Ganga Quest quiz to increase awareness. Similarly, Gyan Ganga includes frequent water quality monitoring, high resolution mapping of Ganga using light detection and ranging (LiDAR), microbial diversity aquifer development, mapping and spring rejuvenation, cultural and climate scenario mapping, and urban river management planning. Continuous and sufficient presence of sediments, nutrients, and other natural constituents throughout the river network improves the natural flow cycle of rivers. Sustainable agriculture is critical for Ganga rejuvenation in order to achieve improved soil health and water efficiency. Moreover, it assists in lowering pollution, balancing ecological services, mitigating climate change and increasing crop productivity. This has led to the development of sustainable agri-scapes in the basin which promote organic and natural farming in the gram panchayats in the region. Wetland mapping and conservation is another significant step taken as a component of the mission to improve ground water recharging for sustained water utilization. It includes use of wetlands for recharging, establishment of a State Wetland Authority, and detailed conservation plans for states. For rejuvenation of small rivers, the program incorporates activities, in coordination with MNREGA, involving the revitalization of small rivers that are Ganga tributaries. A GIS-based inventory of all rivers and districts has been developed to gather relevant data and model the correct approach. The activities introduced include desilting of small kunds, ponds, and lakes, embankment construction, water harvesting system construction, preparation of storage structures, and afforestation, which will restore the natural river flow.

The community inclusive approach requires raising public awareness, promoting people-river connectivity, and large-scale participation and involvement of the community and common masses. State Mission for Clean Ganga has been initiated at the state level along with involvement of district specific committees, such as Ganga Vichar Manch, Ganga Task Force, National Cadet Corps, Ganga Mitras, and Ganga Bal Praharis, amongst many others, for effective execution of targeted knowledge dissemination. Moreover, the Clean Ganga Initiative has been introduced as a component to provide a unique platform for the general public to participate in the cause. Ganga Utsav, a diverse activity program engaging students and youth through cinemas, quiz, storytelling, games on ecological learnings, and group discussions is also organized each year in the month of November to celebrate declaration of Ganga as the national river and expand its outreach. Ganga Amantran is a 34-day river rafting expedition over the Ganga River from Devprayag to Gangasagar. It is one of the largest social outreach programmes through adventure sports, with the goal of connecting lakhs of people to the initiative.

Since its implementation it has achieved some key achievements such as an increase in sewage treatment capacity through the implementation of 54 sewage management projects in the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, West Bengal, Delhi, Himachal Pradesh, Haryana, and Rajasthan, and successful competition of 92 sewage projects. Under the river-front development program, it has initiated 67 Ghats and Crematoria projects along with the construction, modernization, and renovation of 265 existing kunds and ponds. Efforts have been undertaken for collection and disposal of floating solid waste from the surface of the ghats and rivers at 11 different locations in the country to accomplish the set goal for river surface cleaning. It has worked hard on its vision of restoration of viable populations of all endemic and endangered biodiversity of the river by maintaining the integrity of Ganga River ecosystems. Holistic conservation of the river also included afforestation as an important aspect owing to its utility in increasing the productivity and diversity of forests in headwater areas and all along the river and its tributaries. The program has also made a strong case for public outreach and community participation in the programme attributable to a series of activities conducted, such as events, workshops, seminars, and conferences, along with numerous information, education & communication (IEC) activities. Various awareness activities such as rallies, campaigns, exhibitions, shram daan, cleanliness drives, competitions, plantation drives, and the development and distribution of resource materials were organized alongside the mass media outreach goals involving TV advertisements, radio messages, print media advertisements, advertorials, and featured articles, published for wider publicity. Moreover, the Gange Theme Song was widely distributed and played on digital media to increase the program's visibility and the team ensured a presence on social media platforms such as Facebook, Twitter, and YouTube to effectively dissipate relevant information about the program which can be beneficial to the citizens. Effectual monitoring of industrial effluents was attained through regulation and enforcement which were carried out through regular and surprise inspections of Grossly Polluting Industries (GPIs) to ensure compliance with specified environmental norms and lower the degradation in the quality of water bodies. The Ministry of Drinking Water and Sanitation (MoDWS) identified 1674 Gram Panchayats on the Ganga's banks across five states and has completed more than half the targeted toilet unit constructions for obtaining the necessary sanitation levels. These measures are fulfilling the desired objectives and ameliorating the water quality of the river Ganga.

6.6.5.1. BUDGETARY ALLOCATION FOR NAMAMI GANGE PROGRAMME

In June 2014, the Government of India has initiated with Namami Gange Programme for the achieving dual objectives of effective pollution abatement, and conservation and rejuvenation of the National River Ganga and its tributaries. From the Financial Year 2020–21 to the Financial Year 2021–22 (up to January 31, 2022), the actual release of fund was **INR 2,250 crore** to the National Mission for Clean Ganga (NMCG). In which Releases/Disbursements by NMCG was of **INR 2,355.96 crore** up to January 31, 2022. In the fiscal year 2022-2023 the Indian government assigned estimated budget of **INR 2,800 crore** for the Namami Gange Mission II National Ganga Plan under the Department of Water Resources, River Development and Ganga Rejuvenation.

The State-wise and year-wise fund released/expended by NMCG to State Governments /State Programme Management Groups/Central Public Sector Undertakings (CPSUs)/ Other Executing Agencies from the financial year 2020-21 up to 31 January 2022 is as below in **INR crore.**

TABLE 25. THE STATE-WISE AND YEAR-WISE FUND RELEASED/EXPENDED BY NMCG

SR.NO	STATE	FY 2020-21	FY 2021-22*	TOTAL
1	Uttarakhand	124.82	143.42	268.24
2	Uttar Pradesh	472.46	331.98	804.44
3	Bihar	194.43	47.97	242.40
4	Jharkhand	28.03	2.59	30.62

5	West Bengal	105.06	72.87	177.93
6	Delhi	235.00	240.00	475.00
7	Urban Improvement Trust, Kota, Rajasthan	-	20.00	20.00
8	Irrigation & Public Health Department, Himachal Pradesh	1.25	2.50	3.75
9	NMCG's Expenditure including other Basin wide interventions	178.92	154.66	333.58
	Total	**1,339.97**	**1,015.99**	**2,355.96**

Sources: National Mission for Clean Ganga, Ministry of Jal Shakti, Press Information Bureau (PIB), Union Budget of India

Note: (* till 31 January 2022)

In total of 364 projects have been approved under Namami Gange Programme with an estimated cost of **INR 30,853 crore** among which 183 of those projects have been finished and put into service. Among these 363 projects, 160 projects are related to sewerage infrastructure projects have been taken on to create and rehabilitation of 5024 MLD of sewage treatment plant (STP) capacity and install 5227 km of sewage network. Among these 160 projects, 76 projects have been finished resulting in creation and rehabilitation of 1,079 MLD of STP capacity and installing 3860 km of sewerage network. The remaining projects are in varying stages of implementation. In addition, with main Ganga Stem, projects are being undertaken in 15 tributaries including, Yamuna, Saryu, Kali (West), Kali (East), Kosi, Ramganga, Gomti, Son, Banka, Hindon, Barakar, Rispana-Bindal, Damodar, Chambal, and Burhi Gandak.

TABLE 26. SANCTIONED PROJECTS, COSTS AND COMPLETION STATUS

SR.NO	TYPE OF PROJECT		NO OF PROJECTS SANCTIONED	TOTAL SANCTIONED COST (INR CRORE)	NO OF PROJECTS COMPLETED
1	Sewerage Projects	Uttarakhand	36	1,373.19	32
		Uttar Pradesh	53	10,563.17	29
		Bihar	30	5,530.65	5
		Jharkhand	3	217.17	1
		West Bengal	24	4,099.88	3
		Haryana	2	217.87	2
		Delhi	10	2,295.84	3
		Himachal Pradesh	1	11.57	1
		Rajasthan	1	258.48	0

	Total	160	24,567.82	76
2	Modular STP Decentralized	1	410	0
3	River front, Ghats and Crematoria	90	1553.33	66
4	Ghats Cleaning & River Surface Cleaning	5	85.16	1
5	Industrial Pollution Abatement	15	1,267.37	0
6	Afforestation and Biodiversity conservation	41	634.55	26
7	Rural Sanitation	1	1,421.26	0
8	Bioremediation	13	235.89	2
9	Ganga Knowledge & Monitoring Center	8	192.46	2
10	Composite Ecological Task Force and Ganga Mitra	5	199.29	3
11	R&D, Public Outreach & Support to District Ganga Committee	25	286.40	7

Grand Total	**364**	**30853.53**	**183**

Sources: National Mission for Clean Ganga, Ministry of Jal Shakti, Press Information Bureau (PIB), Union Budget of India

6.6.6. SWAJAL

Swajal is a demand-driven and community-centred pilot programme which has been launched with the aim to provide people in rural areas with sustainable access to drinking water with at least minimum quality standards, on a long-term basis to fulfil fundamental requirements of drinking, cooking and other basic domestic necessities. Under the National Rural Drinking Water Programme (NRDWP), it was proposed in the first phase to select pilot project districts in six states, which are Uttar Pradesh, Maharashtra, Uttarakhand, Madhya Pradesh, Rajasthan, and Bihar. The state government, in collaboration with rural communities, is intended to plan, design, build, operate and maintain the water supply and sanitation systems of their jurisdictions, ensuring that each rural household has safe drinking water. Moreover, the state government and its sector institutions serve as supporters, facilitators, and co-financiers of the project along with providing technical assistance, training and larger construction projects as needed. Its impact is anticipated to expand into a multitude of advantages in terms of health and hygiene. The demonstrated success of demand-driven reform in rural water supply and sanitation has contributed significantly to the replication of such models in other states. The formulation of the swajal project intends to amalgamate these models by presenting a central government level programme for mainstreaming the key principles countrywide. Observations from previous models and policy formulation based on demand-driven and community-centred principles have been incorporated into the initiative to ensure an effective result.

The approach involves a collaboration between village communities, local committees and NGOs, and the role of the government is as a facilitator and co-financer. Stakeholders are tasked with the responsibility to monitor transparency at each stage by adhering to the proposed guidelines to minimize the possibility of misappropriating and misusing funds. Panchayati Raj Institutions (PRIs) have been empowered to scale up the decentralized service delivery models for a viable and long-term output. The approach also marks a transition from a supply-based model to a demand-based model which demonstrates the need for a new mind-set and investment at various levels in order for the problems to be tackled through the new model. Furthermore, it ensures the implementation of a good facilitation model and appropriate techniques in the community management model, with external support for communities for long-term sustainability. The State Water and Sanitation Mission (SWSM) is the highest policy-making body for the Swajal Pilot Project with the Department of Drinking Water & Sanitation (DDWS) being responsible for implementing rural drinking water supply in the State and for collaborating effectively with sector stakeholders such as Health, Education, PRI, Rural Development, Panchayati Raj Institutions, and Watershed management. At the lower levels, District Water and Sanitation Mission (DWSMs) have been established in the pilot districts which facilitate the program and report to the SWSM. Their tasks involve reviewing the Swajal Pilot Project's implementation, guiding the DWSC in planning, designing, and implementing operations and maintenance of water supply schemes, approving the scheme's annual budget, channelling funds to gram panchayats and assisting them in scheme procurement and construction. At the lowest levels gram panchayats are responsible for ensuring a participatory approach and mobilizing and supporting the formation of Village Water and Sanitation Sub-Committees (VWSSC). The work involved will be mostly administrative such as raising awareness among the villagers about sanitation and hygiene through deliberation on technical construction alternatives and adoption of these measures to meet the expectations of the villagers. Furthermore, they will plan, design, implement, operate, and maintain water supply and sanitation schemes through collection of suitable user charges from drinking water scheme users.

Single-sector rural water supply and sanitation approach is adopted in the project attributable to those areas being the most water-scarce for each of the states, with the greatest demand for improved water supply. Moreover, the single-sector approach becomes especially relevant on account of appropriate sector policies and institutional rules supportive of a community-based, demand-responsive approach to water supply that were initially not in place. The Project Management Units (PMUs) have been established by certain state governments as a legally registered body under the Indian Societies Registration Act of 1860, for facilitation, coordination, and monitoring with a complete operational autonomy and flexibility. PMUs have a core multidisciplinary and gender-balanced team of experienced professionals and NGOs which has resulted in a cross-pollination of ideas, experiences, and attitudes for better results. The NGOs serve as a link between the PMU and the project village communities, assisting in policy planning to achieve the main outcomes of community mobilization through the use a specialized PRA-type tool for water and sanitation, SARAR (Self Esteem, Associative Strengths, Resourcefulness, Action Planning, Responsibility), initiatives for women's development, design of water supply and sanitation systems, and community's capital cost share collection. Furthermore, the incentive system at all levels, ensures effective functioning and reduces chances of corruption. The incentive structure includes a unique compensation package, contributing to the high level of motivation for PMU employees, and a secured source of funding for a water supply scheme for the community individuals.

The key objective of the project is to provide 117 aspirational districts, covered under Swajal, with decentralized and sustainable, preferably solar energy-based, piped water supply through a community-designed single village water supply scheme. It includes some mandatory schemes based on groundwater, the most commonly used source in rural areas, which have to be compiled by every district. It includes formulation of crucial infrastructure, including bore-well or tube well construction or improvement of a similar existing structure of required yield with proper casing, installation of a pump with the required capacity and a dry run sensor which controls the pump's operation, availability and installation of pipes of the necessary size and length, and delivery and distribution of standard quality water. Furthermore, a recharge structure is prepared alongside to ensure the sustainability of the source. Sufficient number of stand-posts are required to be installed along with a soak pit for each to ensure safe disposal of wastewater. The gram panchayats are encouraged to provide piped water supply to schools, anganwadis, hospitals, and other government establishments and establish the necessary infrastructure, such as multiple hand wash units. Owing to the wide utilization of groundwater, the program further mentions some optional elements such as a community water treatment unit which will address the issue of water quality through frequent testing of water sources, an online chlorination unit with the ability to disinfect water, an LED light powered by a battery charged by a solar panel for water drawl at night, and sensors with data logging capabilities to measure groundwater levels, discharge, and leakage. Surface water or springs are another commonly used water source with compulsory schemes of community consultation to identify a sustainable surface water source, certification of the source's sustainability by the Water Resources Department, infrastructure construction of intake structure and filtering arrangement, and installation of a pump with the required capacity and a dry run sensor, amongst others.

Information, education and communication are the three pillars being used to propel growth in the schemes. Artistic and creative mediums of workshops at each level, road shows, wall writings, slogans, and other activities, are being employed for an extensive campaign to raise awareness about the project's principles, objectives, scope, implementation, approach, roles, and responsibilities of all stakeholders. The campaign also emphasizes community involvement, social auditing, credit requirements for household connection, and meeting operational and maintenance costs to ensure transparency and knowledge of the progress by the locals. Moreover, it will collaborate with reputed institutions in various states, along with NGOs and key resource centers to undertake capacity building of stakeholders at various levels. The Ministry of Drinking Water and Sanitation (MoDWS) will also organize twinning training programmes for interstate cross learning to ensure an equitable growth across regions. Documents prepared by MoDWS on capacity building and training will be shared with states in order for them to build adequate capacity and align with the goals to achieve the set targets. Effective monitoring is essential for smoothly running the program. Dedicated dashboards linked to the MoDWS's Integrated

Management Information System (IMIS) would be set up for monitoring at the state level, with data loggers feeding the dashboard. Information delivery via mobile phone apps and SMS will enable community empowerment and wider accessibility. MoDWS also reviews the progress made at regular intervals using the monthly progress data feed into the system by the state authorities. Physical monitoring is also carried out through field visits, and third-party monitoring using national monitors.

As a consequence of the Swajal villages having their own water supply schemes, they are now embarking on other development projects which denote the expansive cycle of reforms it can bring. The program is building the pathway to achieve the objectives of water sustainability in rural regions by following a demand-driven approach with increasing community participation, women empowerment and involvement, setting up of Support Organizations (SOs) to provide single window assistance, integrated approach for holistic solutions and a continuous training and capacity building program. It is also playing a crucial role in making women and socially disadvantaged groups more assertive of their rights and taking an active role in both project and village activities to develop cost recovery development programmes for a sustainable future.

6.6.6.1. BUDGETARY ALLOCATION FOR SWAJAL

The Swajal scheme was launched by the Union Minister for Drinking Water and Sanitation with outlay of worth **INR 750 crore** in 115 aspirational districts of the country through flexi-funds under the National Rural Drinking Water Programme (NRDWP) budget. The main aim of the scheme is to offer villages with piped water supply which are powered by solar energy. In order to offer piped water to village with minimal operation and maintenance cost that would aid in minimizing the tariff burden on community, each Swajal scheme may cost up to **INR 50 lakhs**. The ongoing Swajal programs will continue in accordance with the current Swajal guidelines and should be ensure of completion of scheme within the allotted time frame. Additional new projects in these aspirational districts will be undertaken under Jal Jeevan Mission (JJM). The Swajal schemes that have already been finished but do not contain the Functional Household Tap Connection (FHTC) provision must be retrofitted under Jal Jeevan Mission (JJM).

TABLE 27. FUNDING PATTERN

SR.NO	AREAS	FUNDING PATTERN OF CENTRE: STATE: GRAM PANCHAYAT (GP)
1	North Eastern States & Himalayan States	81:09:10
2	Other States	45:45:10

Sources: Ministry of Jal Shakti, Jal Jeevan Mission (JJM), Press Information Bureau (PIB), Union Budget of India

6.7. BUDGET ALLOCATIONS FOR WATER AND WASTEWATER INDUSTRY (2023-2024)

In the union budget for 2023-2024, roughly 1,12,478 crore INR is projected for the water domain, which is distributed between the Ministries of Jal Shakti, Agriculture and Farmers' Welfare, Rural Development, and Housing and Urban Affairs2. This allocation is over 15% greater than the projected budget for the previous fiscal year. The 70,000-crore allocation to Jal Jeevan Mission (JJM) for installing functional household tap connections (FHTC) in rural India deserves the majority of the credit. The goal for fiscal year 2023-24 is to obtain an extra 4 crore FHTCs.

TABLE 28. BUDGET ALLOCATIONS (2023-2024)

Department / Budget Head	Budget Estimated: 23-24	Revised Estimated: 22-23	Budget Estimated: 22-23	Actual: 21-22
Ministry of Jal Shakti				
Total - MoJS	97,278.00	74,029.00	86,189.00	83,467.00
Department of Water Resources, River Development and Ganga Rejuvenation				
Total - DoWR, RD, GR	20,054.67	14,000.00	18,967.88	17,215.16
Namami Gange	4,000.00	2,500.00	2,800.00	1,394.00
Pradhan Mantri Krishi Sinchai Yojna	8,587.00	7,084.00	10,954.00	8,541.00
Servicing of loans from NABARD under PMKSY	3,875.00	3,875.00	4,585.00	3,736.00
Har Khet Ko Pani	300.00	550.00	785.00	1,264.00

Command Area Development and Water Management	400.00	140.00	1,044.00	108.00
Atal Bhujal Yojana	1,000.00	700.00	700.00	327.00
Water Resources Management	2,042.00	1,703.00	2,112.00	753.00
Department of Drinking Water and Sanitation (DDWS)				
Total - DDWS	77,223.00	60,029.00	67,221.00	66,252.00
Jal Jeevan Mission (JJM)	70,000.00	55,000.00	60,000.00	63,125.00
Swachh Bharat Mission (Gramin)	7,192.00	5,000.00	7,192.00	3,099.00
Department of Land Resources, Ministry of Rural Development				
Integrated Watershed Development Program	2,200.00	1,100.00	2,000.00	941.00

Ministry of Housing and Urban Affairs				
Swachh Bharat Mission Urban	5,000.00	2,000.00	2,300.00	1,952.00
Atal Mission for Rejuvenation and Urban Transformation	8,000.00	6,500.00	7,300.00	7,280.00

Source: Ministry of Finance, Government of India

The Ministry of Jal Shakti, which includes the Departments of Drinking Water and Sanitation as well as Water Resources, River Development, and Ganga Rejuvenation, has been allocated a planned budget of 86,189 cr INR, which is 12% more than the previous fiscal year's budget. The JJM program receives nearly all of the new funding. The budget of the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) at the Department of Water Resources, River Development, and Ganga Rejuvenation has been reduced by about 20% compared to previous year's 10,954 Cr. Within PMKSY, both the budget heads for command area development, i.e. 'Har Khet Ko Pani,' as well as the budget head for 'Command Area Development and Water Management,' have suffered a fall in allocation. Continuing the pattern, nearly 50% of the allocation under PMKSY this year is going to service NABARD loans under PMKSY, which includes payment of interest to NABARD. The budget for the Namami Gange and Atal Bhujal Yojana component has been significantly increased. The Namami Gange budget has been boosted to 4,000 crores, up from 2,800 crores last year. The Atal Bhujal Yojana has also seen almost 40% growth from the previous year's 700 cr.

The entire allocation for the Department of Drinking Water and Sanitation is 77,223 cr INR, up from 67,221 cr INR the previous year. The Jal Jeevan Mission hopes to have the Functional Household Tap Connection (FHTC) in place by 2024. The yearly allocation of JJM has been enhanced as the deadline approaches and a big objective of additional 8 cr FHTCs remains. The budget has been boosted from 60,000 cr to 70,000 cr this year, up from 60,000 cr last year.

The Department of Land Resources has allocated a total of 2,200 crores for the Watershed Development Component-Pradhan Mantri Krishi Sinchai Yojana (WDC PMKSY 2.0). The PMKSY's Integrated Watershed Development Program was in charge of a large chunk of the watershed until March 31, 2022. The MGNREGA funding support a significant amount of watershed and water conservation activities. The MGNREGA budget in the Department of Rural Development has reduced by over 20% this year compared to previous year's 73,000 crores. The Per Drop More Crop (Micro Irrigation) component has been combined with the Rashtriya Krishi Vikas Yojana (RKVY) from the previous fiscal year budget. The paper makes no mention of a separate financial allocation. However, the entire RKVY budget has fallen by about 25% as compared to last year's allocation of 10,433 cr INR. The allocation for the Swachh Bharat Mission Urban has been enhanced to 5,000 cr INR, up from 2,300 cr INR previous year. In addition, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) would get 8,000 crore INR. The major activities in this budget, according to the Output Outcome Framework, include functional water tap connections to urban homes, sewage treatment, and water body rejuvenation, among others.

6.8. GROUNDWATER RECHARGING

6.8.1. NATIONAL SCENARIO OF GROUNDWATER AND AVAILABILITY

India is one of the largest users of groundwater in the world. Groundwater is the only source of water for most of the population in India and the groundwater is being used for farming and domestic purpose. While groundwater fueled the Green Revolution of India, which transformed India into a food-secure nation, extensive exploitation has resulted in its worrisome depletion. Groundwater will become ever more important as climate change makes rainfall patterns more erratic. Already, declining groundwater levels endanger nearly two-thirds of India's districts (63%). This water is frequently becoming polluted. Worryingly, poverty rates are 9-10% higher in places where groundwater levels have dropped below 8 meters, putting small farmers at risk. If current trends continue, at least 25% of India's agriculture would be threatened. Dynamic groundwater is the amount of groundwater accessible in the zone of water level fluctuation that is renewed yearly. Groundwater has increasingly emerged as the foundation of India's agricultural and drinking water security. Groundwater contributes almost 62% of irrigation, 85% of rural water supply, and 45% of urban water supply. It helps to keep rivers and wetlands flowing and promotes terrestrial vegetation. It is sometimes the only source of water in arid and semi-arid regions. As a result, groundwater is critical to the country's socioeconomic growth. However, groundwater supplies in India are under jeopardy. Pumping that is both intensive and uncontrolled has resulted in a quick and widespread drop in groundwater levels. Between 1950 and 2010, the number of tube wells dug surged from 1 million to approximately 30 million, indicating extraordinary growth. This explosive use of groundwater has resulted in decreasing level of water table (level of groundwater).

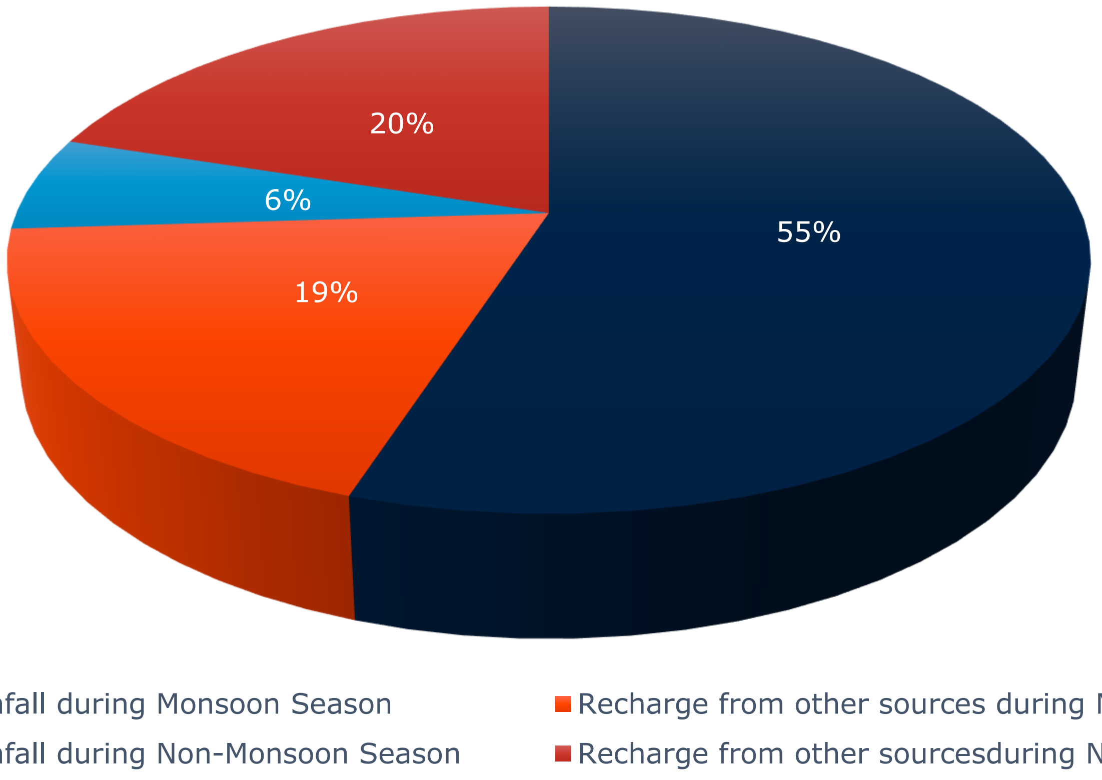
Ground water in the fluctuating water level zone is replenished annually, with rainfall being the primary contributor. As a result, sustainable ground water resource exploitation necessitates a realistic quantitative evaluation of ground water availability in this zone based on generally reliable scientific concepts. The National Water Policy of 2012 emphasized the scientific evaluation of ground water resources on a regular basis. Water availability changes affected by a variety of reasons, including climate change, must also be examined and accounted for during water resource planning. It supports direct use of rainwater, desalination, and prevention of accidental evapotranspiration to supplement utilizable water supplies in order to fulfill the rising demand for water. According to the National Water Policy 2012, safe drinking water and sanitation should be prioritized over other domestic needs (including animal needs), achieving food security, supporting sustenance agriculture, and meeting minimum eco-system needs. After addressing the aforementioned demands, available water should be allocated in a way that promotes conservation and efficient usage.

6.8.2. OVERVIEW OF GROUNDWATER RECHARGING

According to the Ministry of Jal Shakti's study on the evaluation of Dynamic Ground Water Resources 2022, the total annual ground water recharge for the entire nation is 437.60 billion cubic meters (bcm), whereas total natural discharges are 36.85 bcm. As a result, the total annual extractable ground water resources for the country are 398.08 bcm. Monsoon rainfall is a major source of ground water recharge, accounting for 241.35 bcm of total annual ground water recharge. Rainfall during the monsoon season contributes more than 70% of the annual ground water recharge in Goa, Gujarat, Jharkhand, Kerala, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Rajasthan, and Daman & Diu. The overall contribution of rainfall (both monsoon and non-monsoon) recharge to the country's total annual ground water recharge is 61%, with 39% coming from 'Other sources' such as canal seepage, return flow from irrigation, and recharge from tanks, ponds, and water conservation structures.

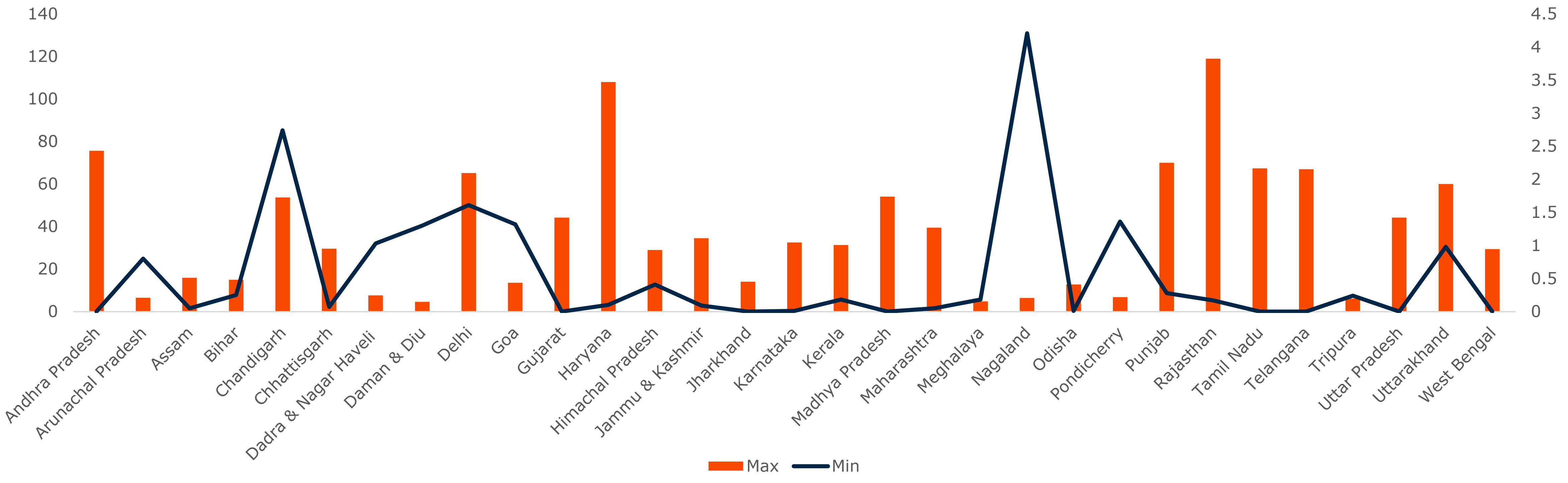
Jal Shakti Abhiyan (JSA) is being implemented in India by the government. The first JSA was launched in 2019 in water stressed blocks of 256 districts, with the primary goal of effectively harvesting monsoon rainfall through the creation of artificial recharge structures, watershed management, recharge and reuse structures, intensive afforestation, and awareness generation, among other things. In addition, The World Bank is assisting the government's national groundwater program, the Atal Bhujal Yojana, in its efforts to enhance groundwater management. This is the world's biggest community-led groundwater management initiative, with 8,220-gram panchayats spread across seven Indian states. Because groundwater conservation is in the hands of hundreds of millions of people and communities, the initiative assists villagers in understanding their water availability and consumption trends so that they may manage their water use properly.

FIGURE 68. GROUND WATER RECHARGE SCENARIO IN INDIA, 2022



Source: Central Ground Water Board (CGWB)

FIGURE 69. STATE-WISE DEPTH TO WATER LEVEL, 2020 (DEPTH TO WATER LEVEL (MBGL))



Source: Ministry of Jal Shakti (GOI)

6.8.2.1. OVERVIEW OF GROUNDWATER RECHARGING IN KARNATAKA

Over-exploitation and insufficient replenishment of groundwater (GW) have resulted in an urgent need to preserve freshwater, and reuse treated wastewater. To solve this issue, the Government of Karnataka initiated a large-scale recycling of 440 million liters/day plan to indirectly recharge GW in drought-prone parts of the Kolar district in southern India. Soil aquifer treatment (SAT) technology is used in this recycling, which entails filling surface run-off tanks with STW that purposely infiltrates and recharges aquifers. The facility cleanses wastewater up to the secondary level before pumping it to 137 tanks designated for groundwater replenishment. Primary treatment includes removing floating particles such as plastics and paper; secondary treatment involves employing microorganisms to remove dissolved organic matter; and tertiary treatment involves making the water drinkable. In the tanks, further filtering occurs naturally. The sandy and loamy soil, as well as soil microbes, further clean the wastewater in Kolar. The results show that the surface water in the revitalized tanks fulfills the country's strict STW water discharge regulations. The GW levels in the boreholes investigated increased by 58-73%, and the GW quality improved noticeably, transforming hard water into soft water. Land use and land cover studies revealed a rise in the number of bodies of water, trees, and cultivated land. The availability of GW increased agricultural output by 11-42%, milk productivity by 33%, and fish productivity by 341%. Thus, the KC Valley project demonstrates a viable solution to the water dilemma in drought-prone areas by recharging groundwater levels using treated wastewater. More similar projects have been launched by the Karnataka government, including Phase II of the KC Valley and the Hebbal-Nagawara Valley Project, which seeks to reuse around 865 million liters of treated wastewater per day for groundwater replenishment.

TABLE 29. WATER SOURCES IN KARNATAKA (% SHARE)

Sources	Percentage
Canals	36%
Tanks	6%
Wells	12%
Tube	34%
Lift Irrigation	4%

Source: Water Resource Department, GOK

6.8.3. TECHNOLOGY USED

Groundwater recharging in India involves the implementation of various technologies and methods to replenish and enhance the groundwater levels. Some of the commonly used technologies and techniques for groundwater recharging in India include direct surface techniques, and direct sub-surface techniques.

