Clean water technologies

Overcoming the challenge of a drier world

L&G

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Turning the tide on water scarcity

Around half of the world's population currently experiences severe water scarcity for at least part of the year, according to the Intergovernmental Panel on Climate Change. The UN estimates around two billion people currently don't have access to safe drinking water.

Pressure on the planet's supply of clean water, exacerbated by a growing population and rising industry use, is drawing increasing public and political focus. Along with hundreds of pledges and commitments, governments are driving investment in clean water. The European Investment Bank commits €3bn to water infrastructure investment annually, and the US Bipartisan Infrastructure Law has launched a €50bn water infrastructure plan.

Alongside the government push, solutions are coming from the private sector, which is trying to turn the tide with innovative technologies that aim to increase usable water supply, improve water quality and increase consumption efficiency.

In this paper, we explore the technologies that are providing clean water solutions, from desalination systems to infrastructure equipment and leak management.

Clean water is precious and scarce, but efforts to conserve it are creating potential growth opportunities across the entire value chain.

Source: (SDG Report 2022), https://www.un.org/en/climatechange/science/climate-issues/water#:~:text=About%20two%20billion%20people%20worldwide,and%20population%20growth%20(WMO).
22 Mar 2023, European Investment Bank news. https://www.eib.org/en/press/news/maximising-scarce-resources-eib-updates-its-water-sector-policy

Key risks
Assumptions, opinions and estimates are provided for illustrative purposes only. There is no guarantee that any forecasts made will come to pass.

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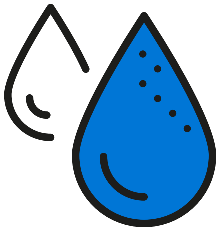
Water scarcity is an urgent problem, and it's getting worse

26% of the global population do not have safe drinking water and 46%[1] lack access to safely managed sanitation.

Demand for water is projected to rise by up to 30%[2] by 2050, but water supply, quantity and quality are increasingly challenged.

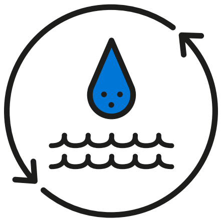


Technology offers a range of potential solutions

In the near term, digitisation and smart water management are allowing water providers to operate more efficiently.

In the midterm, technologies promise to increase the proportion of used water that is recycled.

Long term, technologies could transform today's unusable water resources into affordable fresh water.



Potential growth opportunities are emerging

From individuals to households, from industrial companies to national organisations, a wide range of entities are investing in and contributing to water technology transformation.

The global water and wastewater treatment technologies market is expected to reach $515.8 billion by 2028 at a CAGR of 11.2% from 2023 to 2028.[3]

[1] UN World Water Development Report 2023, 2023
[2] Unesco Partnerships and Cooperation for Water, 2023
[3] Business Wire: Global Water and Wastewater Treatment Technologies Market Report 2023, 2023 CAGR = Compound annual growth rate

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Water scarcity is intensifying, with demand expected to outstrip supply by 40% by 2030[4]

By 2050, the global urban population facing water scarcity is projected to more than double from 930 million people (a third of the urban population) in 2016 to up to 2.4 billion (nearly half the urban population).

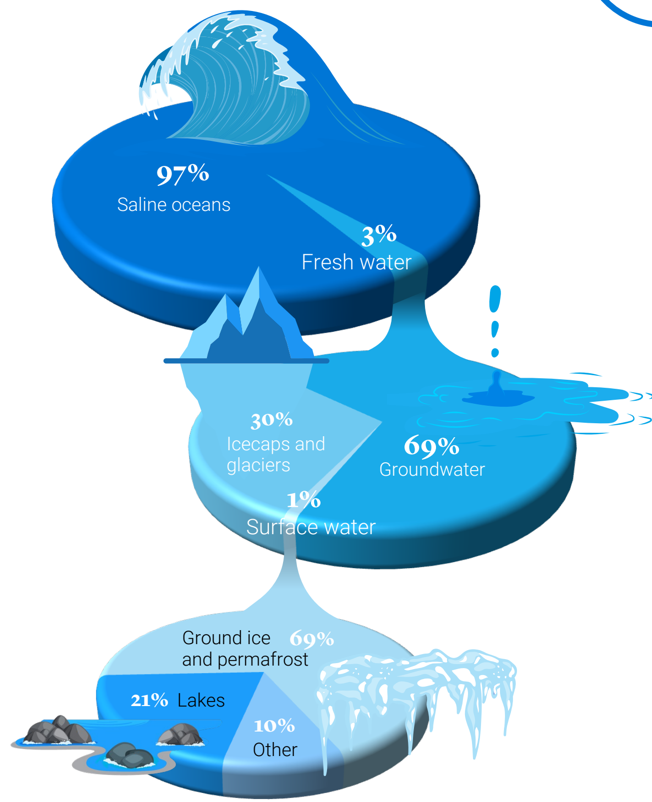
Overall, global water demand is estimated to increase by 30% by 2050. Municipalities, industries and agriculture are three major water-use sectors that will shape future demand.

Despite water covering 70% of our planet, only 3% of this is fresh water, which is needed for people, animals and crops. Two-thirds of that scarce fresh water is locked up in glaciers or otherwise unavailable for use.[5]

Compounding the problem, much of our accessible fresh water has become polluted. Climate change is also accelerating the frequency of extreme weather events.

Together, these factors have put intense pressure on our fresh water resources.[6]

Where is the world's water?



Did you know?

Water scarcity and climate change are inextricably linked

Limiting global warming to 1.5°C compared to 2°C would approximately halve the proportion of the world population expected to suffer water scarcity [7](IPCC).

Clean energy uses less water[8]

Almost