6.8.3.1. SURFACE SPREADING TECHNIQUES

These are intended to increase the contact area and residence duration of surface water over the soil in order to improve infiltration and increase ground water storage in phreatic aquifers. A variety of variables influence water travel downhill, including soil vertical permeability, the presence of grass or entrapped air in the soil zone, and the presence or absence of limiting layers of low vertical permeability at depth. Changes caused by physical, chemical, and bacterial impacts during the infiltration process are also essential in this respect. Important considerations in the selection of sites for artificial recharge through surface spreading techniques include:

- The area should have gently sloping land without gullies or ridges.
- The aquifer being recharged should be unconfined, permeable and sufficiently thick to provide storage space.
- The surface soil should be permeable and have a high infiltration rate.
- Vadose zone should be permeable and free from clay lenses.
- Ground water levels in the phreatic zone should be deep enough to accommodate the recharged water so that there is no water logging.
- The aquifer material should have moderate hydraulic conductivity so that the recharged water is retained for sufficiently long periods in the aquifer and can be used when needed.

6.8.3.1.1. FLOODING

This strategy is appropriate for fields next to rivers or irrigation canals when water levels stay deep even after monsoons and if there are adequate non-committed surface water supplies. To maintain adequate contact time and water distribution, embankments are constructed on both sides to direct unutilized surface water to a return canal, which transports the excess water to a stream or canal. The flooding approach reduces surface water system evaporation losses, is the least expensive of all artificial recharge technologies known and has extremely low maintenance costs.

6.8.3.1.2. DITCH AND FURROWS METHOD

This approach is digging shallow, flat-bottomed, closely spaced ditches or furrows to maximize water contact area for recharging from a source stream or canal. The ditches should have enough slopes to sustain flow velocity and minimize silt accumulation. The ditch widths are normally in the 0.30 to 1.80 m range. A collecting channel should also be created to transport the excess water back to the source stream or canal. Though this approach requires less soil preparation than recharging basins and is less susceptible to silting, the water contact area seldom surpasses 10% of the total recharge area.

6.8.3.1.3. RECHARGE BASIN

Artificial recharge basins are often dug or confined by dykes and levees and built parallel to ephemeral or intermittent stream systems. They can also be built parallel to canals or other sources of surface water. Multiple recharge basins can be built parallel to streams in alluvial areas to a) increase water contact time, b) reduce suspended material as water flows from one basin to another, and c) facilitate periodic maintenance such as silt scraping, etc. to restore infiltration rates by bypassing the basin under restoration.

6.8.3.1.4. RUNOFF CONSERVATION STRUCTURES

These are often multi-purpose practices that are mutually beneficial and promote soil and water conservation, afforestation, and higher agricultural output. They are appropriate for locations that get low to moderate rainfall mostly during a single monsoon season and have little or no capacity for water transfer from other places. There are several metrics available for the runoff zone, recharge zone, and discharge zone. Bench terracing, contour bunds, gully plugs, nalah bunds, check dams, and percolation ponds are all frequent constructions.

6.8.3.1.5. BENCH TERRACING

Bench terracing entails leveling sloping fields with surface gradients of up to 8% and having enough soil cover to put them under irrigation. It aids in soil conservation by retaining runoff water on terraced areas for extended periods of time, resulting in greater infiltration and ground water recharge. Terracing should be implemented once a map of the watershed has been created using level surveying and appropriate benchmarks have been established. A contour map with a contour interval of 0.3 m is then created. The width of each individual terrace should be calculated based on the land slope, but it should never be less than 12 m. The slope between two terraces should not be greater than 1:10, and the terraces should be flat. The land slope determines the vertical elevation difference and terrace width. Water exits of suitable proportions must be built in paddy cultivation regions to drain excess stored water and sustain water circulation. For rainfall intensities between 7.5 and 10 cm, the width of the outflows can range from 0.60 m for watersheds of up to 2 ha to 3.0 m for watersheds of up to 8 ha. Natural drainage channels should be linked to all outputs.

6.8.3.1.6. CONTOUR BUNDS

Contour bunding is a watershed management strategy that involves the construction of tiny embankments or bunds across the slope of the ground in order to increase soil moisture storage. The building of bunds following contours of equal land elevation gave rise to their names. This approach is commonly used in low rainfall locations (typically less than 800 mm) with gently sloping agricultural lands with exceptionally long slope lengths and permeable soils. They are not advised for clayey soils with inadequate internal drainage. Contour bunding entails building narrow-based trapezoidal embankments (bunds) following contours to impound water, which infiltrates into the soil and eventually augments ground water recharge. Prior to contour bunding, the ground must be leveled by removing local ridges and depressions, a map of the region must be prepared by level surveying, and benchmarks must be fixed. Elevation contours, ideally at 0.3 m intervals, are then produced, excluding places that do not require bunding, such as habitations, drainage, and so on.

The bund alignment should then be noted on the map. Contour bund design considerations include i) spacing, ii) cross section, and iii) deviation flexibility to go higher or lower than the contour bund elevation for better alignment on undulating ground.

6.8.3.1.7. PERCOLATION TANKS

Percolation tanks, which work on the same principles as nalah bunds, are among the most prevalent runoff collecting structures in India. A percolation tank is an intentionally produced surface water body that submerges a highly permeable land region, allowing surface runoff to percolate and recharge ground water storage. They are distinguished from nalah bunds by having bigger reservoir areas. They lack sluices or outlets for releasing water from the tank for irrigation or other uses. They may, however, be equipped with provisions for dumping away excess water that may enter the tank in order to prevent the tank bund from overflowing.

6.8.3.1.8. GULLY PLUGS, NALAH BUNDS AND CHECK DAMS

These constructions are built over gullies, nalahs, or streams to slow the flow of surface water in the stream channel and to keep water in the pervious soil or rock surface for extended periods of time. In contrast to gully plugs, which are often built over first order streams, nalah bunds and check dams are built across larger streams and in places with gentler slopes. These can be temporary constructions made of locally accessible materials, such as brush wood dams, loose / dry stone masonry check dams, Gabion check dams, and woven wire dams, or permanent structures made of stones, brick, and cement. For long-term dam stability, competent civil and agro-engineering approaches must be employed in the design, planning, and construction of permanent check dams to provide proper storage and adequate outflow of surplus water to minimize scours on the downstream side. The check dam location should have a sufficient thickness of permeable soils or weathered material to allow for quick recharging of stored water. The water retained in these constructions is usually restricted to the stream flow and the height is less than 2 m. These are built to accommodate the breadth of the stream and enable surplus water to flow over the wall. Water cushions are supplied on the downstream side to prevent scouring from excess runoff. A succession of similar check dams can be built on a regional scale to capture maximum runoff in the stream.

6.8.3.1.9. MODIFICATION OF VILLAGE TANKS AS RECHARGE STRUCTURES

Existing village tanks, which are usually silted and deteriorated, can be converted into recharge structures. Unlike properly engineered percolation tanks, village tanks do not have cut-off ditches or waste weirs. Desilting village tanks, together with the right placement of waste weirs and cut off trenches on the upstream side, can make them more suitable for use as recharge structures. With minimal adjustments, such tanks, which are plentiful in rural India, might be transformed into cost-effective structures for boosting ground water recharge.

6.8.3.1.10. STREAM CHANNEL MODIFICATION / AUGMENTATION

In regions where streams zigzag across large valleys, occupying just a tiny portion of the valley, the natural drainage channel can be changed to promote infiltration by retaining stream flow and increasing the surface of the streambed in contact with water. The channel is adjusted in such a way that the flow is dispersed over a larger area, resulting in increased contact with the streambed. The most common methods are a) widening, leveling, scarifying, or building ditches in the stream channel; b) building L-shaped finger levees or hook levees in the riverbed at the end of the high stream flow season; and c) low head check dams that allow flood waters to pass safely over them. Stream channel alteration can be used in locations with influent streams, which are mainly found in piedmont regions and areas with deep water tables, such as dry and semi-arid regions, as well as in valley fill deposits. The structures built for stream channel alteration are typically temporary, meant to supplement ground water recharge periodically, and are vulnerable to flooding. These approaches are often utilized in alluvial settings, but they can also be useful in hard rock places when thin river alluvium overlies excellent phreatic aquifers or the rocks in and around the stream channel are heavily worn or fractured. Artificial recharge by stream channel alterations might be more successful if surface storage dams exist upstream of the recharge locations since they allow for regulated water release.

6.8.3.2. SUBSURFACE TECHNIQUES

Subsurface approaches try to replenish deeper aquifers that are overlain by impermeable layers, preventing infiltration from surface sources that would normally recharge them. Injection wells or recharge wells, recharge pits and shafts, dug well recharge, borehole flooding, and recharge through natural holes and cavities are the most frequent ways for recharging such deeper aquifers.

6.8.3.2.1. INJECTION WELLS OR RECHARGE WELLS

Injection wells or recharge wells are constructions similar to bore/tube wells, but they are built to supplement ground water storage in deeper aquifers by supplying water under gravity or pressure. The aquifer to be restored is often desaturated owing to overexploitation of ground water. Artificial recharging of aquifers by injection wells can also be done in coastal zones to prevent saltwater infiltration and to counteract land subsidence concerns in places where constrained aquifers are intensively exploited.

6.8.3.2.2. RECHARGE PITS

Recharge pits are often dug pits that are deep enough to reach the low-permeability layers that overflow the unconfined aquifers. In concept, they are identical to recharge basins, with the exception that they are deeper and have a smaller bottom area. Because lateral hydraulic conductivity is significantly higher than vertical hydraulic conductivity in most layered sedimentary or alluvial material, the majority of infiltration occurs laterally through the pit walls in many such systems. Abandoned gravel quarry pits or brick kiln quarry pits in alluvial areas, as well as abandoned quarries in basaltic locations, can be utilized as recharge pits wherever permeable horizons exist. The Nalah trench is a type of recharge pit excavated across a streambed. Input portions of streams are ideal locations for such ditches. Contour trenches, as previously explained, fall into this type as well.

6.8.3.3. INDIRECT METHODS

Indirect techniques of artificial recharging of ground water do not require direct water delivery for recharging aquifers, but rather attempt to recharge aquifers indirectly. In this category, the most frequent approaches are induced recharge from surface water sources and aquifer alteration techniques.

6.8.3.3.1. INDUCED RECHARGE

Pumping water from an aquifer that is hydraulically coupled to surface water to induce recharge to a ground water reservoir is referred to as induced recharge. Once a hydraulic link is formed between the cone of depression and the river recharge border, surface water sources begin to contribute to the pumping yield. Because of its passage through the aquifer material, induced recharge can be employed to improve the quality of surface water resources under favorable hydrogeological circumstances. Collector wells and infiltration galleries, which are used to extract significant amounts of water from riverbeds, lakebeds, and waterlogged regions, also work on the idea of induced recharge.

6.8.3.3.2. AQUIFER MODIFICATION TECHNIQUES

These procedures alter the aquifer's properties in order to boost its ability to store and convey water via artificial means. The two most important procedures in this category are bore blasting and hydrofracturing. Though they are yield augmentation techniques rather than artificial recharge structures, they are also termed artificial recharge structures due to the increase in ground water storage in aquifers as a result.

6.8.3.4. COMBINATION METHODS

Under favorable hydrogeological circumstances, several combinations of surface and subsurface recharge technologies may be utilized in conjunction for optimal replenishment of ground water reservoirs. In such circumstances, the approaches to be integrated are site-specific. Combination methods that are commonly used include a) recharge basins with shafts, percolation ponds with recharge pits or shafts, and induced recharge with wells tapping multiple aquifers and allowing water to flow from upper to lower aquifer zones through the annular space between the walls and casing (connector wells), among others.

6.8.4. PROJECTS IN INDIA

- During 2021-22, Central Ground Water Board (CGWB) under this Ministry has taken up the project on 'Groundwater augmentation through artificial recharge in certain water stressed areas of Rajasthan and Haryana'. Artificial recharge structures will be constructed in water scarce areas of Jodhpur, Jaisalmer & Sikar districts of Rajasthan and Kurukshetra, Yamunanagar, Ambala & Panchkula districts of Haryana.
- Atal Bhujal Yojana (Atal Jal), launched by this Ministry in 2019, has its goal of demonstrating community-led sustainable ground water management which can be taken to scale. The major objective of the scheme is to improve the management of groundwater resources in select water stressed areas in identified states viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh.
- CGWB has in the year 2018, taken up Artificial Recharge work in three aspirational districts, Osmanabad, Maharashtra, YSR Kadapa district, Andhra Pradesh and Jangaon district, Telangana. Under this, suitable structures were constructed to harvest the runoff water in stream to store at suitable locations for augmenting recharge to the ground water.

- Under Jal Shakti Abhiyan campaign, water conservation and rainwater harvesting structures, as well as reuse and recharge structures, are being developed by the State Governments.
- In 2018, CGWB took up a pilot project in the eastern region of Maharashtra covering districts of Wardha and Amravati at five locations for construction of Bridge cum Bandhara (BCB) for ground water recharge. The structures also serve a dual purpose of transportation as well as storage of water in the upstream side for drinking and irrigational needs. The project was completed in 2020.
- Since XII Plan, CGWB has also taken up Aquifer Mapping and Management Programme for the entire country, including low ground water level districts. Under this, aquifer mapping is aimed to delineate aquifer disposition and their characterization for preparation of aquifer/ area specific ground water management plans with community participation.
- Further, Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS) also has provisions for public works relating to natural resource management, water conservation and water harvesting structures to augment and improve ground water like underground dikes, earthen dams, stop dams, check dams and roof top rain water harvesting structures in public buildings.

TABLE 30. STATE-WISE PROJECTS FOR GROUNDWATER RECHARGING IN INDIA

STATE	PROJECTS FOR GROUNDWATER RECHARGING
Andhra Pradesh	• Andhra Pradesh Water, Land and Tree Act, 2002' stipulates mandatory provision to construct rainwater harvesting structures at new and existing constructions for all residential, commercial and other premises and open space having area of not less than 200 sq.m in the stipulated period, failing which

	the authority may get such Rain Water Harvesting (RWH) structures constructed and recover the cost incurred along with the penalty as may be prescribed
Bihar	• The Bihar Ground Water (Regulation and Control of Development and Management) Act, 2006 has been enacted which provides mandatory provision of RTRWH structures in the building plan in an area of 1000 sq. m. or more. • Bihar Ground Water (Regulation & Control of Development and Management) Act, 2006 enacted by the State Government of Bihar.
Delhi	• Modified Building Bye-laws, 1983 to incorporate mandatory provision of roof top RWH in new building on plots of 100 sq. Mt or above. through storage of rain water runoff to recharge underground aquifer in NCT, Delhi exists. • To encourage rain water harvesting by Resident Welfare Associations/Group Housing Societies, the Govt. of NCT Delhi has launched a scheme for financial assistance in the Bhagidari concept, where 50% of the total cost of the project subject to a maximum of Rs. 50,000/- is being given to the RWAs as a grant if they adopt rain water harvesting.
Goa	• The "Goa Ground Water Regulation Act, 2002" has been enacted by the State Legislature • PWD, Goa has been asked to take up RWH structure for Government buildings. The PWD, Goa is studying various designs of roof top RWH for taking up other existing/new coming up large Government buildings.

Gujarat	• Gujarat Ground Water Authority (GGWA) has been constituted vide Government of Gujarat, notification No. GWR/1095/61/I-1/J-1 dated September 2001 for control and regulation of ground water resources. The State Govt. informed that the draft Bill is under process of finalization and suitable legislation will be enacted shortly. • Metropolitan Areas have notified rules under which no new building plan is approved without corresponding rainwater harvesting structure. The D/o Roads & Buildings have been directed to ensure that all major Govt. constructions including educational institutions had adequate rainwater harvesting facilities. The Urban Development and Urban Housing Department has issued necessary orders Gujarat Town Planning Act, 1976 to incorporate the rules for RWH.
Haryana	• Haryana Municipal Building Byelaws 1982 has been amended to incorporate the provision of compulsory Roof Top RWH. been amended to incorporate the provision of compulsory Roof Top Rain Water Harvesting.
Jharkhand	• The State Government has initiated action for construction of RTRWH structures in Government/Public buildings in a phased manner. A promotional scheme has also been started for awareness of protection of ground water and artificial recharge by grant of Rs. 25000/- for construction of artificial recharge structures. Ranchi Regional Development Authority (Jharkhand) has made Building Byelaws for RWH.
Karnataka	• The State Cabinet has approved the "Karnataka Ground Water (Regulation and Control of Development and Management) Bill, 2007.

	• The State has adopted a RWH policy to mandate this in all new construction. Bangalore City Corporation has already incorporated mandatory RWH in Building Bye-laws. Other ULB's are being encouraged to do so. Action to amend building bye-laws in major cities having population of more than 20 lakh to make RWH mandatory has been initiated. • Rural Development & Panchayati Raj Department has issued orders for implementation of roof top RWH in all Government buildings and also in rural schools. State has also extended help to the individual people also to the tune of 20% rebate on tax payment for 5 years duration.
Kerala	• The "Kerala Ground Water (Control and Regulation) Act, 1997" has been enacted. • Roof top RWH has become mandatory as per Kerala Municipality Building (Amendment) Rules, 2004 for all new buildings.
Madhya Pradesh	• The State Govt. vide Gazette notification dated August 2006, has made roof top RWH mandatory for all types of buildings having plot size of more than 140 sq.m. Govt. has also announced 6% rebate in property tax to individuals for the year in which the individual will go for installation of roof top RWH structures.
Maharashtra	• Maharashtra Water Resources Regulatory Authority Act was enacted in May 2005 and the State Govt. is considering amending this Act to incorporate the provision included in the Model Bill circulated by Ministry. • Maharashtra Government is promoting RTRWH under the "Shivkalin Pani Sthawan Yojana". It provides that all houses should have provision for rainwater harvesting without which house

	construction plan should not be approved. Bombay Municipal Corporation and Pimpri - Chinchwad Municipal Corporation have made RWH mandatory by enacting building bye-laws.
Punjab	• The Punjab Ground Water (Control and Regulation) Act, 1998 was prepared on the basis of Model Bill and was submitted to the Punjab State Water Resource Committee. The Committee observed that the draft is too harsh on users and Model Bill circulated by MOWR is not in the larger interest of the farmers and suggested that a system of incentives is better. The State Govt informed that the Govt is of the view that Ground Water Legislation should be attempted after thorough deliberations with all the stakeholders and comprehensive legal scrutiny. • Building Bye-laws amended to make RWH System mandatory in all buildings of above 200 sq. yds. The Punjab Urban Development Authority (PUDA) is in the process of amending the PUDA (Building) Rules 1996 for making this system mandatory. Municipal Corporation of Ludhiana and Jalandhar have framed Bye-laws to make RWH mandatory in new buildings.
Rajasthan	• The State Govt. of Rajasthan has presented "The Rajasthan Ground Water Management Bill, 2006" in the Vihaan Sabha on April 2006 and was referred to the Select Committee. The Bill is under consideration of the Select Committee. • Roof Top RWH has been made mandatory in State owned buildings of plot size more than 300 Sq.m with effect from January 2006. For violation of building bye-laws, punitive measures, viz. disconnection of water supply, has also been made. The Govt. has made provision of compulsory

	installation of rainwater harvesting system in all newly and existing construction building and Govt. offices.
Tamil Nadu	• The State Government of Tamil Nadu has passed an Act "Tamil Nadu Ground Water (Development and Management) Act, 2003" on March 2003 which includes provision of Tamil Nadu Ground Water Authority to regulate and control water development in the State of Tamil Nadu. Framing of rules and constitution of State Ground Water Authority is under consideration of State Govt. New provisions of the Model Bill, 2005 circulated by MoWR would be incorporated at appropriate time. • Vide Ordinance No. 4 of 2003 dated July, 2003 laws relating to Municipal Corporations and Municipalities in the State have been amended making it mandatory for all the existing and new buildings to provide RWH facilities. • The State has launched implementation of RWH scheme on massive scale in Government buildings, private houses/Institutions and commercial buildings in urban & rural areas. The State Government has achieved cent percent coverage in roof top RWH.
Uttarakhand	• The Govt. of Uttarakhand (Awas evam Shahari Vikas) has made rules for compulsory installation of RWH system and directed to adopt rules in building Bye-laws. Accordingly, all the Development Authorities had made partial amendments in the prevalent House Building and Development Bye-laws/Regulations.
Uttar Pradesh	• Mandatory rules have been framed for compulsory installation of RWH system in all the new housing schemes/plots/buildings of all uses, group housing schemes with provisions of separate network of

	pipes for combined RWH/Recharging system. Roof top RWH have been made mandatory for plots of 100-200 sq. mt. In Govt. Buildings (both new as well as old), installation of RWH structures has been made mandatory.
West Bengal	• Vide Rule 171 of the West Bengal Municipal (Building) Rules, 2007, installation of RWH system has been made mandatory. • West Bengal Ground Water Resources (Management, Control and Regulation) Act, 2005 came into effect on September 2005. Rules under the Act have also been framed by the State Govt.

Source: News Article, Ministry of Water Resources Government of India

6.8.5. STATE-WISE ARTIFICIAL RECHARGE PLANS

TABLE 31. STATE-WISE ARTIFICIAL RECHARGE PLANS IN INDIA

STATE	ARTIFICIAL RECHARGE PLANS
Andhra Pradesh	• A total of 26,228 artificial recharge facilities (13085 percolation tanks and 13143 check dams) are suggested for 83914.18 square kilometers scattered throughout 395 mandals in 13 districts of the state. Furthermore, for optimal recharging, 26,209 recharge shafts/recharge wells are proposed to be built in the specified Check dams and Percolation tanks. • The Check Dam unit cost is Rs. 8 Lakhs, the Percolation Tank is Rs. 13 Lakhs, and the Recharge Shaft is Rs. 2 Lakhs. The entire cost of the artificial recharge structures in the state is expected to be around Rs. 3276.67 Crore.

	• Under the WALTA legislation, the Government of Andhra Pradesh is required to create roof top rainwater collecting systems for buildings with roof areas of 200 square meters or more. Roof top rainwater harvesting construction has been estimated to cost Rs. 20,000/- for a 200 sq.m structure. It is projected that 15% of urban houses have a roof area of around 200 square meters, with the total cost for implementing 263694 RTRWH structures estimated to be Rs. 527.00 Crore.
Bihar	• According to state government estimates, rural parts of Bihar would require 163 Percolation Tanks, 2608 each of Gully Plug & Contour Bunding - Trenching, and 122 Check Dams. To improve groundwater recharge in adjacent marginal alluvial lands, 357 NalaBunding, 2842 Contour Bunding& Trenching, 5682 Recharge Shaft, and 265 Percolation Tank may be built. • It is projected that the de-silting of existing 10658 village tanks/ponds/talaos, the de-silting of 44 square kilometers of mauns (Ox-bow lake), the development of injection wells in 13811 village tanks, and the renovation of 2045 kilometers of traditional aharpyne system will result in an estimated rise in water table. The overall cost of the work is expected to be Rs. 2606.44 crore. • Roof-top rainwater gathering has the ability to supplement 216 MCM of rainfall to groundwater resources in the state. The first phase of roof-top rainwater collection application has the capacity to replenish 31.5 MCM of rainwater to groundwater aquifers. The total cost of the first phase of development is projected to be Rs. 500 crore.
Chhattisgarh	• According to Chhattisgarh's hydrogeological parameters, an average percolation tank has a filling capacity of 0.10 MCM. Because of frequent fillings during the monsoon, it may really store 200% of its capacity. As a result, an average

	gross storage capacity of 0.20 MCM was calculated. The total number of percolation tanks practicable in Chhattisgarh is 3426, at a cost of Rs. 1370.4 crore. • There is a lot of potential for building Nala bunds/Cement plugs in the state's many second and third order streams. Approximately 25% of excess monsoon runoff may be recharged by these structures. The average capacity of Nala bunds/Cement plugs was calculated to be 0.03 MCM. It is predicted that the state can build 11417 Nala bunds/Cement plugs for a total cost of 342.5 crore. • The viable recharge shafts and gravity head recharge well structures required for the whole State total 25687 and cost Rs. 1284.4 crore. • The overall cost of possible gully plugs, contour bunds, and gabion structures for the entire state is Rs 97.9 crore. • Even if 10% of the dwellings with an average roof area of 50 square meters are examined, a total roof area of 5.91 square kilometers is accessible to collect rainfall due to the different hydrogeological and other scenarios of space availability. The total amount of water accessible from roof top rainwater gathering was 6.812 MCM. The entire cost of roof top rainwater collection in 1,18,339 dwellings in Chhattisgarh's 114 proclaimed standard urban zones is Rs. 591.69 crore.
Delhi	• Recharge trenches and recharge shafts are recommended for construction in parks and gardens. In regions where it is practical, roof-top rainwater gathering systems are recommended. • The Yamuna flood plain has also been rejected since the water level is quite shallow, and it is recommended that surplus flood water be transferred to the Chhatarpur Basin, where the water level is deeper and can also accommodate recharged water. In steep locations, check dams have been proposed for construction. It is projected to build 22706 recharge trenches with recharge shafts, 304500 roof top rain water gathering systems, and 12 check dams.

	• The artificial recharge to groundwater in NCT of Delhi is of the order of 2206.08 Cr, which includes construction of CD, Recharge Trench with Recharge Shaft and Roof Top Rainwater harvesting structures.
Goa	• In the state, bhandaras and vented dams are acceptable constructions. These buildings may be able to harvest the excess run off and hence have been suggested in the State of at a cost of Rs 279.30 CR. • Roof top rainwater harvesting can be implemented in 45794 dwellings, government buildings, institutes, and other structures in the state's urban and municipal areas that are eligible for artificial recharge in the first phase. It will capture 27.43 MCM of rainwater to supplement groundwater supplies, assuming typical rainfall for the state and a system efficiency of 80%. • The overall cost of artificial recharge for the state of Goa is estimated to be Rs 425.84 Cr, with the rural region costing Rs 279.30 Cr and the urban area costing Rs 146.54 Cr.
Gujarat	• Weirs/check dams are regarded possible in hard rock locations with moderate relief, whereas percolation tanks are deemed acceptable in hard rock plateau and plain areas. Weirs/check dams are deemed possible in semi-consolidated formations. Percolation tanks are deemed acceptable in locations inhabited by alluvium. • There are about 52.83 Lakh households in such centers, and the total area available for harvesting (90% of total roof top) has been estimated to be 475.54 Lakh sq m, taking into account that approximately 25% of homes are appropriate for harvesting and 40 sq.m. as typical house hold roof top size. After allowing for storm rain and other factors, the source water available for harvesting has been calculated to be 60% of typical rainfall in the urban core. As a result, the total amount of source water accessible for harvesting has been calculated to be 26.3 MCM/yr.

	• The total cost for proposed artificial recharge is Rs 3462.73 Cr, out of which Rs 820.84 Cr is in rural areas and Rs 2641.89 Cr is urban areas.
Haryana	• Farm ponds, injection wells, and horizontal trenches with or without recharge shafts are the principal planned recharge structures in the state. In the Aravali Hills, the average cost of a recharge shaft to recharge 0.015 MCM water yearly is approximately Rs. 3.0 lakh, while the cost of a check dam to recharge 0.04 MCM water annually is around Rs. 50 lakhs and Rs. 40 lakhs in the Siwaliks. The average cost of building agricultural ponds is around 0.50 lakh, while the recharge pit in individual residences and clusters of buildings would cost 0.30 lakh. • It is recommended to build approximately 335 check dams, 44392 recharge shafts with recharge tube wells near percolation ponds and adjacent to canals to utilize surplus surface runoff, 393811 farm ponds in agricultural lands, and 304377 roof top rain water harvesting structures in urban and rural areas to divert runoff from the roof top area. • Roof top rainwater harvesting may be implemented in 30 lakh dwellings with 200 Sq.mt roof area, government buildings, institutes, and other structures in urban and municipal areas of the state appropriate for artificial recharge in the first phase. It will capture 24.5 MCM of rainwater to supplement groundwater supplies, assuming typical rainfall for the state and a system efficiency of 80%. • It is planned to use farm ponds to capture runoff from agricultural fields and farms located in rural areas. The runoff generated that can be used for recharging has been approximated by taking into account the 10% of total area of the districts covered by big farms where farm ponds can be built for recharge. It is anticipated that around 393811 agricultural ponds can be built to replenish approximately 3294.17 MCM of water.

Himachal Pradesh	• In general, in valley locations, Modification of Village Ponds/Tanks, Recharge Shaft, Injection well, Sub-surface dykes, and Roof Top Rainwater Harvesting Structures are considered, but in hilly areas, Gabbion, Check dams / Nala Bunds / Cement Plug, and Roof Top Rainwater Harvesting Structures are considered. • Rooftop rainwater may be collected and utilized to recharge ground water in hilly and urban locations. This method entails connecting the roof top output pipes to channel the water to either existing wells/tubewells/borewells or specifically developed wells. Large roof surfaces of urban housing complexes or institutional buildings can be used to capture roof top rain water to recharge aquifers in metropolitan regions. • The entire cost of artificial recharge for the state of Himachal Pradesh is in the range of Rs 1055.40 Cr, with an estimate of Rs 1018.65 Cr for artificial recharge buildings and 36.75 Cr for rooftop rainwater collection in urban areas.
Jharkhand	• As per Ranchi Rainwater Harvesting Regulation implemented by Ranchi Municipal Corporation, houses with 300 square meter of roof area or more are to be taken into consideration for roof top rain water harvesting. The cost of roof top rainwater harvesting of a roof area 300 square meters or above is estimated as Rs.1305 crores for 5.22 lakh buildings
Karnataka	• In the State, surface water spreading infrastructure such as percolation tanks, check dams, recharge shafts, sub-surface dykes, and vented dams (Dakshina Kannada District) are taken into account. The number of structures planned is based on the current structures built under various schemes in the state. The projected cost of artificial recharge structures in the state of Karnataka is Rs. 7111.64 Cr. • Roof top rain water harvesting may be implemented in 8.9 lakh dwellings, government buildings, institutes, and other structures in urban and municipal regions of the state appropriate for artificial recharge in the first phase. It will

	capture 149.64 MCM of rainwater to supplement ground water supplies, assuming typical rainfall for the state and a system efficiency of 80%.
North Eastern States	• The total cost towards artificial recharge works out to be Rs 7889.77 Cr, out of which the cost towards artificial recharge structures is Rs 4885.46 Cr, RWH in schools and Health centre is Rs 1683.49 Cr and for spring Development is Rs 1320.83 CR.
Kerala	• The annual rainfall in the urban area ranges from 2267 mm to 3428 mm, with an average of 3000 mm. After accounting for possible evapotranspiration, a total of 1755 mm of precipitation is available for conservation. A total of 57 MCM of rain water may be gathered from 4.8 lakh residential dwellings, according to estimates. Thus, the total cost of roof top rain water harvesting throughout the state in the first phase has been projected to be Rs. 724.18 crores. If the pilot project for RWH implementation in commercial buildings is a success, the remaining buildings can be considered in the second phase.
Madhya Pradesh	• The State Govt. vide Gazette notification dated August 2006, has made roof top RWH mandatory for all types of buildings having plot size of more than 140 sq.m. Govt. has also announced 6% rebate in property tax to individuals for the year in which the individual will go for installation of roof top RWH structures. • RTRWH considers a total of 408938 homes. Using an average of 50 square meters for each dwelling, the total roof area is projected to be 20446830 square meters (20.45 square kilometers). These methods are expected to recharge 17.41 MCM/year.

Maharashtra	• The total cost estimate for artificial recharge in Maharashtra is Rs 30834.06Cr with a break up of Rs 13893.74 Cr for rural areas & Rs 16940.31 Cr for urban areas. • The amount of surface water considered for artificial recharge plans is 2060.52 MCM. Based on the field circumstances, it has been estimated that 70% of the storage would be provided by percolation tanks, with the remainder provided by check dams (hard rock regions) or recharge shafts (alluvial areas). As a result, 1436.38 MCM (70%) will be kept in percolation tanks, 577.12 MCM in cement plugs/check dams, and 46.93 MCM in recharge shafts. As a result, 7188 percolation tanks, 19243 check dams/cement plugs, and 838 recharging shafts are recommended in Maharashtra's specified locations. • In the planned plan, 50% of the houses (56,46,772) with dugwells or borewells are targeted for replenishing the roof-top captured water. The average cost of making the necessary preparations to recharge existing wells will be roughly Rs. 30,000/- per dwelling. The anticipated total cost for covering all 537 urban towns is Rs. 16940.31 crores. • Except for Mumbai and Mumbai Sub-urban, it is predicted that roughly 8995 initiatives will be required across Maharashtra's 537 urban areas, with an average of 15 schemes per town/city. Suburban regions are planned with 100 schemes each, whilst the other 24 significant cities/towns under Municipal Corporations, such as Navi Mumbai, Thane, Kalyan-Dombivali, Vasai-Virar, Pune, PCMC, Nashik, Aurangabad, Nagpur, and others, are proposed with 50 schemes each.
Punjab	• Uncommitted surplus run-off is to be used by the proposed Check dam and recharge shaft, while surplus canal water is to be recharged through injection wells and run-off from large agricultural land through farm ponds in respective farms, as well as provision of RTRWH in urban areas for roof-top rainwater. The number of injection wells has been

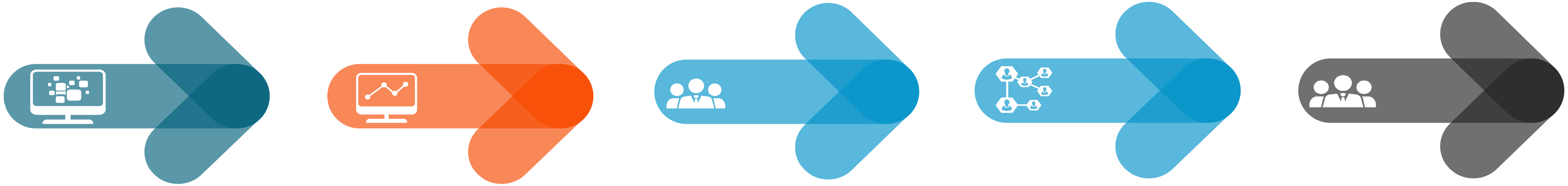
	decided based on the intake capacity of injection wells, and 1 farm pond per Ha has been recommended to gather run off from agricultural land. • In the first phase, it has been determined that roof top rainwater collecting may be implemented in government buildings, institutes, and 55 lakh dwellings in the state with 200 Sq.mt roof space for artificial recharge. It will use 52.49 MCM of rainwater to supplement groundwater supplies. • The total cost of artificial recharge in Punjab is of the order of Rs 6773.55 Cr, out of which artificial recharge in rural area is of the order of Rs 5119.63 Cr and RTRWH in urban areas is Rs 1653.92 Cr.
Rajasthan	• Ajmer, Alwar, Banswara, Baran, Bharatpur, Bhilwara, Bundi, Chittaurgarh, Dausa, Dholpur, Dungarpur, Jaipur, Jalore, Jhalawar, Karauli, Kota, Pali, Pratapgarh, Rajsamand, Sawai Madhopur, Sirohi, Tonk, and Udaipur are among the 23 districts of Eastern Rajasthan. Water conservation/augmentation solutions advocated in these locations include Catchment Area Treatment (Plantation, Staggered Trenches& CCT, etc.), Recharge Shaft in existing village ponds, Mini Percolation Tanks, Percolation Tanks, Pacca Check Dam, Anicut, MST, and Recharge/Farm Pond, among others. • Rajasthan's western desertic region includes ten districts: Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, and Sikar. Artificial recharging has been proven to be almost impossible in these arid areas of the state under the current conditions. As a result, it is advocated to encourage rainwater collection using storage structures such as Tankas. • Total number of urban households: 48,00,000 Nos., The total number of harvesting jobs suggested for 20% of families is 9,60,000 and total cost of the harvesting works envisaged by the project is Rs. 1,440 crores.

Tamil Nadu	• In respect of rainwater harvesting, the State of Tamil Nadu was the first State to make it mandatory for all the buildings in the State and hence it is considered as an activity already completed. The proposed artificial recharge in the State of Tamil Nadu would have an estimated cost of Rs 2463.14. • July, 2003 laws relating to Municipal Corporations and Municipalities in the State have been amended making it mandatory for all the existing and new buildings to provide RWH facilities. The State has launched implementation of RWH scheme on massive scale in Government buildings, private houses/Institutions and commercial buildings in urban & rural areas. The State Government has achieved cent percent coverage in roof top RWH.
Uttarakhand	• The State Government (Avas and Shahri Vikas) has issued necessary regulations for the installation of Rainwater Harvesting Systems and has mandated that rules be incorporated into building bylaws. As a result, all development authorities have amended the existing house building and development by-laws/regulations. • Furthermore, the Directorate of Watershed Management has implemented water conservation measures in the state through various schemes, and rainwater harvesting and water conservation structures have been built under the Uttarakhand Decentralized Watershed Development Projects (UDWDP), Integrated Livelihood Support Program (ILSP), PMKSY-Watershed Development Program, and Gramya. • Aside from these initiatives, the Swajal Project's Project Management Unit (PMU) has taken up the basin/sub-basin catchments program as part of the Catchments Areas Conservation and Management Plan (CACMP). • The overall cost of the planned artificial recharge is Rs 40.57 Cr, with rural regions costing Rs 12.86 Cr and urban areas costing Rs 27.72 Cr.

Uttar Pradesh	• Based on the hydrogeology and terrain conditions, different structure, viz., Check Dam (CD)/ Nala Bund (NB)/ Cement Plug (CP), Ponds, Dug Well (DW) Recharge/ Tube Well (TW) Recharge/ Recharge Shafts & Percolation Tanks have been considered for artificial recharge. • The total cost of artificial recharge for the State of Uttar Pradesh is of the order of Rs 7156.45 Cr, out of which, cost estimate for Rural area is of the order of Rs 5099.23 Cr and Urban area is 2057.22 Cr.
West Bengal	• Given the terrain conditions, for hard rock terrains, percolation tanks, check dams, gabion structures/contour bunds, sub-surface dyke, recharge shaft/dug well recharge are proposed, whereas in alluvial areas, percolation tanks, re-excavation of existing tanks (renovation) with recharge shaft & injection wells, and RTRWH are proposed. • The overall cost of artificial recharge for the state of West Bengal is estimated to be Rs1698.17 crore, with the rural region costing Rs1631.15 crore and the urban area costing Rs67.02 crore.

Source: News Article, Ministry of Water Resources Government of India, Central Ground Water Board, Department of Water Resources, Ministry of Jal Shakti

6.9. VALUE CHAIN ANALYSIS



Raw Material Provider

- Veolia Water Technologies
- Suez Water Technologies & Solutions
- Xylem Inc.
- Aquatech International LLC
- Ecolab Inc.
- IDEXX Laboratories
- Danaher Corporation
- Kurita Water Industries Ltd.
- Pentair plc
- Thermo Fisher Scientific Inc.

Water Collectors

- Mueller Water Products Inc.
- Badger Meter Inc.
- IDEX Corporation (Including ADS Environmental Services)
- IDEX Corporation (Including EJ)
- CUES Inc.
- Xylem Inc. (Flygt brand)
- Aclara Technologies LLC
- Schneider Electric SE (Including Telvent)
- SUEZ - Water Technologies & Solutions (Innovyze)
- Clean Harbors Inc. (Including HydroChemPSC)

Treatment providers

- GE Water & Process Technologies (Now part of Suez)
- ABB Ltd.
- A.O. Smith Corporation
- Evoqua Water Technologies
- Trojan Technologies (Subsidiary of Danaher)
- Pall Corporation (Part of Danaher)
- Calgon Carbon Corporation (Now part of Kuraray)
- Nalco Water (Part of Ecolab)
- Kemira Oyj
- Ashland Global Holdings Inc.

Distributors

- American Water Works Company Inc.
- California Water Service Group
- Veolia North America
- Suez North America
- Aqua America Inc.
- EPCOR Utilities Inc.
- York Water Company
- Middlesex Water Company
- American States Water Company
- Global Water Resources Inc.

End-Users

- Pentair plc
- Ecolab Inc.
- Dow Inc. (Water Solutions business)
- Netafim Ltd.
- Jain Irrigation Systems Ltd.
- Toro Company
- Rain Bird Corporation
- Valmont Industries Inc.
- Lindsay Corporation
- Hunter Industries

Source: Water and Wastewater Treatment Association, Indian Society of Water and Wastewater Treatment, American Society for Nutrition, The Nutrition Society, International & American Associations of Water and Wastewater Treatmentists, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

6.10. PORTER’S FIVE FORCE ANALYSIS

FIGURE 70. PORTERS FIVE FORCE ANALYSIS

Threat of New Entrants: Low to Moderate

- Government initiatives
- Huge capital requirement
- Presence of already established companies

Bargaining Power of Buyers: Low to Moderate

- Government regulations and standards for water treatment
- Buyers volume is high relative to suppliers

Competitive Rivalry: Moderate to High

- Focus on improvement in services and prices
- Players following various market strategies to gain market share
- Industry has high growth potential

Bargaining Power of Suppliers: Moderate to High

- Low volume of suppliers compared to buyers
- Switching cost
- Technological advancement

Threat of Substitution: Low

- Research & development for technological development

Source: Water and Wastewater Treatment Association, Indian Society of Water and Wastewater Treatment, American Society for Nutrition, The Nutrition Society, International & American Associations of Water and Wastewater Treatmentists, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

6.10.1. BARGAINING POWER OF BUYERS: LOW TO MODERATE

The ability of the customers to drive prices lower or up to their level of power is one of the five forces. It is generally affected by how many customers or buyers a company has, and how much it would cost a company to find markets for its output or new customers. A company that has many, smaller but independent customers will have an easier time charging higher prices to increase their profitability.

In the case of water and wastewater treatment market, the buyers' power is likely to be low to moderate. This can be mainly associated with the fact that the customer base for water and wastewater treatment must buy owing to several industry regulations & standards regarding water purity. Furthermore, there are relatively high number of buyers over the suppliers. Thus, they have less power in price negotiations.

6.10.2. BARGAINING POWER OF SUPPLIERS: MODERATE TO HIGH

The bargaining power of suppliers refers to the pressure that suppliers can put on companies by raising their prices, offering different products, or reducing the availability of their products. In case of water and wastewater treatment market, the suppliers power is likely to be moderate to high. This can be mainly associated with the fact that there are relatively less suppliers as compared to buyers and recent technological advancement resulted in the high power for suppliers. However, it is necessary for suppliers to maintain good qualities and standardized products to their customers, as customers can easily switch suppliers and thus bargaining power of suppliers is moderate. Generally, supplier power is investigated through concentration of supplier, volume importance to the supplier, differentiation of inputs, and switching costs of firms in the industry.

6.10.3. THREAT OF NEW ENTRY: LOW TO MODERATE

A company's power is affected by the power of new entrants into the market. An industry with stronger barriers to entry is ideal for the existing companies within that particular industry as the company would be able to charge higher prices and negotiate better terms. The presence of already established companies and technological knowledge in terms of manufacturing processes and product is required, which creates a challenge for new entrants to enter the market. Furthermore, government policies within the water and wastewater industry require strict adherence to regulations. The water and wastewater treatment industry requires high initial investment of capital and switching cost. As some industries are interrelated and switching from one industry to another does not mean a completely new idea. However, many countries have started funding the water based projects, which is likely to boost the new competitor entry into the market and hence the overall threat of new entry is low to moderate.

6.10.4. THREAT OF SUBSTITUTES: LOW

Substitute products that can be used in place of a product or service poses threat. When close substitutes are available in a market, the customers will have the option to forgo buying a company's product, and thus, the company's power can be weakened. In case of water and wastewater treatment market, the product is widely used in multiple end-use industry. Currently there are no substitutes for water treatment methods but there can be alternative technologies that can be used for the same in the future. Continuous research and development of the new technologies and water treatment chemicals would enhance the development of innovative technological treatment systems.

6.10.5. INTENSITY OF COMPETITIVE RIVALRY: MODERATE TO HIGH

The intensity of rivalry among competitors in an industry refers to the extent to which firms within an industry put pressure on one another and limit each other's profit potential. The competition amongst existing players is moderate to high in water and wastewater treatment market, as the companies provide products with different technological & advance features. Furthermore, it is easy for customers to switch from one firm to another that best suits their interests. Also, the initial capital requirement is high for the industry along with the other costs associated with production. Thus, the overall intensity of competitive rivalry in water and wastewater treatment market is moderate to high.

6.11. PESTEL ANALYSIS

Political

- Government grants funds and subsidies to businesses for water projects and gives low interest loans in countries like China and the U.S.
- The growing trend of privatization and giving private companies ownership rights of water in countries can overcome certain challenges.
- Complete private ownership, contractual ownership, and public-private partnerships are all growing solutions to cut costs while investing in improved infrastructure.

Economic

- The cost of living has improved in many countries which have significantly improved the demand for services, tools and solutions in water industry.
- Three main factors contribute to high sewage prices relative to water prices are system design, population served, and system complexity.

Social

- The continued phenomenon of urbanization is a major force contributing to the growth of the water industry.
- Consumers from urban households are more likely than consumers from rural households to use water filtration devices.

Technological

- In order to improve efficiency, the key players have integrated the water and wastewater treatment with various technologies like sensors, artificial intelligence, IoT and others.
- Technological improvements in the market provides the strong foot for the players and enhances the consumer demand to opt for their services.
- In order to overcome infrastructure inefficiency, recycling and reuse technologies of both sludge and water pose radical changes to the market.

Environmental

- Climate change like temperature rise and rainfall are the main ecological concerns for the water and wastewater industry.
- Many regions are working to upgrade their sewer system, which can directly affect the water bodies.
- According to various organizations, the need for infrastructure improvements has direct impacts on the environment and its inhabitants.

Legal

- Water regulations by federal and state entities have become more strict to ensure water safety, quality, and supply.
- The several rules & regulations include, The Clean Water Act (CWA), Water Framework Directive 2000/60/EC (WFD) and others.

Source: Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

6.12. WATER AND WASTEWATER TREATMENT MARKET AVERAGE PRICE TREND ANALYSIS

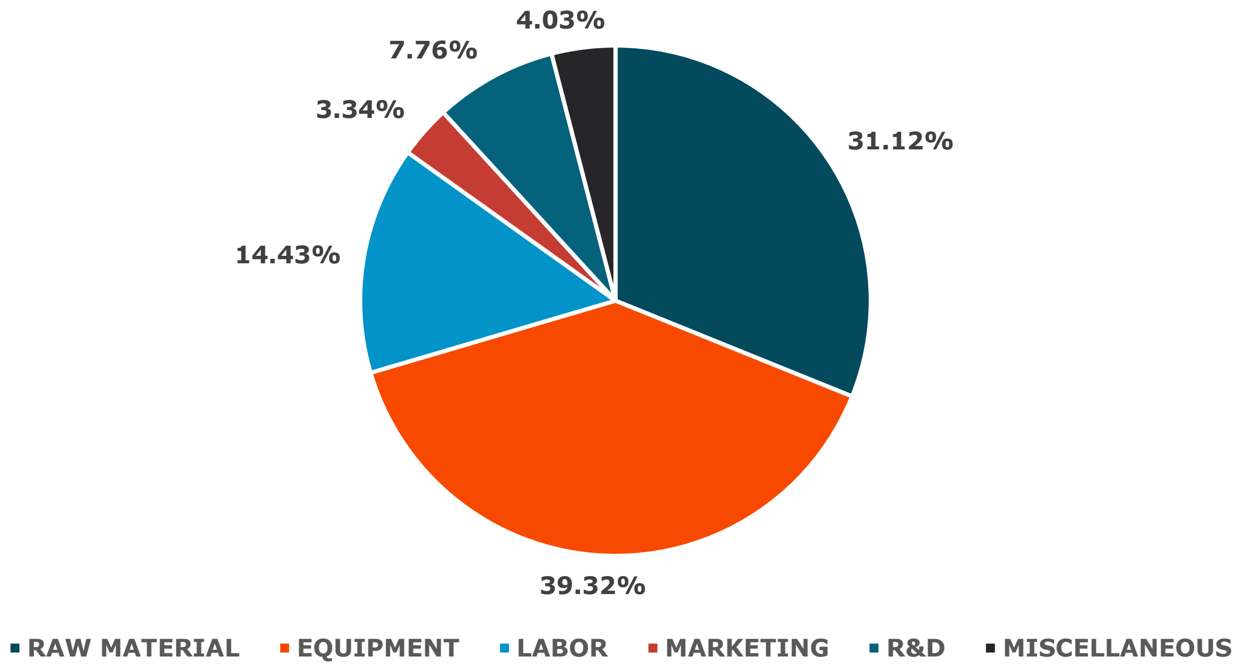
One of the economic tools for ensuring efficient water use and allocation is water pricing. A pricing policy may be the most effective tool for controlling water demand and achieving financial and economic objectives if it is well executed. Due to the enormous demand and the fact that the quality of the water has declined and now requires additional processing before being given to consumers, water costs have been continuously rising in recent years. Water sources that have collected a lot of pollution were left to today's water users, not as a result of their own behavior, but rather that of previous generations. Compared to the household and industrial sectors, agriculture has made less progress toward effective water pricing.

The Water Framework Directive states that a legally binding revenue requirement must be established in order for utilities to be able to cover the fair costs of delivering water and sewage services. Water pricing is based on average cost pricing or marginal cost pricing in the majority of OECD (Organization for Economic Cooperation and Development) nations and in the United States. Each kiloliter of water consumed results in a fee to the consumer. This price varies according to the city's pricing system. Additionally, water boards in many nations, including India, are also in charge of maintaining the sewerage system, and customers are charged for this service. Additionally, the "polluter pays principle" has been adopted by the majority of developed nations for the quantity of water pollution loads discharged by businesses. Urban water consumers pay the whole cost of wastewater treatment.

The water bill includes a minimum service fee in the majority of Indian cities. In India, water is a heavily subsidized good, which results in market inefficiencies and wasteful use of the already limited resource. In addition, contemporary wastewater treatment plants (WTPs) demand the employment of cutting-edge technology, including sensors, Internet of Things (IoT) gadgets, and AI-based trackers. This is a high-risk industry that discourages private sector participation due to the substantial upfront capital expenditures in machinery and equipment and the unpredictability of revenue streams. Therefore, these elements are likely to have an impact on water and wastewater treatment costs all over the world.

6.13. COST STRUCTURE ANALYSIS

FIGURE 71. WATER AND WASTEWATER TREATMENT MARKET COST STRUCTURE ANALYSIS



Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

The cost structure of water and wastewater treatment includes cost of raw materials, labor, maintenance, infrastructure fixed capital and miscellaneous cost. Raw material holds a major share of the cost and accounts for over 40.21% of the total cost. The cost of raw material has the potential to influence the overall cost of water and wastewater treatment. Fixed capital cost includes rent, utilities, security, software, and hardware. Manufacturing businesses are typically characterized by high fixed costs due to the investments required in renting the facilities and the equipment. In the long run this cost could be easily covered. However, there has been increasing use of automated machines and equipment that have been developed by several equipment manufacturers. The equipment cost comes around 25% as modern technologies requires new & high end products which results in high cost and thereby equipment serves as the most capital consuming factor followed by labor, marketing, R & D and miscellaneous.

7. INDIA WATER AND WASTEWATER TREATMENT MARKET BY TYPE INSIGHTS & TREND

KEY TRENDS & HIGHLIGHTS

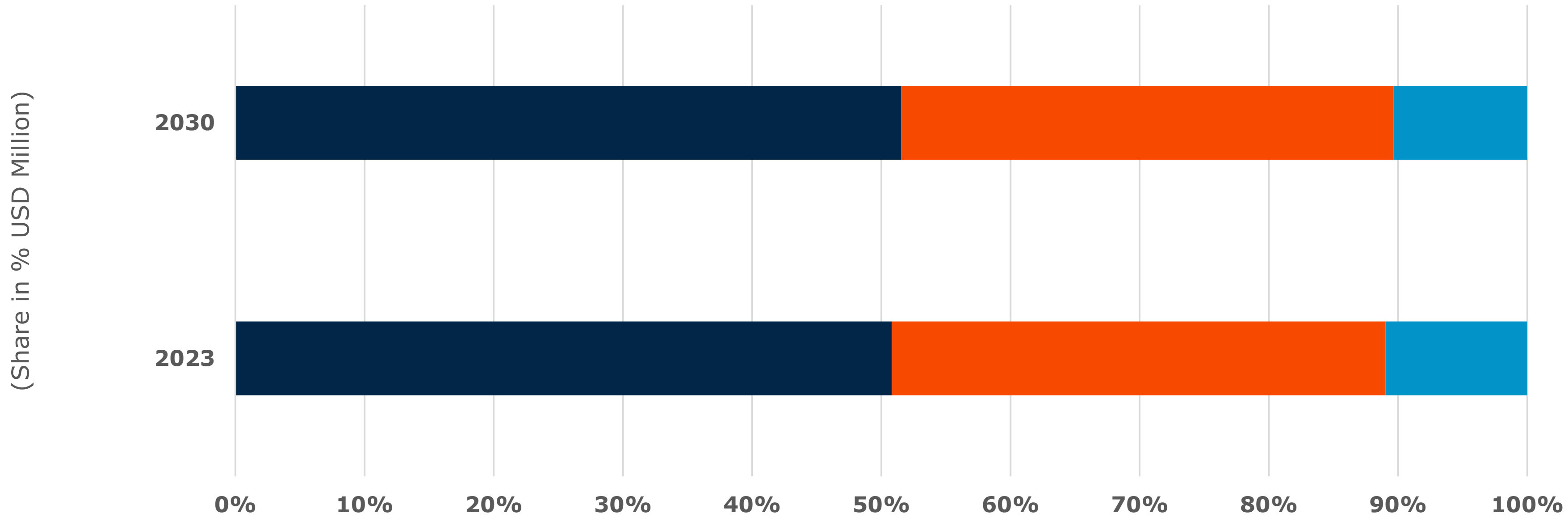
- The demand for Water Treatment accounted for over USD 6,276.633 Million in 2022 and is expected to grow at a CAGR of 6.29% in the forecast period.

7.1. TYPE DYNAMICS & MARKET SHARE, 2023 & 2030

By Type, the market is segmented into:

- Water Treatment
- Sewage Treatment
- Effluent Treatment

FIGURE 72. INDIA WATER AND WASTEWATER TREATMENT MARKET: TYPE DYNAMICS (SHARE IN % USD MILLION)



	2023	2030
Water Treatment	50.80%	51.52%
Sewage Treatment	38.23%	38.13%
Effluent Treatment	10.98%	10.35%

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

7.2. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY TYPE, 2019-2030, (USD MILLION)

TABLE 32. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY TYPE, 2019-2030, (USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	5,366.400	5,595.612	5,921.555	6,276.633	6,654.796	7,494.849	10,201.477	**6.29%**
Sewage Treatment	4,073.319	4,240.226	4,477.177	4,734.731	5,008.400	5,614.197	7,549.278	**6.04%**
Effluent Treatment	1,201.160	1,243.961	1,304.345	1,369.422	1,437.961	1,587.609	2,049.225	**5.19%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

7.3. WATER TREATMENT

The demand for water treatment is expected to grow significantly during the forecast period. 71% of the surface of the Earth is covered by water, and 97% of that water, which is salty and unsuited for human and other uses, is found in the seas. Only 3% of the water is clean and suitable for human consumption. Freshwater is mostly kept in icebergs and polar ice caps, with just a minor amount being preserved as groundwater and surface water. Surface water, which is mostly found in lakes, ponds, and rivers, is the type of water that is used. However, as population and development activities increase, surface and groundwater pollution worsen, resulting in the entry of hazardous chemicals and other substances into the water system.

In addition, rivers, reservoirs, and lakes contain a variety of microorganisms, pathogens, and other toxins that are harmful to people, plants, and animals, and increase the necessity for a water treatment plant. The practice of enhancing water quality through various methods is known as "water treatment." To make it safe for applications or for reintroduction back into the ecological system, it comprises the removal of suspended solids and other dangerous compounds. Such a demand targets both water quantity and quality, the latter of which is related to unhygienic conditions and pollution. Additionally, the industrial sector places a greater emphasis on integrated processes and green technology, as well as on waste reduction and water reuse. Depending on the water type and intended application, various methods and chemical treatments are applied.

7.3.1. WATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 33. WATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	1,405.040	1,464.062	1,547.935	1,639.222	1,736.353	1,951.813	2,643.589	**6.19%**
West	1,391.265	1,453.215	1,541.464	1,637.825	1,740.699	1,970.064	2,715.785	**6.56%**
South	1,601.319	1,670.159	1,768.078	1,874.787	1,988.476	2,241.168	3,056.463	**6.33%**
East	968.776	1,008.175	1,064.079	1,124.799	1,189.268	1,331.804	1,785.640	**5.98%**
Total	**5,366.400**	**5,595.612**	**5,921.555**	**6,276.633**	**6,654.796**	**7,494.849**	**10,201.477**	**6.29%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

7.4. SEWAGE TREATMENT

The sewage treatment segment plays a pivotal role within the broader water and wastewater treatment market, addressing the critical need for effective purification of contaminated water before its release into the environment. As urbanization and industrialization continue to surge globally, the demand for efficient sewage treatment solutions has intensified. Sewage treatment is paramount not only for safeguarding public health but also for preserving aquatic ecosystems and ensuring sustainable water resources. Modern sewage treatment processes encompass a range of advanced technologies that collectively target the removal of pollutants, organic matter, and harmful pathogens from wastewater. Primary treatment involves physical separation to remove larger solids, while secondary treatment employs biological processes to break down organic contaminants. Tertiary treatment employs additional advanced techniques, such as filtration, chemical precipitation, and disinfection, to achieve the highest quality effluent standards.

The sewage treatment market is characterized by a dynamic landscape of innovation and adaptation to meet evolving regulatory standards and environmental imperatives. Key players in the industry continually invest in research and development to enhance treatment efficiency, reduce energy consumption, and minimize the environmental footprint of sewage treatment facilities. Moreover, the market's growth is not solely driven by regulatory compliance; it also stems from a growing awareness of the interconnectedness of water quality, human health, and ecological well-being. Governments, municipalities, and industries recognize the need for comprehensive sewage treatment solutions that align with broader sustainability objectives.

7.4.1. SEWAGE TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 34. SEWAGE TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	1,206.590	1,255.171	1,324.093	1,398.938	1,478.391	1,654.014	2,213.005	**5.93%**
West	1,087.822	1,134.251	1,200.271	1,272.189	1,348.780	1,518.908	2,066.972	**6.29%**
South	1,148.127	1,195.436	1,262.614	1,335.654	1,413.287	1,585.217	2,135.031	**6.07%**
East	630.780	655.368	690.200	727.950	767.942	856.058	1,134.270	**5.73%**
Total	**4,073.319**	**4,240.226**	**4,477.177**	**4,734.731**	**5,008.400**	**5,614.197**	**7,549.278**	**6.04%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

7.5. EFFLUENT TREATMENT

Effluent treatment plays a pivotal role in the water and wastewater treatment market by addressing the critical issue of managing industrial and municipal wastewater before its discharge into the environment. As industries continue to expand and urban populations grow, the volume of wastewater generated increases, necessitating effective treatment to safeguard ecosystems and public health. Effluent treatment involves a comprehensive set of processes designed to remove contaminants, pollutants, and harmful substances from wastewater, ensuring compliance with environmental regulations and sustainability goals. The effluent treatment process encompasses a range of physical, chemical, and biological techniques to achieve optimal purification. Physical methods include processes like sedimentation, filtration, and flotation, which aid in the removal of suspended solids, oil, and grease. Chemical treatments involve the use of coagulants, flocculants, and disinfectants to precipitate and neutralize contaminants. Biological treatment methods, such as activated sludge processes and biofiltration, utilize microorganisms to biodegrade organic matter and convert it into less harmful substances.

Driven by increasing environmental awareness and stringent regulatory frameworks, the global water and wastewater treatment market has witnessed significant growth in the adoption of efficient effluent treatment solutions. Industries across sectors like pharmaceuticals, textiles, food and beverage, and petrochemicals are investing in advanced treatment technologies to minimize their environmental footprint. Municipalities are also upgrading their wastewater treatment facilities to mitigate pollution and protect water resources. Moreover, advancements in technology have led to the development of innovative effluent treatment solutions, including membrane filtration, ion exchange, and advanced oxidation processes. These cutting-edge methods offer higher efficiency in contaminant removal, reduced chemical consumption, and improved resource recovery, further driving the expansion of the market.

7.5.1. EFFLUENT TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 35. EFFLUENT TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2030	2030	CAGR% (2023-30)
North	340.755	352.863	369.947	388.362	407.759	450.124	580.935	**5.19%**
West	345.816	358.854	377.287	397.212	418.259	464.426	608.478	**5.50%**
South	316.453	327.526	343.132	359.928	377.592	416.073	534.063	**5.08%**
East	198.136	204.718	213.978	223.921	234.351	256.985	325.748	**4.82%**
Total	**1,201.160**	**1,243.961**	**1,304.345**	**1,369.422**	**1,437.961**	**1,587.609**	**2,049.225**	**5.19%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8. INDIA WATER AND WASTEWATER TREATMENT MARKET BY OFFERING INSIGHTS & TREND

KEY TRENDS & HIGHLIGHTS

- The demand for Process Control and Automation accounted for over USD 4,008.099 Million in 2022 and is expected to grow at a CAGR of 6.05% in the forecast period.

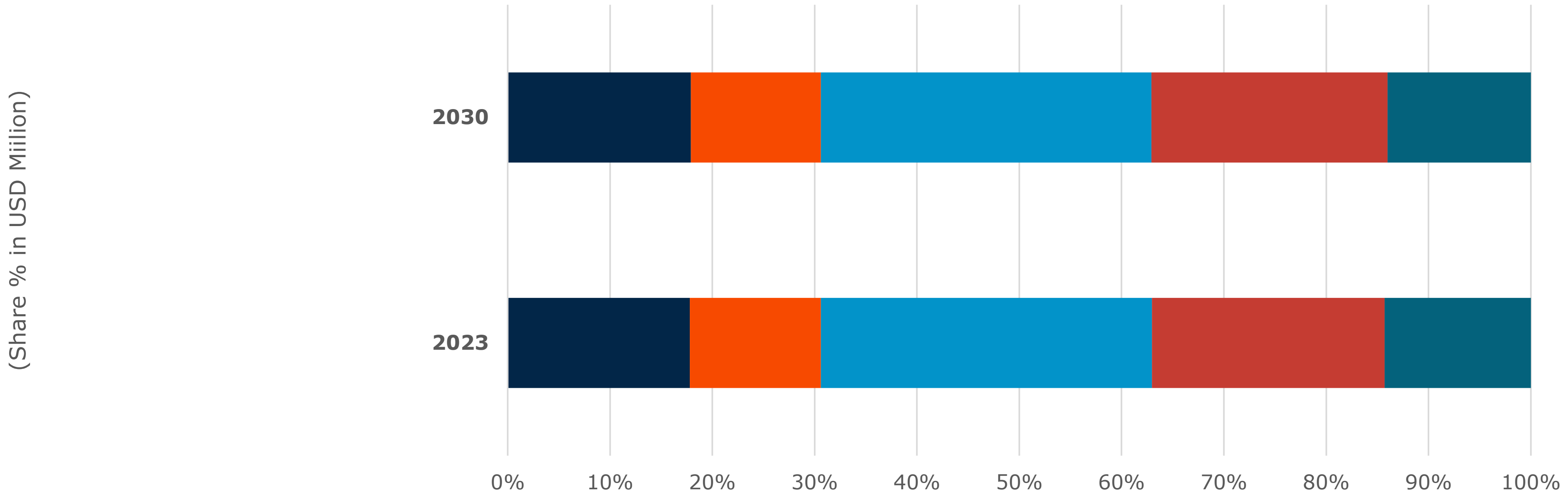
8.1. OFFERING DYNAMICS & MARKET SHARE, 2023 & 2030

By Offering, the market is segmented into:

- Treatment Technologies
    - Activated Sludge Process
    - Membrane Bio Reactor
    - Moving Bed Bio Reactor
    - Sequencing Batch Reactor
    - Upflow Anaerobic Sludge Blanket Reactor
    - Submerged Aerated Fixed Film Reactor
    - Other Treatment Technologies
- Treatment Chemicals
    - Corrosion Inhibitors
    - Scale Inhibitors
    - Biocides & Disinfectants
    - Coagulants & Flocculants

    - Chelating Agents
    - Anti-Foaming Agents
    - Ph Adjusters and Stabilizers
    - Others
- Process Control and Automation
- Design, Engineering, and Construction Services
- Operation and Maintenance Services

FIGURE 73. INDIA WATER AND WASTEWATER TREATMENT MARKET: OFFERING DYNAMICS (SHARE IN % USD MILLION)



	2023	2030
Treatment Technologies	17.79%	17.90%
Treatment Chemicals	12.81%	12.71%
Process Control and Automation	32.36%	32.30%
Design, Engineering, and Construction Services	22.74%	23.10%
Operation and Maintenance Services	14.30%	13.99%

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.2. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 36. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**1,887.272**	**1,966.340**	**2,078.688**	**2,200.950**	**2,331.020**	**2,619.485**	**3,545.169**	**6.17%**
Activated Sludge Process	*715.327*	*744.530*	*785.982*	*831.030*	*878.887*	*984.791*	*1,322.822*	**6.01%**
Membrane Bio Reactor	*388.825*	*404.817*	*427.522*	*452.207*	*478.442*	*536.533*	*722.238*	**6.06%**
Moving Bed Bio Reactor	*293.292*	*305.994*	*324.067*	*343.771*	*364.773*	*411.482*	*562.431*	**6.38%**
Sequencing Batch Reactor	*173.776*	*181.527*	*192.569*	*204.628*	*217.503*	*246.214*	*339.603*	**6.57%**
Upflow Anaerobic Sludge Blanket Reactor	*141.170*	*146.886*	*154.997*	*163.808*	*173.164*	*193.855*	*259.793*	**5.97%**
Submerged Aerated Fixed Film Reactor	*121.197*	*126.377*	*133.743*	*141.767*	*150.314*	*169.300*	*230.481*	**6.30%**
Other Treatment Technologies	*53.685*	*56.210*	*59.807*	*63.739*	*67.939*	*77.310*	*107.801*	**6.82%**
Treatment Chemicals	**1,368.002**	**1,423.344**	**1,501.871**	**1,587.168**	**1,677.738**	**1,878.009**	**2,516.035**	**5.96%**
Corrosion Inhibitors	*360.870*	*375.256*	*395.657*	*417.800*	*441.293*	*493.179*	*657.992*	**5.87%**
Scale Inhibitors	*23.453*	*24.359*	*25.642*	*27.033*	*28.506*	*31.751*	*41.995*	**5.69%**

Biocides & Disinfectants	*318.102*	*330.849*	*348.931*	*368.561*	*389.395*	*435.427*	*581.796*	**5.90%**
Coagulants & Flocculants	*94.112*	*98.104*	*103.780*	*109.961*	*116.541*	*131.149*	*178.151*	**6.25%**
Chelating Agents	*195.332*	*203.556*	*215.245*	*227.969*	*241.509*	*271.550*	*368.050*	**6.20%**
Anti-Foaming Agents	*268.383*	*278.983*	*294.009*	*310.310*	*327.597*	*365.747*	*486.704*	**5.82%**
Ph Adjusters and Stabilizers	*67.216*	*70.082*	*74.157*	*78.595*	*83.322*	*93.820*	*127.629*	**6.28%**
Others	*40.534*	*42.155*	*44.450*	*46.939*	*49.576*	*55.385*	*73.718*	**5.83%**
Process Control and Automation	**3,447.321**	**3,588.822**	**3,789.716**	**4,008.099**	**4,240.167**	**4,753.948**	**6,395.672**	**6.05%**
Design, Engineering, and Construction Services	**2,401.085**	**2,503.947**	**2,650.237**	**2,809.630**	**2,979.416**	**3,356.680**	**4,573.019**	**6.31%**
Operation and Maintenance Services	**1,537.198**	**1,597.347**	**1,682.564**	**1,774.939**	**1,872.816**	**2,088.533**	**2,770.086**	**5.75%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3. TREATMENT TECHNOLOGIES

The demand for treatment technologies for water & wastewater treatment is expected to grow significantly during the forecast period. In order to have clean, drinkable water supplies delivered before pollutants and germs can be removed, water treatment technologies are a crucial line of defense. Water sources may be contaminated, and hence must undergo proper treatment to remove or neutralize any pathogens. Several techniques are used by public drinking water systems to supply their populations with clean drinking water. Before raw water can be delivered, it must first be purified using a number of different water treatment technologies that must operate in concert and in succession. Despite the fact that most people seldom think about how much water is used in daily activities, like cooking, bathing, drinking, and cleaning, there are a staggering number of other items that are made using water. For instance, the manufacture of one ton of steel uses 62,600 gallons of water. One barrel of crude oil requires 1851 gallons of water to refine. A pound of wool or cotton requires 101 liters. In order to meet the need for clean, contaminant-free water, there is now a greater need for various treatment technologies.

8.3.1. WATER & WASTEWATER TREATMENT TECHNOLOGIES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 37. WATER & WASTEWATER TREATMENT TECHNOLOGIES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	531.943	553.814	584.867	618.626	654.504	733.946	987.878	**6.06%**
West	546.263	570.070	603.953	640.907	680.308	767.988	1,051.720	**6.42%**
South	521.123	543.050	574.212	608.132	644.227	724.304	981.499	**6.20%**
East	287.944	299.405	315.655	333.285	351.982	393.247	524.071	**5.85%**
Total	**1,887.272**	**1,966.340**	**2,078.688**	**2,200.950**	**2,331.020**	**2,619.485**	**3,545.169**	**6.17%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.2. ACTIVATED SLUDGE PROCESS

The demand for an activated sludge process for water and wastewater treatment is expected to grow significantly during the forecast period. The activated sludge method, which refers to biological treatment procedures that employ a suspended growth of organisms to remove BOD and suspended particles, is one of the most often used for secondary wastewater treatment. Air or oxygen is blasted into raw, unsettled sewage to crush the particles and create a biological 'soup' that digests the organic components and contaminants in the sewage. These plants lack the main settlement chamber, which is emptied by tanker on a regular basis in most three-stage sewage treatment plants. Once the sewage has been 'bubbled' sufficiently, surplus sewage liquor is discharged into a clarifying chamber where living bacteria drop to the bottom, dead bacteria ascend to the top, and a crust with a clear liquid in the center forms. After that, the clean water is dumped into a river or a soakaway. The living bacteria, known as activated bacterial sludge, are returned to the digestion chamber to re-seed the new raw sewage entering the tank, while the dead bacterial crust is cleaned on a regular basis by either the homeowner or a service engineer.

However, the activated sludge process requires more operator control than the other treatment methods to maintain the balance of food, organisms, and oxygen. Aeration, return rates, and waste rates must all be managed by the operator. To identify the mixing pattern, type and amount of foam, color of activated sludge, and odors, operators must monitor the aeration basin's operation. The flow pattern, settling, amount, and kind of particles leaving with the process effluent are all observed in the settling tank. Process control operations rely heavily on sampling and testing. Stability testing to determine settled sludge volume; suspended solids testing to determine influent and mixed liquor suspended solids, return activated sludge solids, and waste activated sludge concentrations; volatile content of the mixed liquor suspended solids determination; dissolved oxygen and pH of the aeration tank; BOD and/or COD of the aeration tank influent and process effluent.

8.3.2.1. ACTIVATED SLUDGE PROCESS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 38. ACTIVATED SLUDGE PROCESS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	200.436	208.471	219.868	232.242	245.374	274.392	366.671	**5.91%**
West	200.806	209.339	221.470	234.682	248.749	279.984	380.511	**6.26%**
South	201.154	209.406	221.122	233.857	247.391	277.351	373.073	**6.04%**
East	112.931	117.314	123.522	130.249	137.373	153.064	202.566	**5.70%**
Total	**715.327**	**744.530**	**785.982**	**831.030**	**878.887**	**984.791**	**1,322.822**	**6.01%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.3. MEMBRANE BIO REACTOR

The demand for membrane bio reactor for water and wastewater treatment is expected to grow significantly during the forecast period. Membrane bioreactor (MBR) technology is quickly expanding and is increasingly being used for municipal and industrial wastewater treatment applications across the world. Because of its capacity to create drinking water quality effluent, MBR technology is well suited for wastewater reclamation. The resulting effluent can be reused in industrial operations or released into surface waters without polluting streams and rivers. The MBR system's modest footprint and ease of operation make it ideal for usage in isolated places where wastewater may be reused for irrigation or groundwater discharge. These are also used to thicken sludge. They are also well-suited to handle significant or fluctuating organic loading to a plant, as in industrial wastewater treatment applications. In addition, MBR can be adapted to almost any industrial or municipal wastewater, reducing demand on local water supplies, and pollution in local waterbodies.

However, the MBR system must be properly cared for and maintained in order to prevent fouling and maximize cost-effectiveness for the MBR system as a whole by extending the life of the membrane element because the membranes will eventually degrade and need to be replaced. MBR units need to be cleaned on a regular basis, maybe using both physical and/or chemical cleaning methods. Each installation's specific cleaning and maintenance schedule will be different, but it will typically include at least weekly routine cleanings as well as deeper cleaning cycles a few times per year. When considering MBR technology, facilities should think about how labor costs, system downtime, and cleaning chemical costs will affect the technology's overall viability.

8.3.3.1. MEMBRANE BIO REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 39. MEMBRANE BIO REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	110.378	114.830	121.146	128.006	135.289	151.389	202.653	**5.94%**
West	116.682	121.670	128.765	136.494	144.725	163.013	221.949	**6.30%**
South	104.954	109.286	115.438	122.128	129.239	144.990	195.376	**6.08%**
East	56.811	59.030	62.173	65.579	69.188	77.141	102.260	**5.74%**
Total	**388.825**	**404.817**	**427.522**	**452.207**	**478.442**	**536.533**	**722.238**	**6.06%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.4. MOVING BED BIO REACTOR

The demand for moving bed bio reactor for water and wastewater treatment is expected to grow significantly during the forecast period. The moving bed bioreactor (MBBR) is an economical solution offered for wastewater treatment if the "bulk" of the pollution load must be disposed of (as means of cost reduction) or if applicable discharge regulations are not as strict. The advanced wastewater treatment solutions significantly increase the capacity and efficiency of existing wastewater treatment plants, while minimizing the size of new plant deployments. This method makes it possible to attain good efficiency results of disposal with low energy consumption. This process is used for the removal of organic substances, nitrification, and denitrification. The MBBR system consists of an activated sludge aeration system where the sludge is collected on recycled plastic carriers. These carriers have an internal large surface for optimal contact with water, air, and bacteria.

Furthermore, on the inside surface of the carriers, the bacteria and activated sludge proliferate. The bacteria in the wastewater break down the organic material. The carriers carrying activated sludge are kept moving by the aeration system. Only the surplus sludge and bacteria growth will separate from the carriers and go with the cleaned water to the final separator. Depending on the unique requirements, the system may have one step or more (see timetable below). The reason why the specific bacteria remain in their own duty tank is that the carriers do not leave their single, screen-protected tank. In addition, the MMBR is economically attractive, compact (saves space), maintenance-friendly, strong, high volume load, simply to extend, financial savings on discharge costs, these associated benefits have increased its demand in the industry.

8.3.4.1. MOVING BED BIO REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 40. MOVING BED BIO REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	81.706	85.183	90.127	95.511	101.244	113.976	154.965	**6.27%**
West	79.099	82.667	87.752	93.309	99.247	112.500	155.712	**6.65%**
South	84.630	88.316	93.561	99.282	105.380	118.952	162.860	**6.42%**
East	47.856	49.828	52.627	55.669	58.901	66.055	88.894	**6.06%**
Total	**293.292**	**305.994**	**324.067**	**343.771**	**364.773**	**411.482**	**562.431**	**6.38%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.5. SEQUENCING BATCH REACTOR

The demand for sequencing batch reactors for water and wastewater treatment is expected to grow significantly during the forecast period. An active sludge-style wastewater treatment device that can perform many treatment processes in a single tank is known as a sequencing batch reactor. Prior to further processing, a batch of wastewater is screened to get rid of larger impurities. The reactor is a tank into which air is pumped in order to guarantee that there is an enough amount of oxygen for aerobic biochemical reactions to take place. When oxygen is added to wastewater, dissolved organic matter that cannot be removed through screening or settling can be consumed by microorganisms. The wastewater in the reactor is given time to aerate before being permitted to settle. Batch reactors that operate in sequence use an activated sludge treatment procedure. All except a tiny percentage of the sludge, which is rich in microorganisms, is taken out of the reactor once the treated effluent is released.

This shortens the time needed to treat each batch of wastewater by helping the microorganisms in the next batch of wastewater fed to the reactor quickly repopulate. Usually, more than one reactor is required so that extra flow may be routed elsewhere while one batch of effluent is being treated. The predicted amount of wastewater flow and the amount of time allotted for the treatment of each batch in the reactor ultimately determine the number of reactors. Less sludge and cleaner effluent are produced with a longer retention time. The major advantages of the technology include effluent with low-organic compounds which may be utilized to satisfy stringent effluent regulations. Other benefits include the ability to fit it on a small piece of land and the ease with which it may be expanded by adding more reactors. This system's functionality is more intricate than others, though. The system does have a tendency to cost more to build and maintain than most others, but during its lifespan, it often has fewer maintenance issues.

8.3.5.1. SEQUENCING BATCH REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 41. SEQUENCING BATCH REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	50.258	52.452	55.576	58.983	62.616	70.701	96.877	**6.43%**
West	56.964	59.601	63.363	67.480	71.886	81.744	114.075	**6.82%**
South	44.129	46.101	48.910	51.978	55.255	62.562	86.338	**6.58%**
East	22.425	23.373	24.720	26.186	27.747	31.207	42.314	**6.21%**
Total	**173.776**	**181.527**	**192.569**	**204.628**	**217.503**	**246.214**	**339.603**	**6.57%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.6. UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR

The demand for upflow anaerobic sludge blanket reactor for water and wastewater treatment is expected to grow significantly during the forecast period. UASB reactor is a widely employed anaerobic system for sewage treatment in tropical countries including Latin America and India. It has been recognized as the third most popular and extensively used sewage treatment technology in Latin America where Brazil alone is known to have more than 650 full-scale UASB installations.

In the process of treating wastewater, UASB is a type of anaerobic digester, that produces methane and creates granular sludge that is then broken down by anaerobic microorganisms. A single tank technology known as the UASB reactor is utilized in centralized or decentralized anaerobic industrial wastewater treatment to remove a large amount of organic contaminants. It is acknowledged as one of the key technologies in the anaerobic treatment procedure. Anaerobic therapy indicates that there is no usage of oxygen or air during the procedure. It tries to eliminate organic contaminants from sewage, sludge, and slurries. The microbes turn organic contaminants into methane- and carbon dioxide-containing biogas. Although the up-flow anaerobic sludge blanket is effective in removing BOD, COD, and TSS from wastewater, it has little effect on removing nutrients. Additionally, it can handle the treatment of agricultural wastewater, industry effluent, blackwater, and greywater.

8.3.6.1. UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 42. UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	41.385	43.024	45.347	47.868	50.541	56.442	75.163	**5.83%**
West	48.399	50.430	53.317	56.458	59.801	67.215	91.014	**6.18%**
South	34.915	36.330	38.338	40.518	42.834	47.956	64.279	**5.97%**
East	16.470	17.102	17.996	18.963	19.988	22.242	29.337	**5.63%**
Total	**141.170**	**146.886**	**154.997**	**163.808**	**173.164**	**193.855**	**259.793**	**5.97%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.7. SUBMERGED AERATED FIXED FILM REACTOR

The demand for submerged aerated fixed film reactors for water and wastewater treatment is expected to grow significantly during the forecast period. The submerged aerated fixed film (SAFF) technology is considered to be one of the most economical and uncomplicated methods in the wastewater sector. It is mostly utilized in sewage sanitation, business complexes, and residential complexes. When land is scarce and operational manpower is not cost-effective throughout the operation, this technique is generally employed. organic load, biochemical oxygen demand, and suspended solids of residential and commercial sewage effluent are reduced as a result of the procedure. The majority of small to medium-sized treatment facilities choose this method. It is an aerobic biological technique that employs corrugated inert UV stabilized PVC material. The increased surface area of Submerged Aerated Fixed Film Technology aids in the quick digestion of biomass-by-biomass microorganisms. The air in this technique is provided via a mechanical aeration system consisting of a blower and diffusers. The SAFF media is supported by the bottom support, which is positioned in the fixed reactor. In addition, SAFF offers several associated benefits including predictable performance, lower operation & maintenance, better whole life costs, easy and simple installation, and no interruption in processing, among others.

8.3.7.1. SUBMERGED AERATED FIXED FILM REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 43. SUBMERGED AERATED FIXED FILM REACTOR FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	32.874	34.258	36.225	38.366	40.645	45.700	61.938	**6.20%**
West	27.805	29.046	30.813	32.744	34.805	39.402	54.355	**6.58%**
South	37.886	39.518	41.840	44.371	47.068	53.063	72.415	**6.35%**
East	22.632	23.555	24.864	26.286	27.796	31.135	41.772	**5.99%**
Total	**121.197**	**126.377**	**133.743**	**141.767**	**150.314**	**169.300**	**230.481**	**6.30%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.3.8. OTHER TREATMENT TECHNOLOGIES

The demand for other treatment technologies such as desalination, and LED technology for water and wastewater treatment is expected to grow significantly during the forecast period. In order to remove chemicals, debris, and biological impurities from water, light emitting diodes (LEDs) trap contaminants in filters. The mesh through which the water is filtered has nanotechnology covering that is illuminated by the LEDs. As a result of the process, molecules split apart and subsequently dissolve in the water as a result of a chemical reaction. In addition to using sunlight to filter water, modern nanotechnology and renewable energy sources are also being utilized. In addition, Desalination may be costly and energy-intensive, but advances in reverse osmosis have made the process of removing salt from ocean water more effective for boosting clean fresh water supplies for drinking and industrial use. When further developments in membrane technology are thrown into the equation, the procedure becomes even more economically viable. Researchers and engineers are also working on using solar electricity instead of gasoline to power water desalination facilities, making the procedure cheaper for underdeveloped nations.

8.3.8.1. OTHER WATER & WASTEWATER TREATMENT TECHNOLOGIES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 44. OTHER WATER & WASTEWATER TREATMENT TECHNOLOGIES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	14.905	15.595	16.578	17.650	18.795	21.345	29.612	**6.71%**
West	16.508	17.317	18.473	19.739	21.095	24.131	34.104	**7.10%**
South	13.455	14.093	15.003	15.997	17.060	19.432	27.156	**6.87%**
East	8.817	9.204	9.754	10.352	10.989	12.402	16.929	**6.37%**
Total	**53.685**	**56.210**	**59.807**	**63.739**	**67.939**	**77.310**	**107.801**	**6.82%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4. TREATMENT CHEMICALS

The market for water treatment chemicals is being driven by rising demand for chemically treated water from various end-use segments, as well as severe environmental regulatory and sustainability standards. Freshwater resources account for only 2.5 percent of total world water resources, making industrial and domestic water supply challenging. The rising demand for water necessitates efficient recycling, which may be accomplished by treating it using water treatment chemicals. As a result, wastewater consumption has increased significantly in many end-use areas such as oil and gas, power production, mining, chemicals, and others. The need for fresh and clean water for home, agricultural, and industrial reasons has expanded dramatically in emerging nations as industrialization has increased. As a result, the demand for water treatment chemicals in such regions is expected to be higher than that in the developed countries. In addition, the purification of water using chemicals is a more cost-effective method than physical purification.

8.4.1. WATER & WASTEWATER TREATMENT CHEMICALS MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 45. WATER & WASTEWATER TREATMENT CHEMICALS MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	371.255	386.053	407.037	429.814	453.979	507.351	676.884	**5.87%**
West	317.936	331.369	350.462	371.250	393.375	442.480	600.329	**6.22%**
South	416.801	433.803	457.935	484.159	512.017	573.660	770.380	**6.01%**
East	262.009	272.120	286.437	301.946	318.367	354.519	468.442	**5.67%**
Total	**1,368.002**	**1,423.344**	**1,501.871**	**1,587.168**	**1,677.738**	**1,878.009**	**2,516.035**	**5.96%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.2. CORROSION INHIBITORS

The demand for corrosion inhibitors for water and wastewater treatment is expected to grow significantly during the forecast period. The term corrosion refers to the process through which a metal becomes chemically soluble and can result in the failure of critical boiler system components, the buildup of corrosion products in critical heat exchange zones, and a general decrease in efficiency. Owing to which corrosion inhibitors are routinely utilized. A metallic surface is protected to some extent by inhibitors, compounds that react with it. Inhibitors usually work by adhering to metallic surfaces and coating them to protect them. There are several different types of corrosion inhibitors, including cathodic, organic, passivators, and others. The passivity inhibitors (passivators), which cause the corrosion potential to change, cause the metallic surface to enter the passive range. These inhibitors are the most potent and are thus used the most frequently.

The cathodic inhibitors, which include compounds of arsenic and antimony, among the other inhibitors, function by making the recombination and discharge of hydrogen more challenging. When present at a certain concentration, organic inhibitors influence the whole surface of corroding metal and shield it by creating a hydrophobic layer. Organic inhibitors will be adsorbed in accordance with their surface charge and ionic charge. Additionally, substances known as precipitation-inducing inhibitors produce precipitates on the metal's surface, coating it with a protective layer. Silicates and phosphates are the most prevalent inhibitors in this group. Volatile Corrosion Inhibitors (VCI) are substances that are transferred to the corrosion site in a sealed environment by the volatilization of a source.

8.4.2.1. CORROSION INHIBITORS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 46. CORROSION INHIBITORS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	96.887	100.694	106.091	111.944	118.150	131.841	175.207	**5.79%**
West	81.001	84.375	89.169	94.384	99.930	112.224	151.629	**6.14%**
South	111.357	115.836	122.189	129.089	136.412	152.599	204.108	**5.93%**
East	71.626	74.351	78.208	82.383	86.801	96.516	127.048	**5.59%**
Total	**360.870**	**375.256**	**395.657**	**417.800**	**441.293**	**493.179**	**657.992**	**5.87%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.3. SCALE INHIBITORS

The demand for scale inhibitors for water and wastewater treatment is expected to grow significantly during the forecast period. Scale is a precipitate that develops on water-contacting surfaces as a result of typically soluble particles that become insoluble with rising temperature. Calcium carbonate, calcium sulphate, and calcium silicate are a few types of scale. Scale inhibitors are negatively charged, surface-active polymers. The polymers bind to the minerals when they become more soluble than they can be and start to combine. Scale development is inhibited by the disruption of the crystalline structure. The scale and inhibitor particles will then be distributed and stay in suspension. Phosphate esters, phosphoric acid, and solutions of low molecular weight polyacrylic acid are a few examples of scale inhibitors. Additionally, as it increases flow velocity and prevents some corrosive compounds from adhering to the walls and tubes, the scale inhibitor also aids in the prevention of corrosion. This covers issues with heating systems, heat exchangers, and other heat transfer equipment. It results in more efficient water production systems by reducing clogging of pipes, water handling machinery, and well tubing.

8.4.3.1. SCALE INHIBITORS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 47. SCALE INHIBITORS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	7.058	7.325	7.703	8.112	8.545	9.497	12.490	**5.57%**
West	7.348	7.642	8.060	8.514	8.996	10.060	13.443	**5.91%**
South	6.215	6.455	6.796	7.166	7.557	8.419	11.142	**5.70%**
East	2.833	2.936	3.083	3.241	3.409	3.775	4.920	**5.38%**
Total	**23.453**	**24.359**	**25.642**	**27.033**	**28.506**	**31.751**	**41.995**	**5.69%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.4. BIOCIDES & DISINFECTANTS

The demand for biocides & disinfectants for water and wastewater treatment is expected to grow significantly during the forecast period. A maximum tolerated microbial population limit in systems is established by laboratory experiments. When these facts are recognized, it is sometimes necessary to significantly reduce the number of bacteria and other microbes. Biocides—chemical substances poisonous to the existing microorganisms—can be added to the mixture to achieve this. In order to achieve quick, effective population reductions from which the microbes cannot readily recover, biocides are often slug-fed to a system. There are many distinct types of biocides, some of which have a variety of effects on several different bacterial species. Oxidizing and non-oxidizing agents can be distinguished between them.

The disinfectants also eliminate any undesired bacteria that are already present in the water. Chlorine (dosage 2–10 mg/L), chlorine dioxide, ozone, hypochlorite, and chlorine dioxide disinfection are only a few examples of the diverse types of disinfectants available. Primarily, ClO_2 is utilized as a major disinfectant for surface waters that have odor and taste issues. It works well as a biocide over a wide pH range and at doses as low as 0.1 ppm. Similar to chlorine, chlorine dioxide also disinfects, however unlike chlorine, chlorine dioxide has no negative health effects on people. Similar to chlorine dioxide and chlorine, hypochlorite is administered. Hypo chlorination is a disinfection method that is not used widely anymore since an environmental agency proved that the Hypochlorite for disinfection in water was the cause of bromate consistency in water.

Additionally, ozone has an astonishingly short lifespan and is a very powerful oxidation medium. O_3 is made up of oxygen molecules that have an additional O-atom added to them. Ozone's additional O-atom immediately oxidizes germs, viruses, and odors when it comes into touch with them. The ozone molecules then lose their third O-atom, leaving just oxygen behind. Different sectors can make use of disinfectants. In the pharmaceutical sector, ozone is used to prepare drinking water, treat process water, create ultra-pure water, and disinfect surfaces. Chlorine dioxide is generally used to disinfect pipes and prepare drinking water.

8.4.4.1. BIOCIDES & DISINFECTANTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 48. BIOCIDES & DISINFECTANTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	85.686	89.070	93.868	99.074	104.594	116.776	155.405	**5.82%**
West	72.171	75.193	79.487	84.159	89.130	100.153	135.519	**6.17%**
South	97.782	101.734	107.343	113.434	119.903	134.204	179.762	**5.96%**
East	62.463	64.852	68.233	71.894	75.769	84.293	111.109	**5.62%**
Total	**318.102**	**330.849**	**348.931**	**368.561**	**389.395**	**435.427**	**581.796**	**5.90%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.5. COAGULANTS & FLOCCULANTS

The demand for coagulants & flocculants for water and wastewater treatment is expected to grow significantly during the forecast period. The processes used by industrial wastewater treatment units frequently include sedimentation. The process of sedimentation, often referred to as clarifying, involves lowering the wastewater's velocity below the suspension velocity so that the suspended particles can gravitationally settle out of the wastewater. Sludge is used to remove particles that have settled, whereas scum is used to remove solids that are floating. After exiting the sedimentation tank over an effluent weir, industrial wastewater is transferred to the following step of treatment. Coagulants, which speed up the sedimentation, are added to the clarity tanks as part of the coagulation and flocculation process. Inorganic or organic compounds like high molecular weight cationic polymer, aluminium hydroxide chloride, or aluminium sulphate are used as coagulants. The use of coagulant at this stage of treatment aims to remove around 90% of the suspended particles from industrial wastewater.

Furthermore, polymer flocculants (polyelectrolytes) are used to encourage the creation of linkages between particles in water that contains suspended solids in order to increase floc formation. Based on their charges, molar weights, and molecular degree of ramification, these polymers have a highly unique impact. The polymers have a molar weight that ranges between 105 and 106 g/mol and are water soluble. On a single flocculent, numerous charges may exist. There are polymers that are both positively and negatively charged, cationic polymers made of nitrogen, anionic polymers made of carboxylate ions, and polyampholytes.

8.4.5.1. COAGULANTS & FLOCCULANTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 49. COAGULANTS & FLOCCULANTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	26.690	27.803	29.384	31.103	32.933	36.987	49.986	**6.14%**
West	25.019	26.124	27.699	29.417	31.251	35.337	48.600	**6.51%**
South	27.130	28.288	29.934	31.727	33.636	37.878	51.540	**6.29%**
East	15.273	15.889	16.764	17.713	18.721	20.947	28.025	**5.93%**
Total	**94.112**	**98.104**	**103.780**	**109.961**	**116.541**	**131.149**	**178.151**	**6.25%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.6. CHELATING AGENTS

The demand for chelating agents for water and wastewater treatment is expected to grow significantly during the forecast period. Cheating substances are often referred to as sequestrants. The molecules of the chelating agent create many bonds with the metal ions to stop the metal from reacting properly. The fundamental structure and chemical make-up of metal ions are altered by bonding. Many metals have chemical structures that are quite similar to chains. The ends of these "chain-like" structures are joined by chelating agents to stable rings that are mobile in many settings. Chelating agents are utilized in numerous consumer goods, including shampoos and food preservatives, as water softeners for chemical analysis. EDTA is a synthetic chelating agent that is often used. This phrase is used to define steam technology-specific boiler water treatment systems in water treatment projects. During routine operation, the boiler uses the chelating agent to dissolve common forms of scale and to offer efficient online and offline scale removal. It is frequently employed in the agriculture sector for water treatment. To increase their cleaning power, chelating compounds are generally utilized in soaps, shampoos, and detergents. It is transformed into a metallic salt and used as a water-soluble fertilizer in agriculture. There are also readily accessible environmentally friendly biodegradable chelating agents (ASDA).

8.4.6.1. CHELATING AGENTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 50. CHELATING AGENTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	54.667	56.931	60.146	63.643	67.360	75.597	101.965	**6.10%**
West	49.931	52.123	55.244	58.648	62.280	70.367	96.576	**6.47%**
South	57.289	59.717	63.168	66.927	70.928	79.810	108.380	**6.24%**
East	33.445	34.786	36.688	38.751	40.941	45.777	61.129	**5.89%**
Total	**195.332**	**203.556**	**215.245**	**227.969**	**241.509**	**271.550**	**368.050**	**6.20%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.7. ANTI-FOAMING AGENTS

The demand for anti-foaming agents for water and wastewater treatment is expected to grow significantly during the forecast period. Foam, a mass of bubbles, is created when certain forms of gas are dispersed in a liquid. After then, the bubbles are encircled by thick liquid layers, which results in a massive volume of useless foam. Physical chemists struggle to understand how foam forms, yet its presence has a significant negative impact on both the efficiency of industrial processes and the caliber of the finished product. If foam is not regulated, it may reduce the capacity of equipment, extend operations, and increase expenditures. Silica and oils are included in trace amounts in antifoam mixtures. They damage foam because silicone tends to spread and has issues operating in watery settings. Antifoam compounds are available either as a powder or as an emulsion of the pure product.

Additionally, a set of goods based on modified polydimethylsiloxane are covered by the antifoam powder. Although the goods' fundamental characteristics differ, as a whole, they introduce outstanding antifoaming in a variety of applications and circumstances. Since the antifoams are chemically inert, they do not interact with the defoamed media. They do not corrode materials and have no taste, smell, volatility, or odor. The powdered product's inability to be employed in watery solutions is its only drawback. Antifoam Emulsions are also polydimethylsiloxane fluid aqueous emulsions. The main difference is that they may also be used in watery solutions, otherwise they have the same qualities as the powder version.

8.4.7.1. ANTI-FOAMING AGENTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 51. ANTI-FOAMING AGENTS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	71.838	74.635	78.599	82.896	87.449	97.487	129.227	**5.74%**
West	59.645	62.107	65.603	69.405	73.446	82.397	111.033	**6.08%**
South	83.110	86.422	91.119	96.217	101.626	113.572	151.517	**5.87%**
East	53.790	55.818	58.688	61.792	65.075	72.291	94.927	**5.54%**
Total	**268.383**	**278.983**	**294.009**	**310.310**	**327.597**	**365.747**	**486.704**	**5.82%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.8. PH ADJUSTERS AND STABILIZERS

The demand for pH adjusters and stabilizers for water and wastewater treatment is expected to grow significantly during the forecast period. Municipal water is frequently pH-adjusted in order to stop pipe corrosion and lead from dissolving into water sources. pH modifications may also be necessary during water treatment. By adding acidic or basic substances, the pH can be raised or decreased. In the instance of a basic liquid, adding hydrogen chloride is an illustration of how to reduce the pH. The addition of sodium hydroxide in the case of an acidic liquid is one example of raising the pH. When certain amounts of acidic or basic substances are added, the pH will change to between seven and seven and a half. The type and concentration of the material introduced depend on whether the pH has to be decreased or increased.

In order to stabilize the sludge solids, the sludge matrix is also subjected to a variety of chemical treatments. The stabilization of lime and the application of chlorine are two often used techniques. The treatment of raw primary, waste activated, septage, and anaerobically digested sludge may all be accomplished using the lime stabilization method. The sludge must be combined with enough lime during the procedure to raise the mixture's pH to 12 or higher. This often decreases bacterial risks and odor to minimal levels, enhances vacuum filter performance, and offers a sufficient method of stabilizing the sludge prior to disposal.

8.4.8.1. PH ADJUSTERS AND STABILIZERS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 52. PH ADJUSTERS AND STABILIZERS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	17.295	18.023	19.059	20.186	21.386	24.047	32.599	**6.21%**
West	13.030	13.612	14.441	15.347	16.314	18.470	25.484	**6.58%**
South	21.751	22.688	24.022	25.477	27.026	30.471	41.592	**6.35%**
East	15.140	15.758	16.634	17.586	18.597	20.832	27.955	**6.00%**
Total	**67.216**	**70.082**	**74.157**	**78.595**	**83.322**	**93.820**	**127.629**	**6.28%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.4.9. OTHERS

The demand for other treatment chemicals such as resin cleaners, oxygen scavengers for water and wastewater treatment is expected to grow significantly during the forecast period. After application, the ion exchange resins must be regenerated before they may be utilized. However, fouling occurs every time the ion exchangers are employed. Because impurities that enter resins are not eliminated by regeneration, resins must be cleaned using specific chemicals. Chemicals such as sodium chloride, potassium chloride, citric acid, and chlorine dioxide are employed. Cleaning with chlorine dioxide aids in the removal of organic impurities from ion exchange resins. Resins should be replenished prior to each cleaning process. If chlorine dioxide is utilized, 500 ppm of solution chlorine dioxide is poured over the resin bed and oxidizes the impurities.

In addition, scavenging oxygen involves stopping oxygen from initiating oxidation processes. The majority of naturally occurring organics are somewhat negatively charged. They can absorb oxygen molecules because they have a little positive charge, preventing oxidation events in water and other liquids. Oxygen scavengers include both volatile molecules like hydrazine (N_2H_4) and other organic compounds like carbohydrazine, hydroquinone, diethylhydroxyethanol, and methylethylketoxime, as well as non-volatile salts such sodium sulphite (Na_2SO_3) and other inorganic compounds or derivatives thereof. Catalyzing chemicals, such as cobalt chloride, are frequently used in salts to speed up the reaction with dissolved oxygen.

8.4.9.1. OTHER CHEMICALS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 53. OTHER CHEMICALS FOR WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	11.136	11.571	12.188	12.856	13.563	15.118	20.005	**5.71%**
West	9.791	10.191	10.759	11.376	12.029	13.472	18.045	**5.96%**
South	12.168	12.662	13.363	14.123	14.929	16.708	22.339	**5.93%**
East	7.440	7.730	8.140	8.585	9.055	10.088	13.330	**5.68%**
Total	**40.534**	**42.155**	**44.450**	**46.939**	**49.576**	**55.385**	**73.718**	**5.83%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.5. PROCESS CONTROL AND AUTOMATION

The demand for process control and automation is expected to grow significantly during the forecast period. Modern water and wastewater systems rely heavily on instrumentation, control, and automation (ICA). Because of the constant presence of disruptions, it is vital to automatically mitigate their repercussions. A wastewater treatment system is driven by load, whereas a water distribution system is driven by demand. Regardless of the fluctuation, the system outputs must be adequate. Economic considerations urge the use of ICA to make the most use of plant capacity. The rising complexity of competing processes in a contemporary nutrient removal plant need more intricate management. The ultimate aim of natural resource protection involves an integrated perspective of numerous interdependent systems, including collection, transport, and treatment procedures. ICA will be a critical technology in this integrated development.

Moreover, Successful process control requires knowledgeable staff for maintenance. Regular operator choices are less important with automation, but effective routine maintenance and the availability of qualified workers for operational emergencies are still necessary. The execution of the microprocessor control projects would be accomplished through the employment of private consulting firms that have an interest in managing treatment plants as an offered service in order to assure such expertise at small facilities. The growth prompted the creation of an intelligent, decentralized network for the automation system and further encouraged the establishment of an information system in an integrated company for control and administration.

8.5.1. WATER & WASTEWATER TREATMENT PROCESS CONTROL AND AUTOMATION MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 54. WATER & WASTEWATER TREATMENT PROCESS CONTROL AND AUTOMATION MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	1,001.917	1,042.339	1,099.689	1,161.975	1,228.102	1,374.294	1,839.799	**5.94%**
West	912.891	951.932	1,007.451	1,067.938	1,132.362	1,275.488	1,736.765	**6.30%**
South	977.281	1,017.632	1,074.932	1,137.241	1,203.475	1,350.184	1,819.538	**6.08%**
East	555.232	576.919	607.644	640.946	676.228	753.981	999.570	**5.74%**
Total	**3,447.321**	**3,588.822**	**3,789.716**	**4,008.099**	**4,240.167**	**4,753.948**	**6,395.672**	**6.05%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.6. DESIGN, ENGINEERING, AND CONSTRUCTION SERVICES

The demand for design, engineering, and construction services is expected to grow significantly during the forecast period. Compliance with a plethora of environmental standards necessitates owners and operators carefully consider the risks when making wastewater management decisions now that may affect their operations later in the operation cycle. These decisions need efficient, coordinated, and phased procedures that take into consideration economic, social, environmental, and political ramifications. Design, engineering, and construction services range from planning and design to permits and project management. The service provider creates ecologically friendly wastewater solutions that fulfill severe state and federal regulatory requirements. Their teams may assist restrict discharge to surface water and drastically transform wastewater management in the future by remaining at the forefront of emerging treatment technologies and regulations for distinct waste streams. Power generating, oil & gas, and industrial customers benefit from engineering and construction services in both short and long-term time periods. They provide a team of engineers that specialize in reviewing regulations, discovering technological solutions and business consequences for compliance alternatives, and building engineering solutions to handle site-specific difficulties.

8.6.1. WATER & WASTEWATER TREATMENT DESIGN, ENGINEERING, AND CONSTRUCTION SERVICES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 55. WATER & WASTEWATER TREATMENT DESIGN, ENGINEERING, AND CONSTRUCTION SERVICES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	678.470	707.025	747.607	791.781	838.789	943.079	1,278.058	**6.20%**
West	621.490	649.217	688.718	731.855	777.912	880.619	1,214.685	**6.57%**
South	735.828	767.522	812.607	861.746	914.103	1,030.497	1,406.189	**6.35%**
East	365.298	380.183	401.305	424.249	448.612	502.486	674.087	**5.99%**
Total	**2,401.085**	**2,503.947**	**2,650.237**	**2,809.630**	**2,979.416**	**3,356.680**	**4,573.019**	**6.31%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

8.7. OPERATION AND MAINTENANCE SERVICES

The demand for operation and maintenance services is expected to grow significantly during the forecast period. Operations and maintenance comprise the choices and steps taken in relation to the management and maintenance of the real estate and machinery. Operations involve making ensuring the plant generates the appropriate amount and quality of treated water while also complying with current regulations, whereas maintenance involves making sure the plant's equipment continues to operate effectively in order to satisfy operational goals. Water treatment facilities have become more complex, new technologies have emerged, raw water is more difficult to treat, the treatment requires more innovative solutions, there is a rising demand for services, diminishing resources, rising customer service expectations, and more stringent regulatory requirements. Water and wastewater treatment plants that were traditionally used become highly advanced, and high-tech. Monitoring is not just for taste, odor, iron, and manganese. All of this leads to an analysis and improvement in maintaining and operating the water and wastewater sector, as well as the treatment facilities that need to be built or enlarged to handle these significant changes, further increasing the acceptance of operation and maintenance services.

8.7.1. WATER & WASTEWATER TREATMENT OPERATION AND MAINTENANCE SERVICES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 56. WATER & WASTEWATER TREATMENT OPERATION AND MAINTENANCE SERVICES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	368.800	382.866	402.774	424.325	447.129	497.281	654.910	**5.60%**
West	426.323	443.732	468.437	495.277	523.781	586.824	787.737	**6.00%**
South	414.865	431.114	454.136	479.092	505.534	563.814	747.951	**5.76%**
East	327.209	339.634	357.217	376.245	396.372	440.614	579.487	**5.58%**
Total	**1,537.198**	**1,597.347**	**1,682.564**	**1,774.939**	**1,872.816**	**2,088.533**	**2,770.086**	**5.75%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9. INDIA WATER AND WASTEWATER TREATMENT MARKET BY EQUIPMENT INSIGHTS & TREND

KEY TRENDS & HIGHLIGHTS

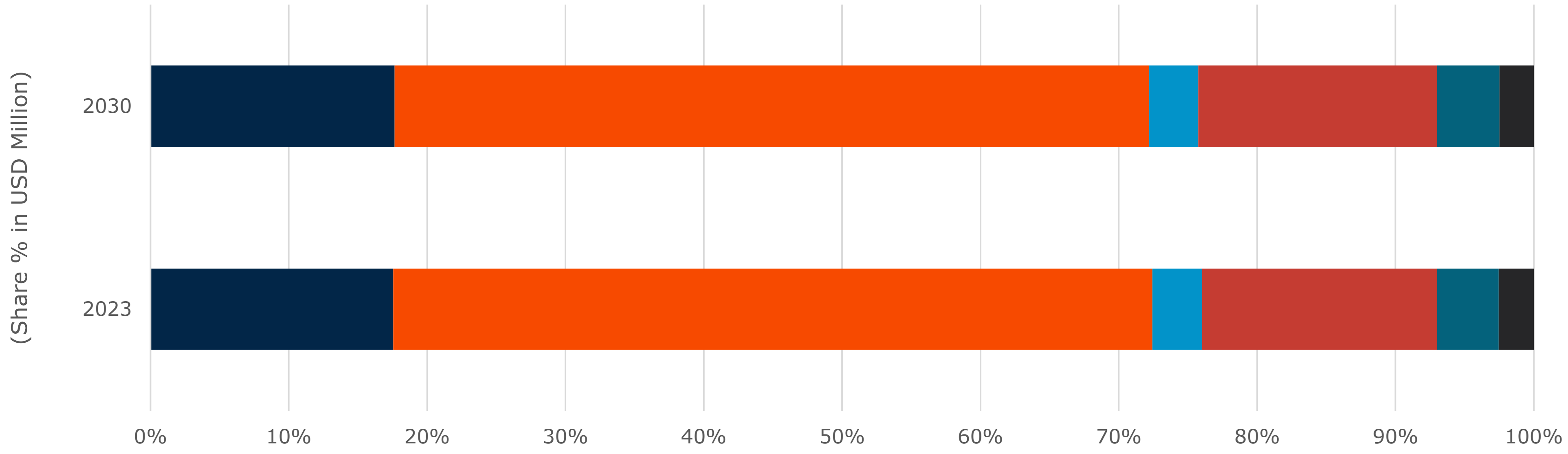
- The demand for Disinfection equipment accounted for over USD 6,798.517 Million in 2022 and is expected to grow at a CAGR of 5.99% in the forecast period.

9.1. EQUIPMENT DYNAMICS & MARKET SHARE, 2023 & 2030

By Equipment, the market is segmented into:

- Filtration
- Disinfection
- Adsorption
- Desalination
- Testing
- Others

FIGURE 74. INDIA WATER AND WASTEWATER TREATMENT MARKET: EQUIPMENT DYNAMICS (SHARE IN % USD MILLION)



	2023	2030
Filtration	17.56%	17.64%
Disinfection	54.87%	54.57%
Adsorption	3.60%	3.54%
Desalination	16.98%	17.27%
Testing	4.45%	4.49%
Others	2.53%	2.49%

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.2. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY EQUIPMENT, 2019-2030, (USD MILLION)

TABLE 57. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY EQUIPMENT, 2019-2030, (USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	1,863.794	1,941.561	2,052.043	2,172.248	2,300.102	2,583.553	3,492.374	**6.15%**
Disinfection	5,854.987	6,093.173	6,431.218	6,798.517	7,188.642	8,051.707	10,804.486	**5.99%**
Adsorption	387.003	402.250	423.861	447.304	472.160	527.005	700.809	**5.80%**
Desalination	1,791.608	1,868.640	1,978.211	2,097.620	2,224.839	2,507.610	3,419.981	**6.33%**
Testing	471.751	491.647	519.924	550.708	583.470	656.169	889.787	**6.21%**
Others	271.735	282.529	297.819	314.390	331.944	370.611	492.543	**5.80%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.3. FILTRATION

The demand of filtration equipment is expected to grow significantly in the forecast period. Water filtration is a treatment method in which variety of filters are being used to remove undesired substances such as, chemical compounds, biological contaminants, organic and inorganic materials, among others. Some of the contaminants that can be removed includes, bacteria, parasites, suspended particles, viruses, algae and fungi, among others. Variety of water filters are used in the filtration equipment such as, mechanical, ion exchange, absorption, reverse osmosis and sequestration, among others. These water filters eliminate the impurities by reducing the water concentration by utilizing physical barrier, a chemical process, and a biological process. Over the recent years, water filters consisting of nanofibers of ion exchange properties are extensively being utilized in the end-use sectors such as, pharmaceutical processing, biotechnology, semiconductor, battery technologies and catalytic conversion processing, among others. Thus, the demand for filtration equipment would rise in the upcoming years.

Moreover, the demand of ultra-filtration equipment is likely to grow significantly in the forecast period. It is water filtration process that utilizes a hollow fiber or sheet membrane for filtering water that consists of very small particulate. The filtration through this equipment is performed by hydrostatic pressure that forces liquid against a semi permeable membrane. Thus, water and low molecular weight solutes pass through the membrane and suspended solids and solutes of high molecular weight are retained. This filtration technology can filter particulate down to nearly 0.025 microns. As compared to microfiltration or standard carbon filter, this equipment can be comparatively removes smaller particulate. The adoption of this equipment for Water softening, treatment and recycling of wastewater and industrial process water is anticipated to grow for removing organic molecules, viruses and range of salts. Over the past few years, this water filtration has gained much more attention as it produces a stable water quality without relying on water source water. The equipment has compact physical footprint and eliminates approximately 90 to 100 percent of pathogens which would have positive influence on the ultra-filtration equipment in the forecast years.

Micro-filtration equipment consisting of membrane usually physically eliminates suspended solids from water. The membranes used in this system ranges pore size from 0.1 – 10 microns. This pore size is relatively larger than other filtration system thus owing to its larger pore size it can easily remove bacteria, flour, fine dust, blood cells and talc, among others. Owing to their larger pore size the equipment can be operated under low pressures usually less than 100 psig. Generally, micro-filtration of water is being carried out by crossflow separation, in which water source as a feed stream is fed into the membrane under pressure and is further passed through this membrane surface in a controlled flow path. The substance which are relatively larger than the pores are flushed away and are referred to as concentrate. Whereas substance which are comparatively smaller in size than pore size and passes through membrane are as called permeate. As crossflow membrane filtration uses relatively higher cross flow rate to enhance permeate passage and aids to prevent the fouling of the membrane which would propel the demand for micro-filtration equipment in the projected years.

9.3.1. FILTRATION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 58. FILTRATION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	527.296	548.890	579.546	612.866	648.270	726.636	976.926	**6.03%**
West	535.319	558.558	591.626	627.682	666.118	751.620	1,028.068	**6.40%**
South	516.604	538.255	569.020	602.501	638.120	717.117	970.629	**6.17%**
East	284.575	295.858	311.851	329.200	347.595	388.180	516.750	**5.83%**
Total	**1,863.794**	**1,941.561**	**2,052.043**	**2,172.248**	**2,300.102**	**2,583.553**	**3,492.374**	**6.15%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.4. DISINFECTION

The demand of disinfection equipment is estimated to grow significantly in the forecast period. Water disinfection is method of removal, deactivation and eliminating of pathogenic microorganisms. This helps in inhibit the growth and reproduction of these microorganisms. This equipment is widely used for production of high-quality water that can be consumed at residential and industrial purpose. The system usually utilizes chemical and physical methods to eliminate microorganisms such as, fungi, bacteria and viruses. Furthermore, one of the most utilized disinfectant equipment is UV Disinfection System. The system has ultraviolet light of wavelength ranging from 240-280 nanometres which is widely used to destroy the algae, viruses, bacteria, and molds, among others. UV rays destroys the DNA of these microorganism which results in death and unable to grow further. It is mostly used for disinfecting drinking water, surface disinfection, process water disinfection and wastewater disinfection, among others. It can be also utilized to total organic carbon (TOC) removal and ozone destruction. Thus, owing to wide range of application associated with disinfection equipment, demand for them would have influence in the upcoming years.

9.4.1. DISINFECTION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 59. DISINFECTION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	1,626.174	1,691.188	1,783.396	1,883.493	1,989.713	2,224.364	2,970.182	**5.89%**
West	1,586.465	1,653.699	1,749.275	1,853.350	1,964.142	2,210.092	3,001.225	**6.24%**
South	1,658.651	1,726.515	1,822.852	1,927.558	2,038.806	2,285.033	3,071.303	**6.03%**
East	983.697	1,021.772	1,075.695	1,134.115	1,195.982	1,332.218	1,761.777	**5.69%**
Total	**5,854.987**	**6,093.173**	**6,431.218**	**6,798.517**	**7,188.642**	**8,051.707**	**10,804.486**	**5.99%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.5. ADSORPTION

The demand of adsorption equipment is expected to grow significantly in the forecast period. Adsorption is a type of wastewater purification method which is widely used to eliminate the variety of compounds from industrial wastewater. It is mostly used for removal of non-degradable organic compounds from water sources such as, drinking water preparation, groundwater, and process water, among others. Adsorption equipment is utilized to adhere molecules to a surface in a process stream. Adsorbents used in the system have relatively high internal surface area which allows adsorption process. Some of the most common adsorbent used includes, natural or synthetic zeolites, silicic acid, activated carbon, natural clay minerals and silica gel and activated aluminium, among others. Activated carbon is among one of the most popular adsorbents for removal of apolar compounds. As this equipment is of simple design and requires relatively lower investment at initial and required land, the demand for them would rise in the forecast years.

9.5.1. ADSORPTION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 60. ADSORPTION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	105.400	109.494	115.295	121.582	128.244	142.927	189.332	**5.72%**
West	74.860	77.942	82.319	87.078	92.135	103.336	139.147	**6.07%**
South	137.352	142.812	150.555	158.957	167.871	187.553	250.040	**5.86%**
East	69.391	72.000	75.692	79.686	83.910	93.190	122.289	**5.53%**
Total	**387.003**	**402.250**	**423.861**	**447.304**	**472.160**	**527.005**	**700.809**	**5.80%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.6. DESALINATION

The demand of desalination equipment is projected to grow significantly in the forecast period. Water desalination equipment is extensively used to removal of salts and other minerals from water sources mostly sea water for further use in oil field, drinking water and process separation applications. This equipment usually utilizes three basic technologies including, thermal desalination, separation desalination and chemical desalination. In thermal desalination systems initially, water is converted into vapor and further is physically separated new phase is removed from remaining salt solution and converts into liquid. In separation desalination system, components are being physically separated during movement with respect to an externally-applied gradient such as a membrane. In chemical desalination systems, chemical process is used along with membranes or distillation. This equipment is widely implemented in residences, hotels, resorts, boats and several other industrial applications. Thus, owing to wide range of adoption of desalination equipment the demand for it would rise in the upcoming years.

9.6.1. DESALINATION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 61. DESALINATION EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	494.820	515.746	545.492	577.879	612.352	688.866	934.876	**6.23%**
West	448.595	468.705	497.360	528.661	562.091	636.672	879.515	**6.60%**
South	542.388	565.863	599.263	635.675	674.483	760.791	1,039.664	**6.38%**
East	305.805	318.326	336.097	355.405	375.913	421.280	565.927	**6.02%**
Total	**1,791.608**	**1,868.640**	**1,978.211**	**2,097.620**	**2,224.839**	**2,507.610**	**3,419.981**	**6.33%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.7. TESTING

The demand of testing equipment is likely to grow significantly in the forecast period. Water testing is a process in which continuous sampling of several liquid streams are being collected and further analysis is being performed to check their quality. Some of the most common liquid streams includes, groundwater, watercourses such as rivers and lakes, boiler feed water, process effluents and recirculated cooling streams, among others. The end-users are widely adopting water testing equipment for preserving a safe public drinking supply and enhancing industrial process efficiency which would have positive influence on the cost reduction. Most widely used water testing equipment includes, colorimeters, test kits for bacteria and chemical compounds, multiparameter meters for measuring pH, TDS testers, oxidation-reduction potential (ORP) instruments, and turbidimeters, among others. This testing equipment are widely used to verify several water affecting factors including, pH value, total dissolved solvents (TDS), rate of movement, turbidity, oxygen, conductivity and nitrogen, among others. Thus, the demand for water testing equipment would rise in the projected years.

9.7.1. TESTING EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 62. TESTING EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	156.476	162.961	172.170	182.186	192.836	216.432	291.977	**6.11%**
West	121.188	126.512	134.090	142.360	151.181	170.824	234.497	**6.47%**
South	131.527	137.105	145.035	153.670	162.862	183.271	248.927	**6.25%**
East	62.560	65.070	68.629	72.492	76.591	85.643	114.386	**5.90%**
Total	**471.751**	**491.647**	**519.924**	**550.708**	**583.470**	**656.169**	**889.787**	**6.21%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

9.8. OTHERS

The others segment consists of biological and solar photocatalytic wastewater treatment, among others. Revenue growth of the other segment is expected to increase to significantly during the forecast period. Bacteria, protozoa, and other specialty microbes are usually used in biological wastewater treatment systems for water cleaning. The organic pollutants present in the water sources are break down by these microorganisms, this led to influence on flocculation effect which allows organic matter to settle out of the solution. From this process, easier-to-manage sludge is being produced that can further dewatered and disposed of as solid waste. Furthermore, solar photocatalytic wastewater treatment helps in eliminating sludge amount by nearly 80 percent as compared with conventional wastewater treatment systems. This process can be performed by photocatalytic system by solar irradiation which is synergetic effect when merged with hydrogen peroxide eliminates the amount of carbon in the sludge. The equipment can be used for solar water disinfection, water splitting, and wastewater treatment, among others. Thus, the demand for other water and wastewater treatment equipment would have influence in the forecast years.

9.8.1. OTHER EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 63. OTHER EQUIPMENT IN WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	42.219	43.817	46.076	48.515	51.089	56.726	74.236	**5.48%**
West	58.475	60.905	64.352	68.096	72.071	80.856	108.784	**6.06%**
South	79.376	82.571	87.098	92.009	97.214	108.694	144.994	**5.88%**
East	91.664	95.236	100.293	105.771	111.570	124.336	164.529	**5.71%**
Total	**271.735**	**282.529**	**297.819**	**314.390**	**331.944**	**370.611**	**492.543**	**5.80%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10. INDIA WATER AND WASTEWATER TREATMENT MARKET BY END-USE INSIGHTS & TREND

KEY TRENDS & HIGHLIGHTS

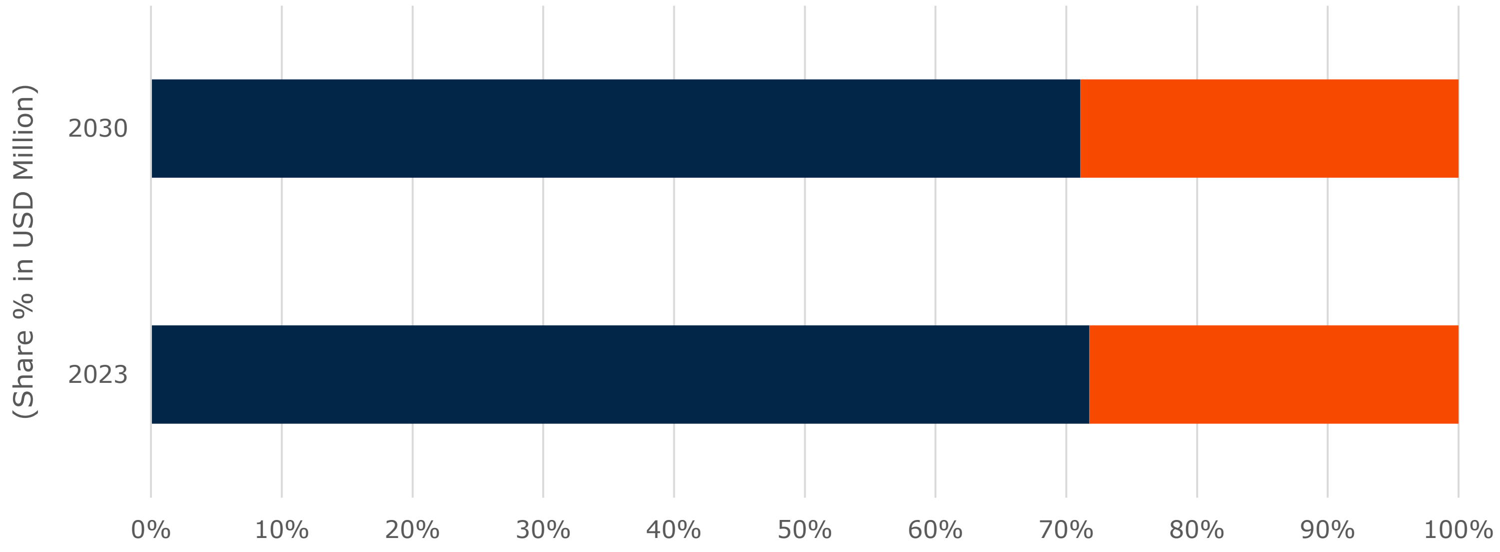
- The demand form Industrial sector accounted for over USD 3,484.882 Million in 2022 and is expected to grow at a CAGR of 6.44% in the forecast period.

10.1. END-USE DYNAMICS & MARKET SHARE, 2023 & 2030

By end-Use, the market is segmented into:

- Municipal
  - Government and Public Utilities
  - Local Communities
- Industrial
  - Power Generation
  - Oil and Gas
  - Food and Beverage
  - Chemicals
  - Pharmaceuticals
  - Others

FIGURE 75. INDIA WATER AND WASTEWATER TREATMENT MARKET: END-USE DYNAMICS (SHARE IN % USD MILLION)



	2023	2030
Municipal	71.76%	71.08%
Industrial	28.24%	28.92%

Source: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.2. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY END-USE, 2019-2030, (USD MILLION)

TABLE 64. INDIA WATER AND WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY END-USE, 2019-2030, (USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**7,672.408**	**7,981.422**	**8,419.819**	**8,895.905**	**9,401.306**	**10,518.473**	**14,074.535**	**5.93%**
Government and Public Utilities	*5,065.533*	*5,276.768*	*5,576.858*	*5,903.346*	*6,250.596*	*7,020.404*	*9,488.279*	**6.14%**
Local Communities	*2,606.875*	*2,704.654*	*2,842.962*	*2,992.558*	*3,150.710*	*3,498.070*	*4,586.256*	**5.51%**
Industrial	**2,968.471**	**3,098.377**	**3,283.257**	**3,484.882**	**3,699.852**	**4,178.182**	**5,725.445**	**6.44%**
Power Generation	*568.630*	*592.071*	*625.350*	*661.525*	*699.964*	*785.057*	*1,056.853*	**6.06%**
Oil and Gas	*254.547*	*264.670*	*279.022*	*294.594*	*311.109*	*347.560*	*463.151*	**5.85%**
Food and Beverage	*322.947*	*336.877*	*356.691*	*378.282*	*401.283*	*452.397*	*617.229*	**6.34%**
Chemicals	*399.791*	*417.792*	*443.440*	*471.457*	*501.378*	*568.126*	*785.398*	**6.62%**
Pharmaceuticals	*579.578*	*606.317*	*644.456*	*686.178*	*730.800*	*830.568*	*1,157.119*	**6.79%**
Others	*842.977*	*880.651*	*934.297*	*992.847*	*1,055.318*	*1,194.474*	*1,645.694*	**6.55%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

10.3. MUNICIPAL

The demand of water and wastewater treatment in municipal sector is likely to grow significantly in the forecast period. Municipal wastewater treatment is a method in which harmful pollutants are eliminated from the wastewater. The key sources of for these pollutants are sewage and wastewater released from households, and commercial buildings such as hotels, and schools, among others. These pollutants are treated by several methods such as, physical, chemical, and biological process. Mostly three stages including, preliminary, primary, secondary and tertiary processes are used in the municipal water & wastewater treatment plants. Initially in preliminary stage the wastewater passes through screens and grit removal. Screening aids in removal of coarse solids such as rag whereas, grit removal helps in separating inorganic, heavy and sand solids. In primary stage in municipal wastewater treatment excrement is passed through the large tanks and these tanks are utilized for skimming off the oils and grease from sludge that are being settled down in the tanks. Further, this refines filths are collected at the bottom of tank and is pumped to filth treatment facilities. The secondary treatment helps in reducing the biological pollutants are that are generated from human waste, detergents, soaps and foods, among others. This filth liquid is treated by the aerobic biological process. At last stage this liquid is disinfected from pathogenic microorganisms and viruses with helps of tertiary treatment. This treated water can be used in agricultural, commercial, industrial, and municipal activities. Thus, the demand for water and wastewater treatment plant in municipal sector would rise in the upcoming years.

10.3.1. WATER & WASTEWATER TREATMENT FOR MUNICIPAL REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 65. WATER & WASTEWATER TREATMENT FOR MUNICIPAL REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	2,097.079	2,180.069	2,297.728	2,425.385	2,560.777	2,859.628	3,807.578	**5.83%**
West	2,052.292	2,138.384	2,260.720	2,393.860	2,535.512	2,849.694	3,858.147	**6.18%**
South	2,264.473	2,356.184	2,486.323	2,627.690	2,777.807	3,109.786	4,167.691	**5.97%**
East	1,258.564	1,306.784	1,375.049	1,448.970	1,527.209	1,699.365	2,241.119	**5.63%**
Total	**7,672.408**	**7,981.422**	**8,419.819**	**8,895.905**	**9,401.306**	**10,518.473**	**14,074.535**	**5.93%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.3.2. GOVERNMENT AND PUBLIC UTILITIES

Effective water and wastewater treatment is a cornerstone of modern society, ensuring access to clean and safe water while safeguarding the environment. Government agencies and public utilities play a pivotal role in managing these critical processes, maintaining the well-being of communities and ecosystems alike. The integration of advanced technologies and comprehensive regulatory frameworks is essential to address the growing challenges posed by population growth, urbanization, and industrial expansion. Government agencies shoulder the responsibility of formulating and enforcing regulations that govern water quality standards and wastewater discharge limits. These regulations not only protect human health but also preserve aquatic ecosystems. For instance, The Jal Jeevan Mission, a government initiative, aimed to provide piped water supply to all rural households by 2024. The mission's goal was to ensure access to tap water to every household, thus reducing the dependence on untreated water sources.

Public utilities, both at the local and national levels, are entrusted with the vital task of delivering potable water to households and industries, while effectively treating and managing wastewater. Cutting-edge technologies such as membrane filtration, UV disinfection, and advanced oxidation processes have revolutionized the treatment landscape, enhancing the removal of contaminants and pollutants. By embracing smart water management systems, utilities can optimize operations, reduce energy consumption, and minimize water loss. Collaboration between government agencies and public utilities is paramount to achieving sustainable water resource management. Robust investment in infrastructure upgrades and maintenance ensures the longevity of treatment facilities, reducing the risk of waterborne diseases and environmental degradation. Moreover, raising public awareness about water conservation and pollution prevention remains a shared endeavor, fostering a culture of responsible water usage.

10.3.2.1. WATER & WASTEWATER TREATMENT FOR GOVERNMENT AND PUBLIC UTILITIES REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 66. WATER & WASTEWATER TREATMENT FOR GOVERNMENT AND PUBLIC UTILITIES MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	1,391.412	1,448.403	1,529.310	1,617.249	1,710.688	1,917.518	2,578.127	**6.03%**
West	1,380.577	1,440.518	1,525.814	1,618.818	1,717.961	1,938.515	2,651.633	**6.40%**
South	1,481.645	1,543.752	1,632.002	1,728.042	1,830.218	2,056.828	2,784.080	**6.18%**
East	811.900	844.095	889.733	939.238	991.729	1,107.543	1,474.439	**5.83%**
Total	**5,065.533**	**5,276.768**	**5,576.858**	**5,903.346**	**6,250.596**	**7,020.404**	**9,488.279**	**6.14%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.3.3. LOCAL COMMUNITIES

Water and wastewater treatment play a pivotal role in ensuring the health and well-being of local communities by providing access to clean and safe water resources. In India, a country grappling with water scarcity and pollution challenges, efficient water and wastewater management is of paramount importance. The government has recognized the urgency of addressing these issues and has implemented various strategies to improve water quality and availability. According to government statistics, as of 2021, only about 40% of India's population has access to piped water supply, emphasizing the need for enhanced water treatment infrastructure. Moreover, a significant proportion of available water sources are contaminated with pollutants, jeopardizing public health. To combat these issues, the Indian government has launched ambitious initiatives such as the Swachh Bharat Mission and the Jal Jeevan Mission. These programs focus on improving water quality, sanitation facilities, and promoting community awareness about responsible water usage and conservation.

Local communities' benefit from these efforts through improved access to potable water and the prevention of waterborne diseases. Robust treatment processes involving physical, chemical, and biological methods are employed to purify raw water from various sources, making it safe for consumption. Additionally, wastewater treatment plants mitigate the environmental impact of untreated sewage and industrial effluents, safeguarding ecosystems and preserving the ecological balance. Community involvement is a crucial aspect of these initiatives. Local residents are educated about the importance of water conservation, pollution prevention, and the significance of proper waste disposal. Furthermore, decentralized treatment systems, such as constructed wetlands and community-based filtration units, are being introduced in rural areas to ensure sustainable water management.

10.3.3.1. WATER & WASTEWATER TREATMENT FOR LOCAL COMMUNITIES REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 67. WATER & WASTEWATER TREATMENT FOR LOCAL COMMUNITIES REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	705.667	731.666	768.418	808.136	850.089	942.110	1,229.452	**5.41%**
West	671.715	697.866	734.906	775.042	817.551	911.180	1,206.514	**5.72%**
South	782.828	812.433	854.321	899.649	947.589	1,052.957	1,383.611	**5.56%**
East	446.664	462.689	485.316	509.732	535.481	591.822	766.680	**5.26%**
Total	**2,606.875**	**2,704.654**	**2,842.962**	**2,992.558**	**3,150.710**	**3,498.070**	**4,586.256**	**5.51%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4. INDUSTRIAL

The demand of water and wastewater treatment in industrial sector is anticipated to grow significantly in the forecast period. Several industries such as, food & beverages, pharmaceuticals and chemicals, power generation, pulp and paper, oil & gas, mining, petrochemical and semiconductors, among others usually implements water and wastewater treatment facilities. These treatment facilities comprise of mechanisms and processes for water treatment which is generated from anthropogenic industrial and commercial activities. The wastewater generated from these sectors consists of hazardous chemical components and other impurities and they can be harmful if this wastewater is directly released into the environment. As governments of a number of countries are implementing more stringent guidelines for industrial water and wastewater treatment and discharge, industries must treat their water and wastewater before releasing into the environment. Treated water can be reused for various industrial activities. Adoption of water and wastewater treatment in the industrial sector also offers benefits such reduced impact on the environment, enables recycling and reusing water, and strengthens the economy, among others. These benefits are expected to support demand for and use of these processes in an increasing number of industrial sett-ups and drive market revenue growth over the forecast period.

10.4.1. WATER & WASTEWATER TREATMENT FOR INDUSTRIAL REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 68. WATER & WASTEWATER TREATMENT FOR INDUSTRIAL REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	855.306	892.027	944.247	1,001.137	1,061.726	1,196.323	1,629.951	**6.32%**
West	772.611	807.936	858.302	913.366	972.226	1,103.705	1,533.089	**6.72%**
South	801.426	836.937	887.500	942.679	1,001.549	1,132.673	1,557.866	**6.51%**
East	539.128	561.477	593.208	627.700	664.351	745.482	1,004.540	**6.08%**
Total	**2,968.471**	**3,098.377**	**3,283.257**	**3,484.882**	**3,699.852**	**4,178.182**	**5,725.445**	**6.44%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.2. POWER GENERATION

The demand of water and wastewater treatment in power generation industry is likely to grow significantly in the forecast period. Purified water is an essential component in the power generation sectors such as, nuclear power plants, fossil power plants, cooling power plants and electricity generation, among others. This purified water aids to enhancing equipment life, assures lasting performance, and reduces chances of corrosion, among others. As a result of these benefits, water treatment is widely adopted in this sector. Usually, pretreating process is widely used for removing colloidal particles, solids, organics and minerals substances. However, high volume of water consumption in this sector has resulted in increasing adoption of water and wastewater treatment processes for internal water reuse for clean, renewable power generation. This treated water can be used for cooling towers, turbines and boilers, among others. Furthermore, rising concerns regarding wastewater generated from the power sector has resulted in large investment and adoption of wastewater treatment in order to meet the high energy requirements, and this is expected to continue to drive demand for water and wastewater treatment in the industry.

10.4.2.1. WATER & WASTEWATER TREATMENT FOR POWER GENERATION REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 69. WATER & WASTEWATER TREATMENT FOR POWER GENERATION MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	165.758	172.455	181.955	192.271	203.221	227.420	304.409	**5.94%**
West	156.067	162.782	172.331	182.735	193.816	218.434	297.762	**6.33%**
South	149.546	155.782	164.638	174.270	184.511	207.201	279.827	**6.13%**
East	97.259	101.053	106.426	112.250	118.417	132.002	174.855	**5.73%**
Total	**568.630**	**592.071**	**625.350**	**661.525**	**699.964**	**785.057**	**1,056.853**	**6.06%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.3. OIL AND GAS

The demand of water and wastewater treatment in oil & gas industry is estimated to grow significantly in the forecast period. Water is among one of the essential components in the oil & gas production without it companies cannot generate consistent revenue and optimize their system. Thus, for this water and wastewater treatment needed to be implemented. Furthermore, during the oil and gas production in a reservoir, water also gets seeps through owing to two major rock types including sandstone and limestone that are being drilled. These rocks are extremely porous which aids to fluids to pass through easily. These all activities are performed in the reservoir and there is need to separate it by the means of water treatment. This treatment helps in separating oil, gas and water for further usage. Furthermore, rising on focus in recycling and reusing the wastewater in order to replace or supplement the utilization of natural sources of water in process, minimize underground injection of waste water, reducing discharges and conserve water resources, among others. The water treatment technologies such as, coagulation and flocculation along with sedimentation and multimedia filtration can be used for removal of the particles. Further, the dissolved ions can be removed by reverse osmosis or ion exchange. This reverse osmosis brine is further treated through evaporation and crystallization for offering zero liquid discharge solutions for the companies. This, fresh water produced can be easily reused for the variety of process in the oil & gas sector which in turn enhances the demand for water and wastewater treatment.

10.4.3.1. WATER & WASTEWATER TREATMENT FOR OIL AND GAS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 70. WATER & WASTEWATER TREATMENT FOR OIL AND GAS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	67.997	70.639	74.381	78.437	82.733	92.198	122.078	**5.72%**
West	77.029	80.217	84.742	89.662	94.891	106.470	143.476	**6.08%**
South	71.728	74.604	78.683	83.110	87.807	98.181	131.121	**5.90%**
East	37.793	39.211	41.216	43.385	45.678	50.712	66.476	**5.51%**
Total	**254.547**	**264.670**	**279.022**	**294.594**	**311.109**	**347.560**	**463.151**	**5.85%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.4. FOOD AND BEVERAGE

The demand of water and wastewater treatment in food & beverages industry is estimated to grow significantly in the forecast period. Food and beverage manufacturers utilize larger volumes of water in their production process. This water is widely used for activities such as, ingredients, cleaning, boiling and chilling, among others. As there is rising in awareness regarding water scarcity food & beverage are more focusing on reusing the treated wash water and wastewater. The major food & beverage industries adopting water and wastewater treatment includes, fruit & vegetable processing, meat processing, dairy, aquaculture, soft drinks, distilleries, breweries and spirits, among others. There is more need of water treatment in these industries as microbiologically contaminated impure water quality can have adverse impact on the food & beverage product quality and also reduces the shelf life of the product. The treated water can be used for variety of activities in food & beverage sector including, equipment washing, evaporators, boilers, cooling towers, dust control, chillers and landscaping, among others. The UV disinfection is used for eliminating algae, bacteria, mold spores, protozoa, and viruses, among others and this treated water can be used in manufacturing of food and beverages. Thus, owing to wide range of application of water and wastewater treatment in food & beverages industry, would enhance the demand for it in the upcoming years.

10.4.4.1. WATER & WASTEWATER TREATMENT FOR FOOD AND BEVERAGE REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 71. WATER & WASTEWATER TREATMENT FOR FOOD AND BEVERAGE REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	94.939	98.946	104.640	110.837	117.431	132.057	179.008	**6.21%**
West	94.181	98.414	104.445	111.032	118.065	133.752	184.784	**6.61%**
South	84.550	88.233	93.473	99.186	105.275	118.816	162.562	**6.40%**
East	49.276	51.284	54.133	57.227	60.512	67.773	90.875	**5.98%**
Total	**322.947**	**336.877**	**356.691**	**378.282**	**401.283**	**452.397**	**617.229**	**6.34%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.5. CHEMICALS

In the chemical industry, effective water and wastewater treatment is of paramount importance to ensure both environmental compliance and sustainable operations. Water plays a critical role in various processes within chemical manufacturing, ranging from cooling and heating to mixing and reacting. However, these processes often generate wastewater containing a diverse array of contaminants, such as organic compounds, heavy metals, and chemicals. Proper treatment of this wastewater is essential to safeguard local ecosystems and public health. To address these challenges, the chemical industry employs advanced water and wastewater treatment technologies. Physicochemical treatment methods, including coagulation, flocculation, and sedimentation, are commonly used to remove suspended solids and certain contaminants. Additionally, biological treatment processes, such as activated sludge and anaerobic digestion, can effectively break down organic pollutants. Advanced techniques like membrane filtration, ion exchange, and adsorption are employed for the removal of dissolved contaminants. These approaches are complemented by stringent monitoring and analytical methods to ensure compliance with environmental regulations.

In India, the government has recognized the significance of water and wastewater management in the chemical sector. As of my last knowledge update in September 2021, the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) oversee the implementation of regulatory frameworks, setting discharge standards and monitoring compliance. The 'Zero Liquid Discharge' (ZLD) initiative has gained traction, encouraging industries to adopt technologies that minimize wastewater discharge by recovering and reusing water and treating residues effectively. Government statistics underline the urgency of sustainable water management in India's chemical industry. According to data available from 2020, the CPCB reported that around 30% of water pollution incidents in the country were attributed to industrial discharges, including those from the chemical sector. To mitigate this impact, the Indian government has been focusing on strengthening enforcement mechanisms, promoting green technologies, and fostering industry collaborations to drive innovation in water and wastewater treatment methods.

10.4.5.1. WATER & WASTEWATER TREATMENT FOR CHEMICALS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 72. WATER & WASTEWATER TREATMENT FOR CHEMICALS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	111.960	116.901	123.936	131.612	139.800	158.035	217.131	**6.49%**
West	111.797	117.051	124.553	132.767	141.562	161.260	225.999	**6.91%**
South	102.983	107.674	114.361	121.671	129.482	146.923	203.830	**6.70%**
East	73.052	76.165	80.590	85.407	90.533	101.908	138.438	**6.26%**
Total	**399.791**	**417.792**	**443.440**	**471.457**	**501.378**	**568.126**	**785.398**	**6.62%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.6. PHARMACEUTICALS

The demand of water and wastewater treatment in pharmaceuticals and chemicals industry is projected to grow significantly in the forecast period. In the pharmaceutical industry, effective water and wastewater treatment processes are of paramount importance to ensure compliance with environmental regulations and the production of high-quality products. Water serves as a critical ingredient in various pharmaceutical manufacturing processes, including formulation, cleaning, and cooling. However, the industry generates complex wastewater streams containing organic compounds, solvents, heavy metals, and other contaminants, necessitating rigorous treatment methods.

The water and wastewater treatment strategies adopted by the pharmaceutical sector are multifaceted and tailored to the specific requirements of each facility. Common treatment techniques encompass physical, chemical, and biological processes, such as coagulation, flocculation, activated carbon adsorption, membrane filtration, and advanced oxidation. Stringent monitoring and control measures are implemented to maintain water quality and minimize the release of pollutants into the environment. In the context of India, a major player in the global pharmaceutical market, government statistics underscore the significance of responsible water management. According to the Central Pollution Control Board (CPCB) of India, the pharmaceutical industry is identified as a significant water polluter, contributing to the nation's water pollution load. A 2019 report indicated that the pharmaceutical sector was responsible for releasing a considerable volume of effluents into water bodies, containing pollutants that could pose risks to aquatic ecosystems and public health. To address these concerns, the Indian government has implemented stringent regulations to govern water usage and wastewater discharge in the pharmaceutical industry. Firms are mandated to adhere to environmental norms, invest in advanced treatment technologies, and periodically report their effluent quality to regulatory bodies. This regulatory framework aims to mitigate environmental pollution, safeguard water resources, and promote sustainable practices within the pharmaceutical sector.

10.4.6.1. WATER & WASTEWATER TREATMENT FOR PHARMACEUTICALS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 73. WATER & WASTEWATER TREATMENT FOR PHARMACEUTICALS REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	168.495	176.113	186.969	198.831	211.502	239.780	331.918	**6.65%**
West	159.776	167.468	178.461	190.517	203.446	232.465	328.383	**7.08%**
South	152.431	159.543	169.693	180.803	192.692	219.300	306.591	**6.86%**
East	98.876	103.192	109.333	116.027	123.161	139.023	190.226	**6.41%**
Total	**579.578**	**606.317**	**644.456**	**686.178**	**730.800**	**830.568**	**1,157.119**	**6.79%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

10.4.7. OTHERS

The demand for water & wastewater treatment for other end-uses such as semiconductor, mining, paper & pulp, textiles, paints & coatings, and personal care, among others is expected to grow significantly during the forecast period. The pulp and paper industry are among key user of water for nearly every step of manufacturing process. This sector generates large volume of wastewater and residual sludge waste. The waste stream from this sector consists of variety of contaminants such as, chlorinated organic compounds, sediments, effluent solids, absorbable organic halides, chemical oxygen demand (COD) and biological oxygen demand (BOD) contaminants, among others. Thus, for treating these contaminants wastewater treatment is usually implemented by the players in the industry. Furthermore, in around 85 percent of water is used in this sector is uses as process water which generates large quantities of contaminated water that have been led to use of onsite wastewater treatment solutions. Treatments such as, primary, secondary and tertiary are being extensively used in this sector. Primary treatment such as, clarification is widely utilized for removal of solids and particulate matter. Secondary biological treatment is utilized for removal of removing biodegradable organic matter and decreasing the effluent toxicity. And tertiary treatment including, UV disinfection, membrane filtration, granular activated carbon and ion exchange, among others are used to treat effluent water to higher qualities. Thus, the demand for water and wastewater treatment in pulp and paper industry would have influence in the upcoming years.

Mining industry produces usually large amount of concentrated wastewater owing to contact between water and minerals resulting in production of distinct reactions. In addition to drainage from rainfall, the several mining activities can be found as the source of effluents. These effluents are composed of variety of composition relying on nature of each mineral. Some of them includes, hydrolysable and non-hydrolysable, more or less soluble and sorbents and non-sorbents, among others. As this wastewater cannot be released into environment without treatment and can also results in provoke serious consequences in mining. Asa result, companies operating in this sector are widely implementing wastewater treatment. Conventionally, treatment methods such as physico-chemical or biological methods were being used for treating these effluents. However, over the past few years, zero discharge methods are considered among the most efficient treatment methods. These methods have less impact on the ecosystem and also enables reusing water. These benefits are driving demand for water and wastewater treatment in the mining industry and supporting revenue growth of the market.

In the semiconductor industry, ultra-pure water (UPW) which is free from all ions, chlorine, silica and particles is widely used for manufacturing semiconductors that are free of contaminants. After the usage of the water, it is discharged from the system as a wastewater, and which need to be treated and then later discharged or can be reused. Mostly the wastewater is produced is from treatment of contaminants in the wafer cleaning process and air pollution prevention facility. As this wastewater cannot be used directly owing to its liquid and solid contaminants. Thus, companies extensively use activated carbon and a total phosphorous removing apparatus for treating this water. Furthermore, recycled water is reused after securing the required water quality as per semiconductor industry. As there is surge in growth in electronic sector which would enhance the demand for semiconductor manufacturing which in turn have positive influence on the water and wastewater treatment in semiconductors industry.

Textile wastewater contains a wide range of colours and chemical additives, posing an environmental issue for the textile sector not just as liquid waste but also due to its chemical makeup. The principal contaminants in textile wastewater include high suspended particles, chemical oxygen demand, heat, colour, acidity, and other soluble compounds from dyeing and finishing operations. Substances that must be removed from textile effluent include COD, BOD, nitrogen, heavy metals, and dyestuffs, necessitating the industry's need for wastewater treatment.

Furthermore, the paint and coating business consumes a lot of water throughout the manufacturing process and generates a lot of polluted effluent. Paint-coating industry wastewater is subject to stringent regulations due to high levels of organic and inorganic pollutants, biological oxygen demand (BOD), chemical oxygen demand (COD), flammable liquids, suspended solids, heavy metals, toxic materials, turbidity, colour, varnish, polish, insulation chemicals, rosins, and solvents. Physical, chemical, and biological procedures are the primary wastewater treatment processes in the paint-coating business.

10.4.7.1. WATER & WASTEWATER TREATMENT FOR OTHER END-USES REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 74. WATER & WASTEWATER TREATMENT FOR OTHER END-USES REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	246.157	256.974	272.366	289.150	307.040	346.833	475.407	**6.44%**
West	173.760	182.003	193.770	206.653	220.445	251.323	352.684	**6.94%**
South	240.187	251.101	266.652	283.640	301.782	342.252	473.934	**6.66%**
East	182.872	190.573	201.509	213.404	226.050	254.065	343.670	**6.17%**
Total	**842.977**	**880.651**	**934.297**	**992.847**	**1,055.318**	**1,194.474**	**1,645.694**	**6.55%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

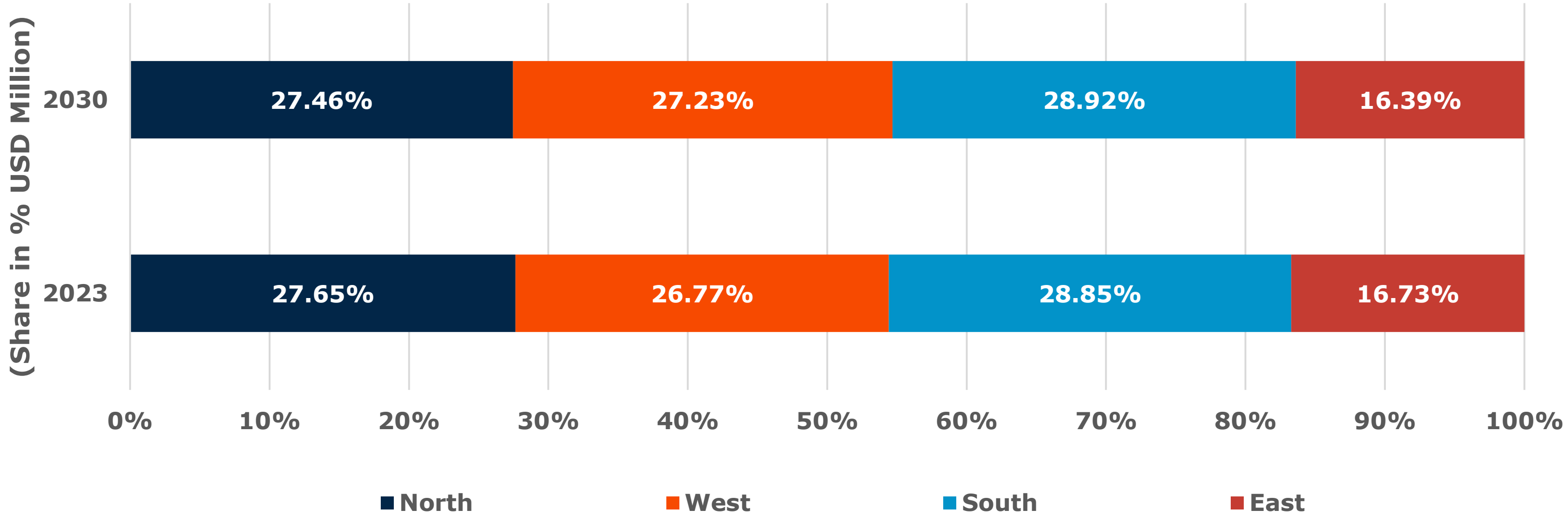
11. INDIA WASTEWATER TREATMENT MARKET BY REGION INSIGHTS & TRENDS

KEY REGIONAL TRENDS & HIGHLIGHTS

- South India is expected to account for a share of 28.85% in the Water & Wastewater Treatment Market in 2030.

11.1. REGION DYNAMICS & MARKET SHARE, 2023 & 2030

FIGURE 76. INDIA WATER & WASTEWATER TREATMENT MARKET: REGION DYNAMICS (SHARE IN % USD MILLION)



Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.2. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

TABLE 75. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY REGION, 2019-2030, (USD MILLION)

Region	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
North	2,952.385	3,072.096	3,241.975	3,426.522	3,622.503	4,055.951	5,437.529	**5.97%**
West	2,824.903	2,946.320	3,119.022	3,307.226	3,507.738	3,953.399	5,391.236	**6.33%**
South	3,065.899	3,193.121	3,373.823	3,570.369	3,779.356	4,242.459	5,725.557	**6.11%**
East	1,797.692	1,868.262	1,968.257	2,076.670	2,191.561	2,444.847	3,245.658	**5.77%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3. INDIA

According to 2018 NITI Aayog assessment, India is one of the most water-stressed countries in the world, with 600 million Indians suffering high water stress. And, by 2030, water demand may double than current supplies, causing acute water scarcity for millions of people. Consequently, it is more vital to comprehend and effectively manage the water needs and resources. A sustainable future requires the reuse and recycling of water resources. Since freshwater is a limited resource, wastewater treatment can provide a backup water source. Depending on the level of treatment, treated water may be obtained for direct consumption or may only be partially treated for use in irrigation and industry. Nitrate and phosphorus recovery from sewage waste has seen tremendous technological advancement. The by-product of wastewater treatment is high-quality manure.

The water and wastewater treatment market in India is expected to grow at a significant growth rate over the forecast period owing to the increasing technological advancements in water treatment coupled with rising demand from wastewater treatment industries to provide clean water. Also, India is making significant investments in wastewater networks and facilities as part of its plans for the remaining 50% of sewage produced in urban areas. The amount of STPs required to treat all of the sewage produced in India is projected to be 4500 or more due to the country's persistent, rapid urbanization and the need to treat sewage from semi-urban and rural areas. Furthermore, the Indian government implements new financial methods to finance the projects in addition to building more sewage treatment facilities. The National Mission for Clean Ganga (NMCG), for instance, implemented the Hybrid Annuity Model under the jurisdiction of the country's water resources department (HAM). In accordance with this plan, the developer is responsible for covering all operation and maintenance (O&M) costs as well as 60% of the capital costs, with the government covering the remaining 40%. Over time (often 15 years), the government pays the developer, plus interest. As a result, several financial institutions and investors have entered the market.

11.3.1. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030 (USD MILLION)

TABLE 76. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030(USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	5,366.400	5,595.612	5,921.555	6,276.633	6,654.796	7,494.849	10,201.477	**6.29%**
Sewage Treatment	4,073.319	4,240.226	4,477.177	4,734.731	5,008.400	5,614.197	7,549.278	**6.04%**
Effluent Treatment	1,201.160	1,243.961	1,304.345	1,369.422	1,437.961	1,587.609	2,049.225	**5.19%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.2. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 77. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**1,887.272**	**1,966.340**	**2,078.688**	**2,200.950**	**2,331.020**	**2,619.485**	**3,545.169**	**6.17%**
Activated Sludge Process	*715.327*	*744.530*	*785.982*	*831.030*	*878.887*	*984.791*	*1,322.822*	**6.01%**
Membrane Bio Reactor	*388.825*	*404.817*	*427.522*	*452.207*	*478.442*	*536.533*	*722.238*	**6.06%**
Moving Bed Bio Reactor	*293.292*	*305.994*	*324.067*	*343.771*	*364.773*	*411.482*	*562.431*	**6.38%**
Sequencing Batch Reactor	*173.776*	*181.527*	*192.569*	*204.628*	*217.503*	*246.214*	*339.603*	**6.57%**
Upflow Anaerobic Sludge Blanket Reactor	*141.170*	*146.886*	*154.997*	*163.808*	*173.164*	*193.855*	*259.793*	**5.97%**
Submerged Aerated Fixed Film Reactor	*121.197*	*126.377*	*133.743*	*141.767*	*150.314*	*169.300*	*230.481*	**6.30%**
Other Treatment Technologies	*53.685*	*56.210*	*59.807*	*63.739*	*67.939*	*77.310*	*107.801*	**6.82%**
Treatment Chemicals	**1,368.002**	**1,423.344**	**1,501.871**	**1,587.168**	**1,677.738**	**1,878.009**	**2,516.035**	**5.96%**
Corrosion Inhibitors	*360.870*	*375.256*	*395.657*	*417.800*	*441.293*	*493.179*	*657.992*	**5.87%**
Scale Inhibitors	*23.453*	*24.359*	*25.642*	*27.033*	*28.506*	*31.751*	*41.995*	**5.69%**
Biocides & Disinfectants	*318.102*	*330.849*	*348.931*	*368.561*	*389.395*	*435.427*	*581.796*	**5.90%**

Coagulants & Flocculants	*94.112*	*98.104*	*103.780*	*109.961*	*116.541*	*131.149*	*178.151*	**6.25%**
Chelating Agents	*195.332*	*203.556*	*215.245*	*227.969*	*241.509*	*271.550*	*368.050*	**6.20%**
Anti-Foaming Agents	*268.383*	*278.983*	*294.009*	*310.310*	*327.597*	*365.747*	*486.704*	**5.82%**
Ph Adjusters and Stabilizers	*67.216*	*70.082*	*74.157*	*78.595*	*83.322*	*93.820*	*127.629*	**6.28%**
Others	*40.534*	*42.155*	*44.450*	*46.939*	*49.576*	*55.385*	*73.718*	**5.83%**
Process Control and Automation	**3,447.321**	**3,588.822**	**3,789.716**	**4,008.099**	**4,240.167**	**4,753.948**	**6,395.672**	**6.05%**
Design, Engineering, and Construction Services	**2,401.085**	**2,503.947**	**2,650.237**	**2,809.630**	**2,979.416**	**3,356.680**	**4,573.019**	**6.31%**
Operation and Maintenance Services	**1,537.198**	**1,597.347**	**1,682.564**	**1,774.939**	**1,872.816**	**2,088.533**	**2,770.086**	**5.75%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.3. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030 (USD MILLION)

TABLE 78. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030(USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	1,863.794	1,941.561	2,052.043	2,172.248	2,300.102	2,583.553	3,492.374	6.15%
Disinfection	5,854.987	6,093.173	6,431.218	6,798.517	7,188.642	8,051.707	10,804.486	5.99%
Adsorption	387.003	402.250	423.861	447.304	472.160	527.005	700.809	5.80%
Desalination	1,791.608	1,868.640	1,978.211	2,097.620	2,224.839	2,507.610	3,419.981	6.33%
Testing	471.751	491.647	519.924	550.708	583.470	656.169	889.787	6.21%
Others	271.735	282.529	297.819	314.390	331.944	370.611	492.543	5.80%
Total	10,640.878	11,079.799	11,703.076	12,380.787	13,101.158	14,696.655	19,799.980	6.08%

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.4. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030 (USD MILLION)

TABLE 79. INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030(USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**7,672.408**	**7,981.422**	**8,419.819**	**8,895.905**	**9,401.306**	**10,518.473**	**14,074.535**	**5.93%**
Government and Public Utilities	*5,065.533*	*5,276.768*	*5,576.858*	*5,903.346*	*6,250.596*	*7,020.404*	*9,488.279*	**6.14%**
Local Communities	*2,606.875*	*2,704.654*	*2,842.962*	*2,992.558*	*3,150.710*	*3,498.070*	*4,586.256*	**5.51%**
Industrial	**2,968.471**	**3,098.377**	**3,283.257**	**3,484.882**	**3,699.852**	**4,178.182**	**5,725.445**	**6.44%**
Power Generation	*568.630*	*592.071*	*625.350*	*661.525*	*699.964*	*785.057*	*1,056.853*	**6.06%**
Oil and Gas	*254.547*	*264.670*	*279.022*	*294.594*	*311.109*	*347.560*	*463.151*	**5.85%**
Food and Beverage	*322.947*	*336.877*	*356.691*	*378.282*	*401.283*	*452.397*	*617.229*	**6.34%**
Chemicals	*399.791*	*417.792*	*443.440*	*471.457*	*501.378*	*568.126*	*785.398*	**6.62%**
Pharmaceuticals	*579.578*	*606.317*	*644.456*	*686.178*	*730.800*	*830.568*	*1,157.119*	**6.79%**
Others	*842.977*	*880.651*	*934.297*	*992.847*	*1,055.318*	*1,194.474*	*1,645.694*	**6.55%**
Total	**10,640.878**	**11,079.799**	**11,703.076**	**12,380.787**	**13,101.158**	**14,696.655**	**19,799.980**	**6.08%**

11.3.5. NORTH INDIA

The water and wastewater treatment sector in North India stands at a critical juncture, as the region grapples with the dual challenge of ensuring sustainable water supply and effectively managing wastewater. Comprising states like Delhi, Uttar Pradesh, Punjab, Haryana, among others this region harbors a vast population and industrial base, exacerbating the strain on water resources and necessitating robust treatment solutions. Government statistics underscore the urgency of the situation. According to the latest data from the Central Pollution Control Board (CPCB), a staggering percentage of water bodies in North India are contaminated, rendering them unfit for consumption or recreation. This alarming scenario has prompted concerted efforts by federal and state governments to ramp up investments in water and wastewater treatment infrastructure. The National Mission for Clean Ganga (NMCG) and various state-level pollution control boards are spearheading initiatives to improve water quality in iconic rivers like the Ganges and Yamuna, a task that involves the augmentation of treatment plants, stringent effluent regulations, and public awareness campaigns.

The market for water and wastewater treatment solutions is witnessing remarkable growth, driven by a fusion of technological innovation and policy imperatives. A surge in urbanization and industrialization has propelled the demand for advanced treatment technologies such as membrane filtration, UV disinfection, and anaerobic digestion. Market players, both domestic and international, are partnering with local stakeholders to implement integrated water management systems that encompass treatment, distribution, and conservation. While the potential for growth is promising, challenges persist. Inadequate infrastructure, lack of proper maintenance, and resource limitations remain impediments to achieving comprehensive water security. Moreover, the intermittent water availability exacerbates stress on treatment facilities and necessitates adaptive solutions like decentralized treatment plants and rainwater harvesting systems.

11.3.5.1. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030 (USD MILLION)

TABLE 80. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030(USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	1,405.040	1,464.062	1,547.935	1,639.222	1,736.353	1,951.813	2,643.589	**6.19%**
Sewage Treatment	1,206.590	1,255.171	1,324.093	1,398.938	1,478.391	1,654.014	2,213.005	**5.93%**
Effluent Treatment	340.755	352.863	369.947	388.362	407.759	450.124	580.935	**5.19%**
Total	**2,952.385**	**3,072.096**	**3,241.975**	**3,426.522**	**3,622.503**	**4,055.951**	**5,437.529**	**5.97%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.5.2. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 81. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**531.943**	**553.814**	**584.867**	**618.626**	**654.504**	**733.946**	**987.878**	**6.06%**
Activated Sludge Process	*200.436*	*208.471*	*219.868*	*232.242*	*245.374*	*274.392*	*366.671*	**5.91%**
Membrane Bio Reactor	*110.378*	*114.830*	*121.146*	*128.006*	*135.289*	*151.389*	*202.653*	**5.94%**
Moving Bed Bio Reactor	*81.706*	*85.183*	*90.127*	*95.511*	*101.244*	*113.976*	*154.965*	**6.27%**
Sequencing Batch Reactor	*50.258*	*52.452*	*55.576*	*58.983*	*62.616*	*70.701*	*96.877*	**6.43%**
Upflow Anaerobic Sludge Blanket Reactor	*41.385*	*43.024*	*45.347*	*47.868*	*50.541*	*56.442*	*75.163*	**5.83%**
Submerged Aerated Fixed Film Reactor	*32.874*	*34.258*	*36.225*	*38.366*	*40.645*	*45.700*	*61.938*	**6.20%**
Other Treatment Technologies	*14.905*	*15.595*	*16.578*	*17.650*	*18.795*	*21.345*	*29.612*	**6.71%**
Treatment Chemicals	**371.255**	**386.053**	**407.037**	**429.814**	**453.979**	**507.351**	**676.884**	**5.87%**
Corrosion Inhibitors	*96.887*	*100.694*	*106.091*	*111.944*	*118.150*	*131.841*	*175.207*	**5.79%**
Scale Inhibitors	*7.058*	*7.325*	*7.703*	*8.112*	*8.545*	*9.497*	*12.490*	**5.57%**
Biocides & Disinfectants	*85.686*	*89.070*	*93.868*	*99.074*	*104.594*	*116.776*	*155.405*	**5.82%**

Coagulants & Flocculants	*26.690*	*27.803*	*29.384*	*31.103*	*32.933*	*36.987*	*49.986*	**6.14%**
Chelating Agents	*54.667*	*56.931*	*60.146*	*63.643*	*67.360*	*75.597*	*101.965*	**6.10%**
Anti-Foaming Agents	*71.838*	*74.635*	*78.599*	*82.896*	*87.449*	*97.487*	*129.227*	**5.74%**
Ph Adjusters and Stabilizers	*17.295*	*18.023*	*19.059*	*20.186*	*21.386*	*24.047*	*32.599*	**6.21%**
Others	*11.136*	*11.571*	*12.188*	*12.856*	*13.563*	*15.118*	*20.005*	**5.71%**
Process Control and Automation	**1,001.917**	**1,042.339**	**1,099.689**	**1,161.975**	**1,228.102**	**1,374.294**	**1,839.799**	**5.94%**
Design, Engineering, and Construction Services	**678.470**	**707.025**	**747.607**	**791.781**	**838.789**	**943.079**	**1,278.058**	**6.20%**
Operation and Maintenance Services	**368.800**	**382.866**	**402.774**	**424.325**	**447.129**	**497.281**	**654.910**	**5.60%**
Total	**2,952.385**	**3,072.096**	**3,241.975**	**3,426.522**	**3,622.503**	**4,055.951**	**5,437.529**	**5.97%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.5.3. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030 (USD MILLION)

TABLE 82. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030(USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	527.296	548.890	579.546	612.866	648.270	726.636	976.926	**6.03%**
Disinfection	1,626.174	1,691.188	1,783.396	1,883.493	1,989.713	2,224.364	2,970.182	**5.89%**
Adsorption	105.400	109.494	115.295	121.582	128.244	142.927	189.332	**5.72%**
Desalination	494.820	515.746	545.492	577.879	612.352	688.866	934.876	**6.23%**
Testing	156.476	162.961	172.170	182.186	192.836	216.432	291.977	**6.11%**
Others	42.219	43.817	46.076	48.515	51.089	56.726	74.236	**5.48%**
Total	**2,952.385**	**3,072.096**	**3,241.975**	**3,426.522**	**3,622.503**	**4,055.951**	**5,437.529**	**5.97%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.5.4. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030 (USD MILLION)

TABLE 83. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030(USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**2,097.079**	**2,180.069**	**2,297.728**	**2,425.385**	**2,560.777**	**2,859.628**	**3,807.578**	**5.83%**
Government and Public Utilities	*1,391.412*	*1,448.403*	*1,529.310*	*1,617.249*	*1,710.688*	*1,917.518*	*2,578.127*	**6.03%**
Local Communities	*705.667*	*731.666*	*768.418*	*808.136*	*850.089*	*942.110*	*1,229.452*	**5.41%**
Industrial	**855.306**	**892.027**	**944.247**	**1,001.137**	**1,061.726**	**1,196.323**	**1,629.951**	**6.32%**
Power Generation	*165.758*	*172.455*	*181.955*	*192.271*	*203.221*	*227.420*	*304.409*	**5.94%**
Oil and Gas	*67.997*	*70.639*	*74.381*	*78.437*	*82.733*	*92.198*	*122.078*	**5.72%**
Food and Beverage	*94.939*	*98.946*	*104.640*	*110.837*	*117.431*	*132.057*	*179.008*	**6.21%**
Chemicals	*111.960*	*116.901*	*123.936*	*131.612*	*139.800*	*158.035*	*217.131*	**6.49%**
Pharmaceuticals	*168.495*	*176.113*	*186.969*	*198.831*	*211.502*	*239.780*	*331.918*	**6.65%**
Others	*246.157*	*256.974*	*272.366*	*289.150*	*307.040*	*346.833*	*475.407*	**6.44%**
Total	**2,952.385**	**3,072.096**	**3,241.975**	**3,426.522**	**3,622.503**	**4,055.951**	**5,437.529**	**5.97%**

Sources: Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.6. WEST INDIA

The water and wastewater treatment sector in West India including Maharashtra, Goa, Gujarat, Chhattisgarh, Madhya Pradesh, among others stands at the crossroads of challenges and opportunities, driven by the region's rapid urbanization, industrial growth, and environmental concerns. With its vibrant cities, industrial hubs, and diverse ecosystems, West India faces escalating pressures on its water resources, demanding robust solutions for effective water and wastewater management. The government's role in addressing these challenges is pivotal. According to the latest available statistics, sourced from the Ministry of Jal Shakti, Government of India, West India contributes significantly to the nation's water consumption. In Maharashtra alone, as of 2021, water demand had surged to approximately 18.6 billion cubic meters, underscoring the urgency for sustainable water management practices. Furthermore, Gujarat witnessed a surge in industrial activity, leading to an increased discharge of industrial effluents, highlighting the need for stringent wastewater treatment measures.

In response, the water and wastewater treatment market in West India is witnessing a remarkable transformation. Municipalities and industries are investing in advanced treatment technologies and infrastructure to meet stringent water quality standards. The market has seen a surge in the adoption of decentralized water treatment systems, water recycling, and smart water management solutions. Companies specializing in membrane filtration, chemical treatment, and bioremediation are gaining traction as the demand for innovative solutions rises. However, the journey towards efficient water and wastewater management is not without its hurdles. West India's complex topography, seasonal water scarcity, and uneven distribution pose logistical challenges. Moreover, socio-economic disparities and awareness gaps underscore the need for comprehensive public outreach and education campaigns to promote water conservation and responsible wastewater disposal practices.

11.3.6.1. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030 (USD MILLION)

TABLE 84. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030(USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	1,391.265	1,453.215	1,541.464	1,637.825	1,740.699	1,970.064	2,715.785	**6.56%**
Sewage Treatment	1,087.822	1,134.251	1,200.271	1,272.189	1,348.780	1,518.908	2,066.972	**6.29%**
Effluent Treatment	345.816	358.854	377.287	397.212	418.259	464.426	608.478	**5.50%**
Total	**2,824.903**	**2,946.320**	**3,119.022**	**3,307.226**	**3,507.738**	**3,953.399**	**5,391.236**	**6.33%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.6.2. NORTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 85. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**546.263**	**570.070**	**603.953**	**640.907**	**680.308**	**767.988**	**1,051.720**	**6.42%**
Activated Sludge Process	*200.806*	*209.339*	*221.470*	*234.682*	*248.749*	*279.984*	*380.511*	**6.26%**
Membrane Bio Reactor	*116.682*	*121.670*	*128.765*	*136.494*	*144.725*	*163.013*	*221.949*	**6.30%**
Moving Bed Bio Reactor	*79.099*	*82.667*	*87.752*	*93.309*	*99.247*	*112.500*	*155.712*	**6.65%**
Sequencing Batch Reactor	*56.964*	*59.601*	*63.363*	*67.480*	*71.886*	*81.744*	*114.075*	**6.82%**
Upflow Anaerobic Sludge Blanket Reactor	*48.399*	*50.430*	*53.317*	*56.458*	*59.801*	*67.215*	*91.014*	**6.18%**
Submerged Aerated Fixed Film Reactor	*27.805*	*29.046*	*30.813*	*32.744*	*34.805*	*39.402*	*54.355*	**6.58%**
Other Treatment Technologies	*16.508*	*17.317*	*18.473*	*19.739*	*21.095*	*24.131*	*34.104*	**7.10%**
Treatment Chemicals	**317.936**	**331.369**	**350.462**	**371.250**	**393.375**	**442.480**	**600.329**	**6.22%**
Corrosion Inhibitors	*81.001*	*84.375*	*89.169*	*94.384*	*99.930*	*112.224*	*151.629*	**6.14%**
Scale Inhibitors	*7.348*	*7.642*	*8.060*	*8.514*	*8.996*	*10.060*	*13.443*	**5.91%**
Biocides & Disinfectants	*72.171*	*75.193*	*79.487*	*84.159*	*89.130*	*100.153*	*135.519*	**6.17%**

Coagulants & Flocculants	*25.019*	*26.124*	*27.699*	*29.417*	*31.251*	*35.337*	*48.600*	**6.51%**
Chelating Agents	*49.931*	*52.123*	*55.244*	*58.648*	*62.280*	*70.367*	*96.576*	**6.47%**
Anti-Foaming Agents	*59.645*	*62.107*	*65.603*	*69.405*	*73.446*	*82.397*	*111.033*	**6.08%**
Ph Adjusters and Stabilizers	*13.030*	*13.612*	*14.441*	*15.347*	*16.314*	*18.470*	*25.484*	**6.58%**
Others	*9.791*	*10.191*	*10.759*	*11.376*	*12.029*	*13.472*	*18.045*	**5.96%**
Process Control and Automation	**912.891**	**951.932**	**1,007.451**	**1,067.938**	**1,132.362**	**1,275.488**	**1,736.765**	**6.30%**
Design, Engineering, and Construction Services	**621.490**	**649.217**	**688.718**	**731.855**	**777.912**	**880.619**	**1,214.685**	**6.57%**
Operation and Maintenance Services	**426.323**	**443.732**	**468.437**	**495.277**	**523.781**	**586.824**	**787.737**	**6.00%**
Total	**2,824.903**	**2,946.320**	**3,119.022**	**3,307.226**	**3,507.738**	**3,953.399**	**5,391.236**	**6.33%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.6.3. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030 (USD MILLION)

TABLE 86. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030(USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	535.319	558.558	591.626	627.682	666.118	751.620	1,028.068	6.40%
Disinfection	1,586.465	1,653.699	1,749.275	1,853.350	1,964.142	2,210.092	3,001.225	6.24%
Adsorption	74.860	77.942	82.319	87.078	92.135	103.336	139.147	6.07%
Desalination	448.595	468.705	497.360	528.661	562.091	636.672	879.515	6.60%
Testing	121.188	126.512	134.090	142.360	151.181	170.824	234.497	6.47%
Others	58.475	60.905	64.352	68.096	72.071	80.856	108.784	6.06%
Total	**2,824.903**	**2,946.320**	**3,119.022**	**3,307.226**	**3,507.738**	**3,953.399**	**5,391.236**	**6.33%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.6.4. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030 (USD MILLION)

TABLE 87. WEST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030(USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**2,052.292**	**2,138.384**	**2,260.720**	**2,393.860**	**2,535.512**	**2,849.694**	**3,858.147**	**6.18%**
Government and Public Utilities	*1,380.577*	*1,440.518*	*1,525.814*	*1,618.818*	*1,717.961*	*1,938.515*	*2,651.633*	**6.40%**
Local Communities	*671.715*	*697.866*	*734.906*	*775.042*	*817.551*	*911.180*	*1,206.514*	**5.72%**
Industrial	**772.611**	**807.936**	**858.302**	**913.366**	**972.226**	**1,103.705**	**1,533.089**	**6.72%**
Power Generation	*156.067*	*162.782*	*172.331*	*182.735*	*193.816*	*218.434*	*297.762*	**6.33%**
Oil and Gas	*77.029*	*80.217*	*84.742*	*89.662*	*94.891*	*106.470*	*143.476*	**6.08%**
Food and Beverage	*94.181*	*98.414*	*104.445*	*111.032*	*118.065*	*133.752*	*184.784*	**6.61%**
Chemicals	*111.797*	*117.051*	*124.553*	*132.767*	*141.562*	*161.260*	*225.999*	**6.91%**
Pharmaceuticals	*159.776*	*167.468*	*178.461*	*190.517*	*203.446*	*232.465*	*328.383*	**7.08%**
Others	*173.760*	*182.003*	*193.770*	*206.653*	*220.445*	*251.323*	*352.684*	**6.94%**
Total	**2,824.903**	**2,946.320**	**3,119.022**	**3,307.226**	**3,507.738**	**3,953.399**	**5,391.236**	**6.33%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS), World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.7. SOUTH INDIA

The water and wastewater treatment sector in South India including Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, among others has emerged as a pivotal player in maintaining ecological equilibrium amidst the region's burgeoning urbanization and industrial growth. With an emphasis on sustainable development and resource conservation, the market for water and wastewater treatment solutions has witnessed steady expansion, driven by the region's pressing need for efficient water management. South India's unique geographical and demographic dynamics, coupled with a proactive government stance, have propelled the growth of this sector. The government of South India has recognized the urgency of addressing water scarcity and pollution concerns, leading to the implementation of robust policies and initiatives. According to recent statistics, over the past five years, the region has invested significantly in wastewater treatment infrastructure, resulting in a substantial increase in the number of treatment plants. The government's allocation of funds towards improving water treatment facilities has played a pivotal role in attracting private sector investments, further boosting the market. Furthermore, the rising consciousness about water conservation has prompted the public and industries to adopt water-efficient technologies, thereby fostering a culture of responsible water consumption.

South India's water and wastewater treatment market is characterized by a diverse range of technologies and solutions, including advanced filtration systems, membrane technologies, and innovative sludge management techniques. The market's competitive landscape is marked by the presence of both domestic and international players, each striving to provide cutting-edge solutions tailored to the region's specific challenges. The demand for decentralized treatment systems has gained traction, particularly in rural areas, reflecting a holistic approach to addressing both sanitation and environmental concerns.

11.3.7.1. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030 (USD MILLION)

TABLE 88. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030(USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	1,601.319	1,670.159	1,768.078	1,874.787	1,988.476	2,241.168	3,056.463	**6.33%**
Sewage Treatment	1,148.127	1,195.436	1,262.614	1,335.654	1,413.287	1,585.217	2,135.031	**6.07%**
Effluent Treatment	316.453	327.526	343.132	359.928	377.592	416.073	534.063	**5.08%**
Total	**3,065.899**	**3,193.121**	**3,373.823**	**3,570.369**	**3,779.356**	**4,242.459**	**5,725.557**	**6.11%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.7.2. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 89. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**521.123**	**543.050**	**574.212**	**608.132**	**644.227**	**724.304**	**981.499**	**6.20%**
Activated Sludge Process	*201.154*	*209.406*	*221.122*	*233.857*	*247.391*	*277.351*	*373.073*	**6.04%**
Membrane Bio Reactor	*104.954*	*109.286*	*115.438*	*122.128*	*129.239*	*144.990*	*195.376*	**6.08%**
Moving Bed Bio Reactor	*84.630*	*88.316*	*93.561*	*99.282*	*105.380*	*118.952*	*162.860*	**6.42%**
Sequencing Batch Reactor	*44.129*	*46.101*	*48.910*	*51.978*	*55.255*	*62.562*	*86.338*	**6.58%**
Upflow Anaerobic Sludge Blanket Reactor	*34.915*	*36.330*	*38.338*	*40.518*	*42.834*	*47.956*	*64.279*	**5.97%**
Submerged Aerated Fixed Film Reactor	*37.886*	*39.518*	*41.840*	*44.371*	*47.068*	*53.063*	*72.415*	**6.35%**
Other Treatment Technologies	*13.455*	*14.093*	*15.003*	*15.997*	*17.060*	*19.432*	*27.156*	**6.87%**
Treatment Chemicals	**416.801**	**433.803**	**457.935**	**484.159**	**512.017**	**573.660**	**770.380**	**6.01%**
Corrosion Inhibitors	*111.357*	*115.836*	*122.189*	*129.089*	*136.412*	*152.599*	*204.108*	**5.93%**
Scale Inhibitors	*6.215*	*6.455*	*6.796*	*7.166*	*7.557*	*8.419*	*11.142*	**5.70%**
Biocides & Disinfectants	*97.782*	*101.734*	*107.343*	*113.434*	*119.903*	*134.204*	*179.762*	**5.96%**

Coagulants & Flocculants	*27.130*	*28.288*	*29.934*	*31.727*	*33.636*	*37.878*	*51.540*	**6.29%**
Chelating Agents	*57.289*	*59.717*	*63.168*	*66.927*	*70.928*	*79.810*	*108.380*	**6.24%**
Anti-Foaming Agents	*83.110*	*86.422*	*91.119*	*96.217*	*101.626*	*113.572*	*151.517*	**5.87%**
Ph Adjusters and Stabilizers	*21.751*	*22.688*	*24.022*	*25.477*	*27.026*	*30.471*	*41.592*	**6.35%**
Others	*12.168*	*12.662*	*13.363*	*14.123*	*14.929*	*16.708*	*22.339*	**5.93%**
Process Control and Automation	**977.281**	**1,017.632**	**1,074.932**	**1,137.241**	**1,203.475**	**1,350.184**	**1,819.538**	**6.08%**
Design, Engineering, and Construction Services	**735.828**	**767.522**	**812.607**	**861.746**	**914.103**	**1,030.497**	**1,406.189**	**6.35%**
Operation and Maintenance Services	**414.865**	**431.114**	**454.136**	**479.092**	**505.534**	**563.814**	**747.951**	**5.76%**
Total	**3,065.899**	**3,193.121**	**3,373.823**	**3,570.369**	**3,779.356**	**4,242.459**	**5,725.557**	**6.11%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.7.3. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030 (USD MILLION)

TABLE 90. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030(USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	516.604	538.255	569.020	602.501	638.120	717.117	970.629	**6.17%**
Disinfection	1,658.651	1,726.515	1,822.852	1,927.558	2,038.806	2,285.033	3,071.303	**6.03%**
Adsorption	137.352	142.812	150.555	158.957	167.871	187.553	250.040	**5.86%**
Desalination	542.388	565.863	599.263	635.675	674.483	760.791	1,039.664	**6.38%**
Testing	131.527	137.105	145.035	153.670	162.862	183.271	248.927	**6.25%**
Others	79.376	82.571	87.098	92.009	97.214	108.694	144.994	**5.88%**
Total	**3,065.899**	**3,193.121**	**3,373.823**	**3,570.369**	**3,779.356**	**4,242.459**	**5,725.557**	**6.11%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.7.4. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030 (USD MILLION)

TABLE 91. SOUTH INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030(USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**2,264.473**	**2,356.184**	**2,486.323**	**2,627.690**	**2,777.807**	**3,109.786**	**4,167.691**	**5.97%**
Government and Public Utilities	*1,481.645*	*1,543.752*	*1,632.002*	*1,728.042*	*1,830.218*	*2,056.828*	*2,784.080*	**6.18%**
Local Communities	*782.828*	*812.433*	*854.321*	*899.649*	*947.589*	*1,052.957*	*1,383.611*	**5.56%**
Industrial	**801.426**	**836.937**	**887.500**	**942.679**	**1,001.549**	**1,132.673**	**1,557.866**	**6.51%**
Power Generation	*149.546*	*155.782*	*164.638*	*174.270*	*184.511*	*207.201*	*279.827*	**6.13%**
Oil and Gas	*71.728*	*74.604*	*78.683*	*83.110*	*87.807*	*98.181*	*131.121*	**5.90%**
Food and Beverage	*84.550*	*88.233*	*93.473*	*99.186*	*105.275*	*118.816*	*162.562*	**6.40%**
Chemicals	*102.983*	*107.674*	*114.361*	*121.671*	*129.482*	*146.923*	*203.830*	**6.70%**
Pharmaceuticals	*152.431*	*159.543*	*169.693*	*180.803*	*192.692*	*219.300*	*306.591*	**6.86%**
Others	*240.187*	*251.101*	*266.652*	*283.640*	*301.782*	*342.252*	*473.934*	**6.66%**
Total	**3,065.899**	**3,193.121**	**3,373.823**	**3,570.369**	**3,779.356**	**4,242.459**	**5,725.557**	**6.11%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS), World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.8. EAST INDIA

The water and wastewater treatment sector in East India has witnessed significant growth and transformation in recent years, driven by the region's expanding industrial and urban landscape. With its burgeoning population and burgeoning industries, the demand for efficient water management solutions has intensified, making the water and wastewater treatment market a focal point of development. East India, comprising states such as West Bengal, Odisha, Bihar, Jharkhand, and the northeastern states, has been actively investing in upgrading its water infrastructure to meet the escalating water scarcity challenges and to mitigate environmental degradation caused by inadequate wastewater management. Government initiatives and policies have played a pivotal role in shaping the water and wastewater treatment landscape in East India. The governments of these states have consistently emphasized sustainable water resource management through initiatives that promote water conservation, pollution control, and efficient wastewater treatment practices. Schemes such as the Namami Gange project and the Clean Ganga Fund have also extended their influence on the region, catalyzing efforts to rejuvenate and cleanse major rivers flowing through East India.

Government statistics further underscore the importance of this market segment. According to the latest available data, East India's water demand has surged by over 30% in the last decade, propelled by rapid urbanization and industrialization. To address this, the government has allocated substantial funds to bolster water and wastewater treatment infrastructure, with an annual increase of 15% in budgetary allocation for the sector. Additionally, the implementation of advanced technologies, including membrane filtration, reverse osmosis, and water recycling systems, has gained momentum, facilitating the sustainable management of water resources and ensuring compliance with environmental norms.

11.3.8.1. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030 (USD MILLION)

TABLE 92. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY TYPE, 2019-2030(USD MILLION)

Type	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Water Treatment	968.776	1,008.175	1,064.079	1,124.799	1,189.268	1,331.804	1,785.640	**5.98%**
Sewage Treatment	630.780	655.368	690.200	727.950	767.942	856.058	1,134.270	**5.73%**
Effluent Treatment	198.136	204.718	213.978	223.921	234.351	256.985	325.748	**4.82%**
Total	**1,797.692**	**1,868.262**	**1,968.257**	**2,076.670**	**2,191.561**	**2,444.847**	**3,245.658**	**5.77%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.8.2. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

TABLE 93. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECASTS, BY OFFERING, 2019-2030, (USD MILLION)

Offering	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Treatment Technologies	**287.944**	**299.405**	**315.655**	**333.285**	**351.982**	**393.247**	**524.071**	**5.85%**
Activated Sludge Process	*112.931*	*117.314*	*123.522*	*130.249*	*137.373*	*153.064*	*202.566*	**5.70%**
Membrane Bio Reactor	*56.811*	*59.030*	*62.173*	*65.579*	*69.188*	*77.141*	*102.260*	**5.74%**
Moving Bed Bio Reactor	*47.856*	*49.828*	*52.627*	*55.669*	*58.901*	*66.055*	*88.894*	**6.06%**
Sequencing Batch Reactor	*22.425*	*23.373*	*24.720*	*26.186*	*27.747*	*31.207*	*42.314*	**6.21%**
Upflow Anaerobic Sludge Blanket Reactor	*16.470*	*17.102*	*17.996*	*18.963*	*19.988*	*22.242*	*29.337*	**5.63%**
Submerged Aerated Fixed Film Reactor	*22.632*	*23.555*	*24.864*	*26.286*	*27.796*	*31.135*	*41.772*	**5.99%**
Other Treatment Technologies	*8.817*	*9.204*	*9.754*	*10.352*	*10.989*	*12.402*	*16.929*	**6.37%**
Treatment Chemicals	**262.009**	**272.120**	**286.437**	**301.946**	**318.367**	**354.519**	**468.442**	**5.67%**
Corrosion Inhibitors	*71.626*	*74.351*	*78.208*	*82.383*	*86.801*	*96.516*	*127.048*	**5.59%**
Scale Inhibitors	*2.833*	*2.936*	*3.083*	*3.241*	*3.409*	*3.775*	*4.920*	**5.38%**
Biocides & Disinfectants	*62.463*	*64.852*	*68.233*	*71.894*	*75.769*	*84.293*	*111.109*	**5.62%**

Coagulants & Flocculants	*15.273*	*15.889*	*16.764*	*17.713*	*18.721*	*20.947*	*28.025*	**5.93%**
Chelating Agents	*33.445*	*34.786*	*36.688*	*38.751*	*40.941*	*45.777*	*61.129*	**5.89%**
Anti-Foaming Agents	*53.790*	*55.818*	*58.688*	*61.792*	*65.075*	*72.291*	*94.927*	**5.54%**
Ph Adjusters and Stabilizers	*15.140*	*15.758*	*16.634*	*17.586*	*18.597*	*20.832*	*27.955*	**6.00%**
Others	*7.440*	*7.730*	*8.140*	*8.585*	*9.055*	*10.088*	*13.330*	**5.68%**
Process Control and Automation	**555.232**	**576.919**	**607.644**	**640.946**	**676.228**	**753.981**	**999.570**	**5.74%**
Design, Engineering, and Construction Services	**365.298**	**380.183**	**401.305**	**424.249**	**448.612**	**502.486**	**674.087**	**5.99%**
Operation and Maintenance Services	**327.209**	**339.634**	**357.217**	**376.245**	**396.372**	**440.614**	**579.487**	**5.58%**
Total	**1,797.692**	**1,868.262**	**1,968.257**	**2,076.670**	**2,191.561**	**2,444.847**	**3,245.658**	**5.77%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.8.3. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030 (USD MILLION)

TABLE 94. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY EQUIPMENT, 2019-2030(USD MILLION)

Equipment	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Filtration	284.575	295.858	311.851	329.200	347.595	388.180	516.750	**5.83%**
Disinfection	983.697	1,021.772	1,075.695	1,134.115	1,195.982	1,332.218	1,761.777	**5.69%**
Adsorption	69.391	72.000	75.692	79.686	83.910	93.190	122.289	**5.53%**
Desalination	305.805	318.326	336.097	355.405	375.913	421.280	565.927	**6.02%**
Testing	62.560	65.070	68.629	72.492	76.591	85.643	114.386	**5.90%**
Others	91.664	95.236	100.293	105.771	111.570	124.336	164.529	**5.71%**
Total	**1,797.692**	**1,868.262**	**1,968.257**	**2,076.670**	**2,191.561**	**2,444.847**	**3,245.658**	**5.77%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS),Central Water Commission (CWC), National Water Development Agency (NWDA), Water Resources Management Organisation, Central Pollution Control Board , Department of Water Resources, River Development, Department of Drinking Water and Sanitation, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

11.3.8.4. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030 (USD MILLION)

TABLE 95. EAST INDIA WATER & WASTEWATER TREATMENT MARKET REVENUE ESTIMATES AND FORECAST, BY END-USE, 2019-2030(USD MILLION)

End-Use	2019	2020	2021	2022	2023	2025	2030	CAGR% (2023-30)
Municipal	**1,258.564**	**1,306.784**	**1,375.049**	**1,448.970**	**1,527.209**	**1,699.365**	**2,241.119**	**5.63%**
Government and Public Utilities	*811.900*	*844.095*	*889.733*	*939.238*	*991.729*	*1,107.543*	*1,474.439*	**5.83%**
Local Communities	*446.664*	*462.689*	*485.316*	*509.732*	*535.481*	*591.822*	*766.680*	**5.26%**
Industrial	**539.128**	**561.477**	**593.208**	**627.700**	**664.351**	**745.482**	**1,004.540**	**6.08%**
Power Generation	*97.259*	*101.053*	*106.426*	*112.250*	*118.417*	*132.002*	*174.855*	**5.73%**
Oil and Gas	*37.793*	*39.211*	*41.216*	*43.385*	*45.678*	*50.712*	*66.476*	**5.51%**
Food and Beverage	*49.276*	*51.284*	*54.133*	*57.227*	*60.512*	*67.773*	*90.875*	**5.98%**
Chemicals	*73.052*	*76.165*	*80.590*	*85.407*	*90.533*	*101.908*	*138.438*	**6.26%**
Pharmaceuticals	*98.876*	*103.192*	*109.333*	*116.027*	*123.161*	*139.023*	*190.226*	**6.41%**
Others	*182.872*	*190.573*	*201.509*	*213.404*	*226.050*	*254.065*	*343.670*	**6.17%**
Total	**1,797.692**	**1,868.262**	**1,968.257**	**2,076.670**	**2,191.561**	**2,444.847**	**3,245.658**	**5.77%**

Sources: International Water Association, Association of Water Technologies, National Ground Water Association, Water Environment Federation, Water Quality Association, Water & Sewer Industry Organizations, Ministry of Jal Shakti (MoJS, World Bank, Journals & Articles, Press Releases, Company Websites, Investor Presentations & Whitepapers, Annual Reports, Primary Interviews, Reports and Data

12. COMPETITIVE LANDSCAPE

12.1. INDIA WATER AND WASTEWATER TREATMENT MARKET: COMPANY SNAPSHOT, 2022

Competition Landscape – India Water & Wastewater Treatment Market				
Company	Megha Engineering and Infrastructures Ltd (MEIL)	EMS Limited	VA TECH WABAG LTD	SPML Infra Limited
Headquarter	Telangana, India	Uttar Pradesh, India	Chennai, India	Kolkata, India
Revenue (USD)	-	USD 69.12 Million	USD 295.85 Million	USD 111.23 Million
Product & Service	• Irrigation • Drinking Water	• Sewerage Management • Design and construction • Water supply • Road & Allied works	• Wastewater Treatment • Water Treatment	• Water Treatment • Wastewater treatment
Market Presence	▪ Internationally	▪ India	▪ India ▪ Rest of the World ▪ Unallocated	▪ India ▪ Overseas
Market Strategy				

Agreements & Partnerships P **New Product Development** N **Investment & Expansion** I **Mergers & Acquisition** M

Source: Company Annual report, Reports and Data, Primary Interview

Key participants in the India water & wastewater infrastructure market are VA TECH WABAG LTD., SPML Infra Limited, Megha Engineering and Infrastructures Ltd (MEIL), EMS Limited, among others.

The market is currently witnessing increasing efforts by players in terms of new product development as companies try to gain a competitive edge over the market by sharing ideas and resources with their counterparts. Market players are also resorting to strategies like mergers & acquisitions, agreement & partnership and investment and expansions wherein they are strategically forming alliances with crucial end-users or organizations in both the public and private sectors. This is helping them to gain a competitive advantage in terms of sales.

12.2. STRATEGY BENCHMARKING

The water & wastewater infrastructure market is expected to grow significantly in the coming years, owing to the increasing demand from various end-use industries. This growth is driving companies to adopt diverse strategies to gain a competitive advantage in the market. Investment and expansion are being pursued to increase production capacity and meet the growing demand for water & wastewater infrastructure.

Agreements and partnerships are being formed to leverage the expertise of other players in the market and to gain access to new technology and markets. Mergers and acquisitions are being pursued to consolidate market share and eliminate competition, while also allowing companies to diversify their product offerings. In addition to these strategies, companies are ramping up their efforts in research and development to develop more innovative and distinctive products. This is aimed at meeting the evolving needs of consumers and staying ahead of competitors in the market. Companies are also focusing on improving their existing products and making them more environmentally friendly.

12.3. COMPANIES ENGAGEAD IN LIFT IRRIGATION PROJECT

Lift irrigation is a critical agricultural practice in India, particularly in regions with water scarcity. It involves the transportation of water from a lower source, such as a river or canal, to a higher elevation where it can be distributed for irrigation purposes. Several top companies in India are actively engaged in lift irrigation projects, aiming to enhance agricultural productivity, support rural communities, and mitigate water stress in various parts of the country.

Kirloskar Brothers Limited:

Kirloskar Brothers Limited (KBL) is a renowned player in the field of lift irrigation projects in India. Founded in 1888, the company has a long-standing history of providing innovative pumping solutions. KBL offers a wide range of pumps and systems that are specifically designed for lift irrigation. Their efficient and reliable products are crucial in raising water from source points to agricultural fields, thereby enabling water resource management and crop cultivation in water-deficient areas. KBL's solutions include submersible pumps, vertical turbine pumps, and electric motors, all of which are designed to cater to the diverse needs of lift irrigation projects. Their expertise in pump technology and commitment to quality has established them as a key player in the industry.

KBL's SPP Pumps:

SPP Pumps, a subsidiary of Kirloskar Brothers Limited (KBL), is another noteworthy player in the lift irrigation sector. With a global presence, SPP Pumps brings its expertise in manufacturing fire pumps and industrial pumps to the Indian market. Their products are widely used in lift irrigation projects to ensure the efficient transport of water. SPP Pumps offers a comprehensive range of pumps designed to handle high flow rates and challenging conditions. Their advanced technologies and commitment to quality have made them a preferred choice for many lift irrigation projects in India.

KSB Pumps Limited:

KSB Pumps Limited is another leading company contributing to lift irrigation projects in India. With a global presence and a significant foothold in the Indian market, KSB specializes in providing reliable pumping solutions for various applications, including lift irrigation. Their pumps are designed to handle the challenges of lifting water from lower sources to higher elevations efficiently. KSB offers a wide range of submersible and centrifugal pumps that are well-suited for lift irrigation systems. Their products are known for their durability and energy efficiency, making them a preferred choice for water management projects across the country.

Crompton Greaves Consumer Electricals Ltd:

Crompton Greaves Consumer Electricals Ltd (CGCEL), a part of the Avantha Group, is a prominent player in the lift irrigation sector. The company is known for its electrical and consumer products, and it has successfully expanded its offerings to include solutions for lift irrigation projects. CGCEL provides a range of water pumps and motors that are suitable for various lift irrigation applications, helping farmers access water efficiently. Their product portfolio includes submersible pumps, monoblock pumps, and electric motors that are designed for energy efficiency and reliability. CGCEL's commitment to delivering high-quality products has made them a trusted choice for lift irrigation systems.

Texmo Industries:

Texmo Industries, a part of the Texmo Group, is a well-established company that has been actively involved in lift irrigation projects in India. Texmo specializes in manufacturing submersible pumps, openwell pumps, and centrifugal pumps, which are widely used for lifting water for agricultural purposes. These pumps are designed to handle the unique challenges of lift irrigation systems, ensuring that water is efficiently transported to the required elevation. Texmo Industries is known for its robust and durable pumps, which are essential components in ensuring the success of lift irrigation projects across the country.

Aquatec Pumps:

Aquatec Pumps, a part of the Texmo Group, specializes in manufacturing submersible pumps that are well-suited for lift irrigation applications. These pumps are designed to meet the specific needs of farmers and agricultural projects, offering energy-efficient solutions for water transportation. Aquatec Pumps' commitment to providing reliable and efficient products has contributed to its recognition in the lift irrigation industry, ensuring that water is made available to agriculture in water-sc arce regions.

Shakti Pumps (India) Ltd:

Shakti Pumps (India) Ltd is a prominent manufacturer of submersible pumps and electric motors that cater to various industries, including agriculture and lift irrigation. With a strong focus on energy efficiency and performance, Shakti Pumps offers a range of products that are suitable for lift irrigation applications. Their pumps are designed to operate in challenging conditions, making them a valuable asset for enhancing water accessibility in agriculture. Shakti Pumps has gained recognition for its commitment to innovation and providing reliable solutions for lift irrigation projects, contributing significantly to India's agricultural sector.

Conclusion:

The role of lift irrigation projects in India is of paramount importance in addressing water scarcity and supporting agricultural growth. The top companies engaged in lift irrigation projects, such as Kirloskar Brothers Limited, KSB Pumps Limited, Crompton Greaves Consumer Electricals Ltd, Texmo Industries, Shakti Pumps (India) Ltd, KBL's SPP Pumps, and Aquatec Pumps, play a vital role in ensuring the success of these projects. These companies provide innovative and reliable pumping solutions, submersible pumps, electric motors, and other essential equipment required for efficiently raising water to higher elevations. Their dedication to quality, energy efficiency, and technological innovation has made them trusted partners in India's ongoing efforts to enhance agricultural productivity, support rural communities, and manage water resources effectively through lift irrigation projects.

12.4. KEY SUCCESS FACTORS ON TECHNOLOGICAL AND INFRASTRUCTURE DEVELOPMENT FOR KEY MARKET PLAYERS

TABLE 96. SUCCESS FACTORS FOR WATER AND WASTEWATER TREATMENT COMPANIES

Company Name	Technological Advancements	Speed to Market	Operational Efficiency	Quality Control and Monitoring	Regulatory Compliance	Supply Chain Management	Financial Management
VA TECH WABAG LTD.	★★	★★★★	★★★	★★	★★★	★★★★	★★★
SPML Infra Limited	★★	★★★	★★	★★★★★	★★★	★★★	★★
Megha Engineering and Infrastructures Ltd (MEIL)	★★★	★★★★	★★★	★★★★★	★★★	★★★★	★★★★
EMS Limited	★★	★★★	★★	★★★	★★	★★	★★★
Excellent ★★★★★ Good ★★★★ Average ★★★ Below Average ★★							

Source: Company Website, Annual Report, News & Press Releases, Primary Interviews and Reports and Data

The water and wastewater treatment industry in India has witnessed significant growth over the past few years, driven by increasing urbanization, industrialization, and environmental concerns. Market leaders in this sector are continually striving to achieve sustainable, efficient, and innovative solutions to address the country's water management challenges. To succeed in this evolving landscape, companies must focus on several key success factors related to technological advancement and infrastructure development.

- **Technological Innovation:** Staying at the forefront of technological advancements is crucial for market leaders. Developing innovative treatment processes, materials, and equipment that enhance efficiency, reduce costs, and minimize environmental impact can provide a significant competitive advantage. Technologies such as membrane filtration, advanced oxidation, and intelligent process control systems can enable efficient water purification and resource recovery.

- **Research and Development (R&D):** Investing in R&D efforts is vital for maintaining a competitive edge. Market leaders should allocate resources to research institutions, collaborations, and in-house R&D teams to continuously develop new solutions and improve existing technologies. This could involve exploring novel treatment methods, optimizing chemical dosing, and developing predictive maintenance algorithms.
- **Customization and Scalability:** Successful companies understand that water treatment solutions need to be adaptable to diverse customer requirements and scalable to handle various project sizes. Providing customizable systems that can be tailored to specific industry needs and geographical conditions will strengthen a company's position in the market.
- **Regulatory Compliance:** India's water and environmental regulations are becoming increasingly stringent. Market leaders must ensure that their solutions not only meet current regulatory standards but also anticipate future requirements. Maintaining compliance demonstrates commitment to environmental responsibility and builds trust with clients and stakeholders.
- **Energy Efficiency:** Energy consumption is a significant operating cost in water and wastewater treatment. Developing energy-efficient technologies and processes, such as incorporating renewable energy sources and optimizing system designs for lower energy consumption, can improve a company's competitiveness and appeal to sustainability-conscious clients.
- **Data-Driven Decision Making:** Embracing digitalization and data analytics can transform how companies operate. Implementing real-time monitoring, data collection, and analytics can optimize process performance, enhance maintenance practices, and reduce downtime. Predictive analytics can also be employed to anticipate equipment failures and optimize system efficiency.

- **Local Manufacturing and Sourcing:** Setting up local manufacturing facilities and sourcing materials domestically can help market leaders reduce costs, minimize supply chain disruptions, and contribute to the country's economic growth. Additionally, proximity to clients allows for faster response times and better customization.
- **Collaboration and Partnerships:** Collaboration with research institutions, technology providers, and industry peers can foster knowledge exchange, accelerate innovation, and enhance market visibility. Strategic partnerships can lead to joint development of cutting-edge solutions, shared resources, and expanded market reach.
- **Talent Development:** A skilled workforce is essential for successfully implementing advanced technologies. Market leaders should invest in training programs, workshops, and educational initiatives to ensure their employees possess the necessary skills to operate, maintain, and innovate in the water and wastewater treatment sector.
- **Sustainability and Circular Economy:** Adopting a circular economy approach, which emphasizes resource recovery and minimizing waste, can resonate well with environmentally conscious clients. Market leaders can explore opportunities to recover valuable resources from wastewater and explore sustainable reuse options.

13. COMPANY PROFILES FOR WATER AND WASTEWATER TREATMENT

13.1. MEGHA ENGINEERING AND INFRASTRUCTURES LTD (MEIL)

Megha Engineering and Infrastructures Ltd (MEIL)	**Type:** Private
	Industry: Environmental Service & Construction
	Founded: 1989
	Headquarters: Telangana, India
	Website: www.meil.com

13.1.1. COMPANY SUMMARY

MEIL, founded in 1989, is a varied industrial group. It is a rapidly expanding worldwide corporation that has built several great landmark projects depicting historical changes and celebrating economic and cultural growth. It has also constructed several important infrastructure projects throughout the world to better people's livelihoods. MEIL does business in several areas, including water management, engineering, construction, manufacturing, transportation, hydrocarbons, electricity, process industries, and military. MEIL aims to use indigenous technical advances for the benefit of all segments of society. For over 30 years, the firm has maintained its leadership position in its key industries by putting the customer first and complying to safety and environmental regulations. MEIL is dedicated to delivering projects 'On-Time' by continuously growing industry-leading knowledge, skills, and experience, as well as applying new and flawless process approaches and technologies.

13.1.2. PRODUCT AND SERVICE INSIGHTS

Service	Description
Irrigation	• Investigation, design, engineering and construction of dams, spillways, reservoirs, canals including distribution systems. • Investigation, design and execution of minor and major lift irrigation projects. • Design, engineering and execution of water transmission mains. • Design, engineering and execution of micro irrigation projects (e.g. Ramthal Drip Irrigation Project) • Design, engineering and execution of piped irrigation canal system (e.g. Khargone Project, SSNNL Project) • Design, engineering and execution of Hydraulic Tunnels and Underground pump houses for major irrigation projects
Drinking Water	• The MEIL has created robust drinking water systems, marshalling its expertise in creating solutions for the efficient utilisation of water. • The company has changed the portrait of potable water across several geographies in the world. It has worked closely with the States, the Government of India, and governments of several other nations on drinking water projects. • It has built water infrastructure to cater to the drinking water needs of rural and urban landscapes.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.1.3. MAJOR PROJECTS

Project	Description
Handri-Niva Sujala Sravanthi Project	The Handri-Niva Sujala Sravanthi (HNSS) project was conceived as a dream project for water-starved regions of Andhra Pradesh. The project is an engineering wonder comprising India's longest canal that will flow from the project to a distance of 565 km. It envisages withdrawal of 40 TMC of flood water of Krishna River from the foreshore of Srisailam reservoir in 120 flood days during the period of August to November. The aim is to provide irrigation facilities to an extent of 6.02 lakh acres in Kurnool, Anantapur, Cuddapah, and Chittoor districts of Andhra Pradesh. The project also provides drinking water facilities to a population of 33 lakhs in 81 mandals and 437 villages en route the canal.
Khargone project	MEIL commissioned this project within a month's notice period from the client. The chief minister of Madhya Pradesh Mr. Shivraj Singh Chauhan inaugurated and dedicated the Khargone Lift Irrigation Project of the Narmada Valley Development Authority (NVDA) on January 13, 2015. After completion of the three phased project, irrigation facility to 33,140 hectares of land will be augmented, benefiting 18,536 farmers' families in 152 villages. Subsequently, Khargone will emerge as the 'number one' district in cash crop production.
Veligonda Project	Veligonda Project, as a whole, envisages to provide irrigational facilities to 4.38 lakh acres of farmlands and drinking water to 15 Lakh people in 29 mandals of fluorine and drought affected upland areas in Prakasam, Nellore and Cuddapah Districts by diverting 43.5 TMC of floodwater of Krishna from foreshore of Srisailam Reservoir near Kollamvagu and proposed to store in Nallamalasagar Reservoir. MEIL's scope in the project has the potential to irrigate more than 65000 acres.
Chintalapudi LIS	The project involves the construction of a lift irrigation scheme for withdrawal of and lifting of water from river Godavari near Pattiseema village in West Godavari district of A.P. to proposed reservoir near Routugudem village in West Godavari district. The project will serve an ayacut of 2.45 lakh acres.

Pranahita-Chevella LIS	The aim of the project in its entirety is to utilise 160 Tmcft of Pranahita water and serve 16.4 lakh acres in the water scarcity areas of Adilabad, Karimnagar, Warangal, Nizamabad, Medak, Nalgonda and Ranga Reddy districts in the state of Telangana. MEIL's scope of work includes the execution of more than 10 packages of the project.
Sauni Yojana Project	The total scope of the project translates to a carrying capacity of 1200 cusecs of excess over flowing flood water of Narmada at an estimated cost of Rs. 1533 crore. 30 reservoirs of Rajkot and Jamnagar Districts will be filled and more than 2 lakh acres of agriculture will be benefited. MEIL is assigned works relating to the execution of two packages of Link-1 of the project.
Devadula - Phase-III Pkg. I	The overall project (including all phases) is the second biggest of its kind in Asia. Devadula is the place in Warangal District, Telangana, where the scheme's intake well is located. The project is specially designed to lift water from the River Godavari to irrigate lakhs of acres in the drought prone areas of the state. MEIL is assigned to deliver 3 packages in Phase-3 of the project. The completed works in this specific package of the project include the construction of super structure of pump house, erection of pumps & motors, construction of control room, fabrication & erection of manifold, outfall structure, laying of 3 rows of pipeline of 3000 mm diameter that run across a length 116.25 km, the entire surge protection system including 18 nos. of vessels and 6 nos. of one-way surge tanks (OWST). All the 18 surge vessels (of length-18.38 Mt. and capacity-124 Cub. Mt.) were manufactured in MEIL's Pressure Vessel Division.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.1.4. SWOT ANALYSIS

S STRENGTHS	W WEAKNESS	O OPPORTUNITIES	T THREATS
▪ Extensive experience in water and wastewater infrastructure projects. ▪ Strong financial position and access to capital. ▪ Robust project management capabilities. ▪ Diversified portfolio of water and wastewater projects. ▪ Established relationships with government agencies and stakeholders.	▪ Dependency on government contracts and regulations. ▪ Competition from other established players in the industry. ▪ Potential for cost overruns in complex projects.	▪ Expansion into international markets. ▪ Innovation in water treatment technologies. ▪ Public-private partnerships for project financing. ▪ Potential for diversification into related sectors.	▪ Regulatory changes affecting project approvals and tariffs. ▪ Economic downturns impacting government spending. ▪ Rising construction and material costs.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.2. EMS LIMITED

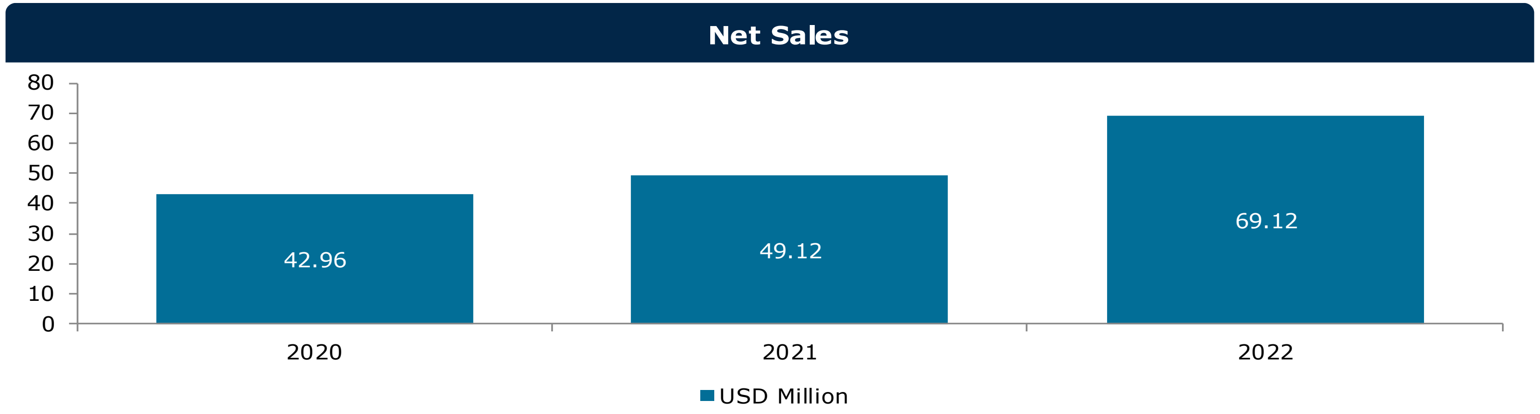
EMS Limited	
	Type: Public
	Industry: Environmental Service & Construction
	Founded: 1998
	Headquarters: Uttar Pradesh, India
	Website: www.ems.com

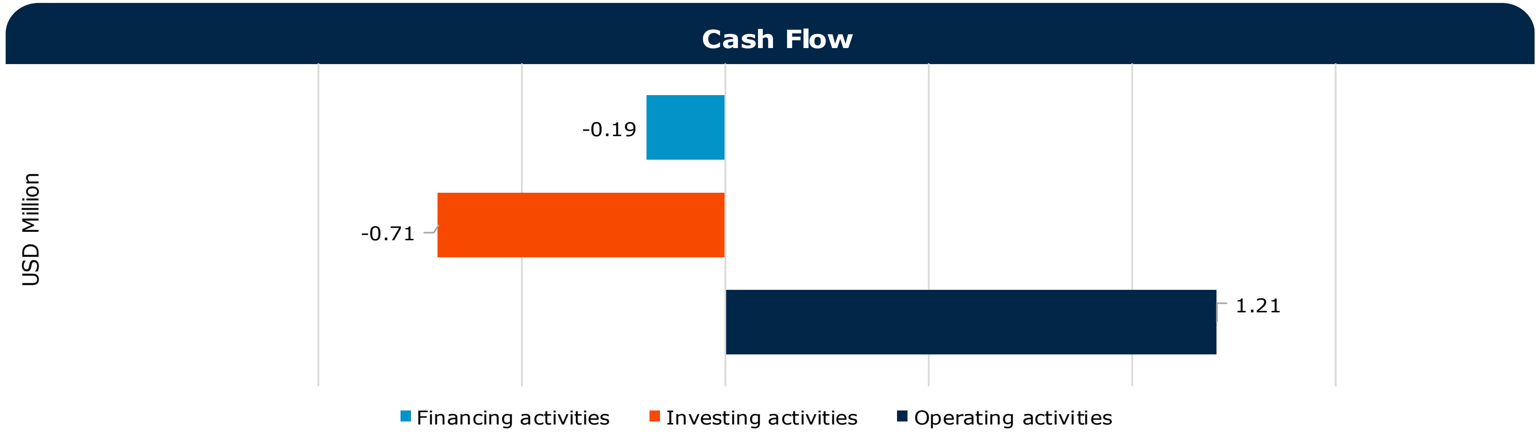
13.2.1. COMPANY SUMMARY

EMS Limited, based in India, was established in 1998, is a dynamic company that offers a comprehensive range of services in the field of environmental management and sustainability. With a strong commitment to environmental responsibility, EMS Limited has established itself as a leader in providing sustainable solutions for businesses and organizations across various sectors. The core services offered by EMS Limited encompass environmental impact assessments, waste management, renewable energy solutions, and sustainability consulting. Their team of experts leverages cutting-edge technology and in-depth industry knowledge to help clients reduce their environmental footprint and comply with regulatory requirements. EMS Limited's services are tailored to meet the unique needs of each client, ensuring effective and sustainable solutions. One of the standout features of EMS Limited is its dedication to innovation and research. Furthermore, EMS Limited has a proven track record of successfully executing projects for a wide range of clients, including multinational corporations, government bodies, and non-governmental organizations.

13.2.2. FINANCIAL INSIGHTS

Founded in 1998 and headquartered in Uttar Pradesh, India. EMS Limited is a public company. The company specializes in Sewerage Infrastructure, Water Supply System, Water And Waste Treatment Plants, Electrical Transmission And Distribution, Buildings And Allied Works.





Source: Company Website, Annual Report, News & Press Releases, and Reports and Data
Note: Exchange rate, for 2022 1 USD = INR 78.598, 2021 1 USD = INR 73.936, for 2020 1 USD = INR 74.102

TABLE 97. FINANCIAL INSIGHTS OF VA TECH WABAG LTD

FINANCIAL INSIGHTS	2020	2021	2022
OPERATING INCOME	▪ 42.959	▪ 49.119	▪ 69.121
OPERATING INCOME GROWTH	▪ NA	▪ 16.51%	▪ 2.09%
OPERATING PROFIT	▪ 20.415	▪ 14.906	▪ 12.271
OPERATING PROFIT MARGIN	▪ 22.554	▪ 34.213	▪ 56.850
OPERATING PROFIT GROWTH	▪ NA	▪ NA	▪ NA

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.2.3. PRODUCT AND SERVICE INSIGHTS

Service	Description
Sewerage Management	• This service includes design, procurement, laying, jointing, testing, commissioning, operation and maintenance of new sewerage network as well as refurbishment of old/existing sewerage network.
Design and construction	• Design and construction of pipeline by trenchless technology. • Design, construction, operation and maintenance of Sewage Treatment Plants. • Design, construction, operation and maintenance of Sewage Pumping Stations. • Design, construction, operation and maintenance of Water Treatment Plants.
Water supply	• Water supply works including design, procurement, laying, jointing, testing, commissioning, operation and maintenance of new water supply and distribution networks as well as construction of reservoir and refurbishment of old/existing water supply infrastructures.
Road & Allied works	• This service includes construction of new road networks as well as repair/renovation of existing road networks. • Design and construction of power transmission and distribution infrastructure. • Design and construction of buildings and allied works. • Design, construction, operation and maintenance of public infrastructure facilities & utilities.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.2.4. MAJOR PROJECTS

Project	Description
Common effluent treatment plant at sidcul, haridwar	Common Effluent Treatment Plant (CETP) of 4.5 MLD capacity (expandable upto 9 MLD) in SIDCUL, Haridwar on Build, Operate, Own and Transfer (BOOT) model under Public Private Partnership with State Industrial Development Corporation of Uttarakhand Limited. Under this project, the industrial units located in the SIDCUL, Haridwar discharge their industrial waste into the metered collection network laid by the company which then is treated at the CETP and discharged after proper treatment and filtration. The industrial units are charged as per volume of the effluent released by them. The concession period of the CETP is till the year 2035.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.2.5. SWOT ANALYSIS

S — STRENGTHS

- Established reputation in the water and wastewater industry
- Strong technical expertise in water treatment and infrastructure
- Robust client portfolio with long-term contracts
- Efficient operations and cost-effective solutions

W — WEAKNESS

- Vulnerability to regulatory changes and compliance issues
- Limited geographic diversification in the market
- High capital requirements for infrastructure development
- Competition from larger, well-established firms

O — OPPORTUNITIES

- Growing demand for sustainable water and wastewater solutions
- Potential for expansion into emerging markets
- Technological advancements in water treatment
- Partnerships with government agencies and environmental organizations

T — THREATS

- Economic downturns impacting infrastructure spending
- Fluctuations in raw material prices
- Environmental concerns and public scrutiny
- Increased competition from new entrants and incumbents

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.3. VA TECH WABAG LTD

VA TECH WABAG LTD	**Type:** Public
	Industry: Water and Wastewater Treatment
	Founded: 1924
	Headquarters: Chennai, India
	Website: www.wabag.com

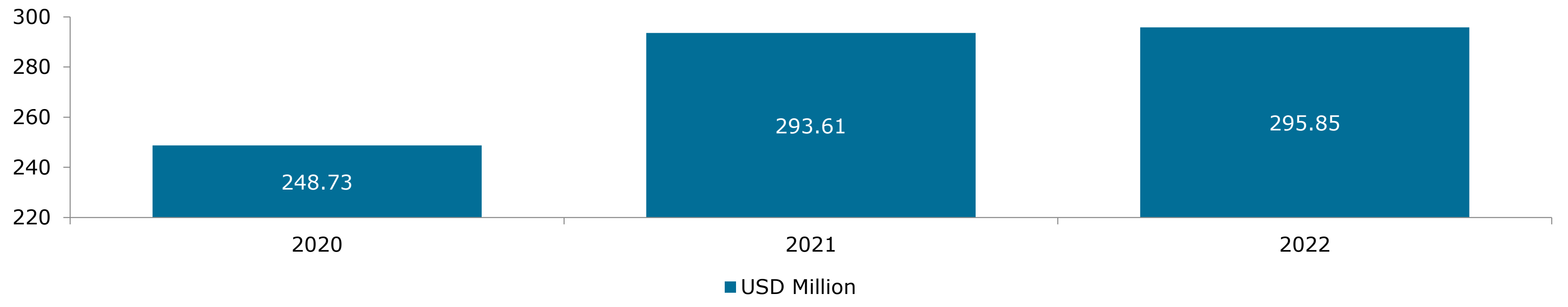
13.3.1. COMPANY SUMMARY

VA TECH WABAG LTD provides comprehensive solutions for water and wastewater treatment, including design, engineering, construction, operation, and maintenance of water treatment plants, sewage treatment plants, and recycling systems. Their solutions cover a range of technologies, such as filtration, desalination, membrane separation, ion exchange, and more. The company serves various sectors, including municipal water supply, industrial water treatment, desalination, and water reuse. Their clients include government bodies, corporations, industries, and municipalities. It has a global presence with operations in multiple countries. They have executed projects in various parts of the world, contributing to water scarcity management, pollution control, and sustainable water solutions.

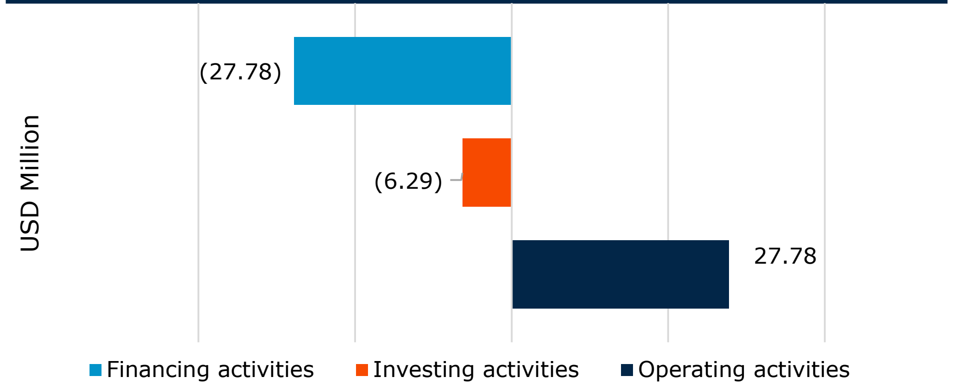
13.3.2. FINANCIAL INSIGHTS

Founded in 1924 and headquartered in Chennai, India. VA TECH WABAG LTD is a public company. As of 2022, the company employed about 5,000 people across the globe.

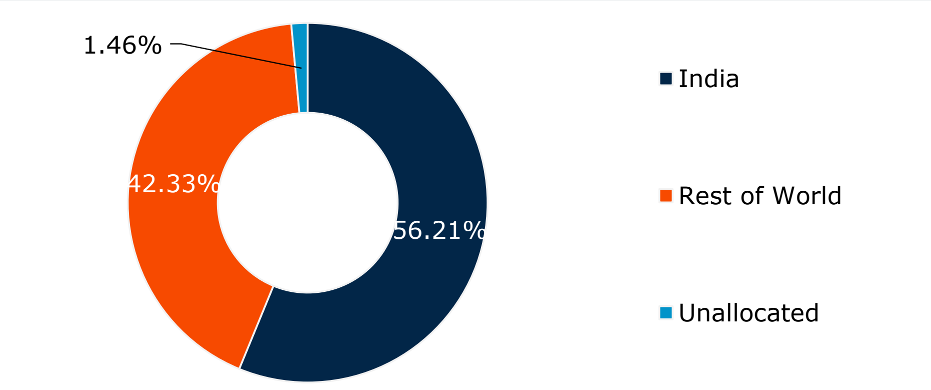
Net Sales



Cash Flow



Geographic Mix



Source: Company Website, Annual Report, News & Press Releases, and Reports and Data
Note: Exchange rate, for 2022 1 USD = INR 78.598, 2021 1 USD = INR 73.936, for 2020 1 USD = INR 74.102

TABLE 98. FINANCIAL INSIGHTS OF VA TECH WABAG LTD

FINANCIAL INSIGHTS	2020	2021	2022
OPERATING INCOME	▪ 248.73	▪ 289.79	▪ 295.85
OPERATING INCOME GROWTH	▪ NA	▪ 16.51%	▪ 2.09%
OPERATING PROFIT	▪ 17.65	▪ 22.78	▪ 38.94
OPERATING PROFIT MARGIN	▪ 231.08	▪ 267.02	▪ 256.91
OPERATING PROFIT GROWTH	▪ NA	▪ 15.55%	▪ -3.79%
NET PROFIT MARGINS	▪ 5.40%	▪ 4.40%	▪ 0.10%
GEARING RATIO / DEBT LEVELS	▪ 22.00%	▪ 32.00%	▪ 16.00%
INTEREST COVERAGE RATE	▪ 2.45	▪ 2.92	▪ 5.65

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.3.3. PRODUCT INSIGHTS

Product	Type	Description
▪ Water Treatment	• BIODEN • PACOPUR • CERAMOPUR • CERAMOZONE	• These water treatment facilities are highly scalable and can be established to suit any business model, be it EPC, DBO or BOOT. • These solutions ensure efficient extraction of potable water from all the available sources of fresh water as well as used water for direct or indirect potable reuse.
▪ Wastewater Treatment	• Nereda • SBR (CYCLOPUR) • MARAPUR • BIOPUR • FLUOPUR	• It promotes sustainability with wastewater treatment solutions that ensure environmentally friendly discharge or reuse of treated wastewater. • It promotes a comprehensive wastewater treatment model that focuses on resource recovery through a combination of innovative technologies.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.3.4. SWOT ANALYSIS

S STRENGTHS	W WEAKNESS	O OPPORTUNITIES	T THREATS
▪ VA TECH WABAG has a strong international presence, with operations and projects in multiple countries. This global reach provides them with diverse revenue streams and exposure to various markets. ▪ The company is known for its technical know-how and expertise in water and wastewater treatment technologies. This gives them a competitive edge in providing innovative and efficient solutions to clients. ▪ VA TECH WABAG offers a wide range of services, including design, engineering, construction, and operation of water and wastewater treatment plants. Their comprehensive portfolio enables them to serve various industries and customer needs. ▪ The company has successfully completed numerous projects worldwide, earning a reputation for reliability and quality. This track record helps them secure new contracts and partnerships. ▪ With increasing emphasis on environmental sustainability, VA TECH WABAG's expertise in providing sustainable water management solutions positions them well to meet growing market demands.	▪ The company's revenue is linked to capital spending by industries and governments on water and wastewater treatment projects. Economic fluctuations or budget cuts in these sectors can impact VA TECH WABAG's financial performance. ▪ Large-scale water treatment projects can be complex and involve multiple stakeholders, regulatory approvals, and technical challenges. Delays or issues in project execution can affect the company's reputation and profitability.	▪ Increasing global awareness of water scarcity and environmental concerns presents opportunities for VA TECH WABAG to provide solutions that address these issues, such as water reuse and resource recovery. ▪ Infrastructure development, especially in emerging markets, offers potential projects for VA TECH WABAG's services, including water treatment plants, desalination plants, and sewage treatment facilities. ▪ Advances in water treatment technologies and digitalization provide opportunities for VA TECH WABAG to develop and implement cutting-edge solutions, staying ahead in the competitive market. ▪ Collaborations with governments and private entities to address water management challenges can open doors for VA TECH WABAG to secure long-term contracts and contribute to public welfare.	▪ The water and wastewater treatment industry is competitive, with both domestic and international players vying for projects. Maintaining market share and pricing power can be challenging. ▪ Evolving environmental regulations and compliance requirements can impact project design and execution, potentially increasing costs or affecting project feasibility. ▪ Dependence on suppliers for equipment and materials could expose VA TECH WABAG to supply chain disruptions, affecting project timelines and costs. ▪ Economic downturns, currency fluctuations, and political uncertainties in the regions where the company operates can impact project investments and profitability.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

13.4. DENTA WATER AND INFRA SOLUTIONS LIMITED

Denta Water and Infra Solutions Limited	**Type:** Private
	Industry: Water and Wastewater Treatment
	Founded: 2016
	Headquarters : Karnataka, India

13.4.1. COMPANY SUMMARY

Established in 2016, Denta Water and Infra Solutions Limited, commonly known as "Denta Water," has emerged as a seasoned player in the field of water engineering, procurement, and construction (EPC) services. With a commendable track record in infrastructure project installations, including groundwater recharging through recycled water, Denta Water has been a key contributor to addressing the rising demand for water-related solutions in the country. Their notable achievements encompass pivotal projects like the Byrapura and Hiremagaluru LIS Project, Karagada LIS Project, and others, primarily executed through lift irrigation systems. Notably, Denta Water played a substantial role in the first phase of the KC Valley project, contributing to Bengaluru's reputation as the second-largest city globally in terms of treated wastewater quantity. The company's significant involvement in the "Jal Jeevan Mission" of the Government of India reflects its commitment to critical water management initiatives. Furthermore, Denta Water secured contracts for lift irrigation projects in various regions, such as Makali, Makali Hosahalli, Krishnapura, and neighboring villages in the Channapatna Taluk of Ramanagar District, Karnataka. Their growth is inherently linked to the nation's infrastructure development, with a focus on design and engineering consultancy that aligns with the ongoing and anticipated projects in the Karnataka Government's water management sector. As water remains a critical resource, Denta Water is poised to continue making substantial contributions to the industry's growth and development in the future.

13.4.2. MAJOR PROJECTS

Project	Description
▪ Koramangala-Challaghatta (KC) Valley project – Phase II	• This project is under the Minor Irrigation department, Government of Karnataka for second stage lifting or pumping secondary treated water from available sources to various ridge points to fill additional 272 tanks in Kolar District and Chintamani Taluk of Chikkaballapura District under ongoing KC Valley Project. Project includes design, construction, commissioning, repair and maintenance for a period of five years.
▪ Bangalore East Lift Irrigation Scheme (LIS)	• With this project the company engages in lifting/pumping of secondary treated water from KR Puram STP to feed 22 tanks in Bangalore (East) Taluk of Bangalore Urban District through LIS. Project includes design, construction, commissioning, repair and maintenance for a period of five years.
▪ 3. Multi Village scheme for drinking water supply – Kopal District	• The company signed the contract with Rural Drinking Water and Sanitation Department, Government of Karnataka, for supplying drinking water to Kerehalli and other 103 habitations of Koppal Taluk in Koppal District in Karnataka. The project comprises designing and engineering for lifting water from Tungabhadra river, installation of water treatment plant with capacity of 14.5 MLD and 8.5 MLD and laying of 388.605 km of pipelines for supply of drinking water.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data (Note: we have profiled major ongoing projects only)

13.5. SPML INFRA LIMITED

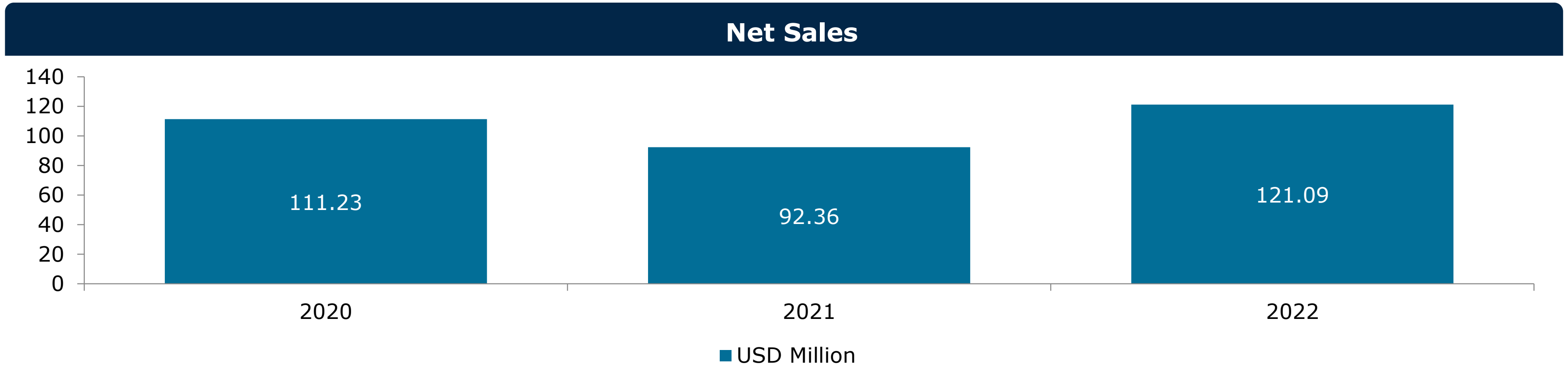
SPML Infra Limited	**Type:** Public
	Industry: Infrastructure Development
	Founded: 1981
	Headquarters: Kolkata, India
	Website: www.spml.co.in

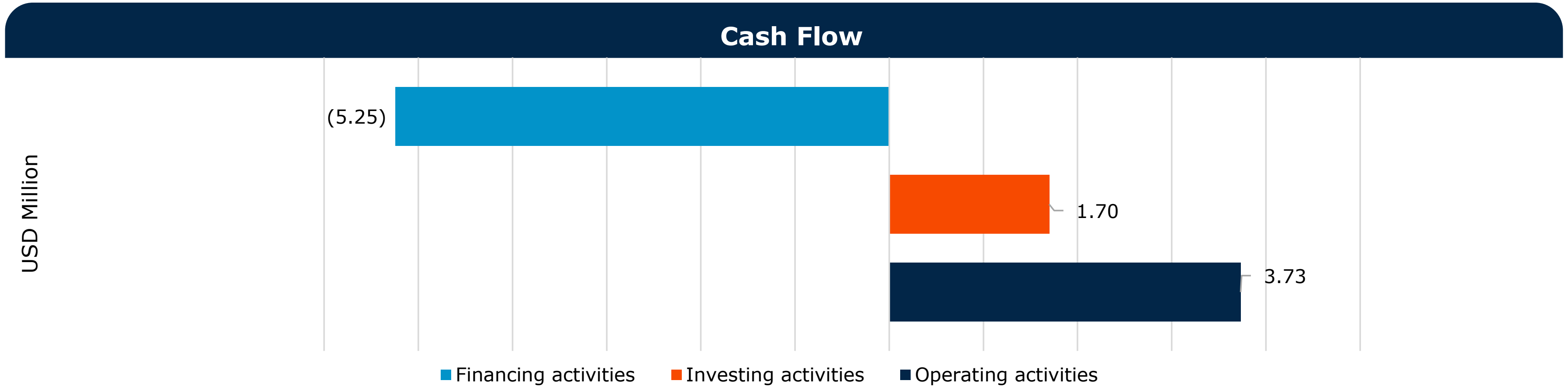
13.5.1. COMPANY SUMMARY

SPML Infra Limited is an Indian infrastructure company specializing in providing integrated water supply, sewerage, and sewage treatment solutions, as well as power and environment management services. It is known for its expertise in designing, constructing, and maintaining water supply projects, including distribution systems and water treatment plants. The company is involved in building sewage collection and treatment systems to improve sanitation and environmental conditions. It is also engaged in power transmission and distribution projects, contributing to India's growing energy needs. The company offered services related to environmental infrastructure, waste management, and green solutions. The company received awards and recognition for its contributions to the infrastructure sector and its commitment to quality and innovation.

13.5.2. FINANCIAL INSIGHTS

Founded in 1981 and headquartered in Kolkata, India. SPML Infra Limited is a public company. As of 2022, the company employed about 10,000 people across the globe.





Source: Company Website, Annual Report, News & Press Releases
Note: Exchange rate, for 2022 1 USD = INR 78.598, 2021 1 USD = INR 73.936, for 2020 1 USD = INR 74.102

TABLE 99. FINANCIAL INSIGHTS OF SPML INFRA

FINANCIAL INSIGHTS	2020	2021	2022
OPERATING INCOME	▪ 124.89	▪ 100.98	▪ 124.83
OPERATING INCOME GROWTH	▪	▪ -19%	▪ 24%
OPERATING PROFIT	▪ 0.21	▪ (15.30)	▪ 1.13
OPERATING PROFIT MARGIN	▪ 124.67	▪ 116.29	▪ 123.70
OPERATING PROFIT GROWTH	▪	▪ -7%	▪ 6%
NET PROFIT MARGINS	▪	▪ -17.40%	▪ 1.17%
INTEREST COVERAGE RATE	▪ 1.03	▪ (1.37)	▪ 1.27

Source: Annual Reports, Primary Interviews, and Reports and Data

13.5.3. PRODUCT INSIGHTS

Product	Description	Scope of Services
▪ WASTEWATER	• It has the capabilities to provide reuse with recovery of resources from waste as well as solutions for proper treatment and disposal of wastewater with specific processes such as anaerobic, anoxic, and aerobic. • It builds plants which are fully equipped with PLC and SCADA system with reliable treatment technology for efficient operation and maintenance.	• Sewage Treatment Plant • Effluent Treatment Plant • Tertiary Treatment Plant • Water Reuse & Recycling • Integrated Sewerage Network • Sewage Pumping Station/Pipeline • Sludge Treatment & Energy Recovery • Storm Water Drainage • Sewer Pipeline Rehabilitation
▪ WATER TREATMENT	• The water treatment plants are essential for modern infrastructure to make drinking water available which comes from groundwater, lakes, streams, rivers, canals or sea, and should be treated and cleaned before being distributed for potable and non-potable use. • With strong foothold in the domain of design, construction, operation and maintenance of high-capacity water treatment plants (WTP), SPML has infrastructure and resources required to implement drinking water supply and distribution system with required technology to monitor quantity and quality of water supplies including billing system.	• Design and planning • Construction of flocculation and filters • Pre-ozonisations and chemical dosing • Lamella settling, sludge beds and pulsating beds. • Single-layer and multi-layer filtration • Adsorption on activated carbon beds • Treatments with Membrane Filtration, Ultra Filtration, Reverse Osmosis, Iron and Arsenic Removal and Electro-dialysis Reversal membranes • Cleaning water recovery system • Operation & maintenance

13.5.4. SWOT ANALYSIS

S STRENGTHS	W WEAKNESS	O OPPORTUNITIES	T THREATS
▪ Strong track record in executing water and wastewater projects. ▪ Established relationships with government agencies and clients. ▪ Diversified portfolio of water and wastewater services. ▪ Technically skilled workforce.	▪ Dependence on government contracts for revenue. ▪ Vulnerability to regulatory changes in the water sector. ▪ Limited international market presence. ▪ Competition from larger, more established firms.	▪ Growing demand for water and wastewater infrastructure in emerging markets. ▪ Potential for public-private partnerships (PPPs) in the sector. ▪ Expansion into innovative water treatment technologies. ▪ Focus on sustainability and eco-friendly solutions.	▪ Economic downturns impacting infrastructure spending. ▪ Environmental regulations and compliance challenges. ▪ Fluctuating raw material costs. ▪ Emerging competitors and disruptive technologies.

Source: Company Website, Annual Report, News & Press Releases, and Reports and Data

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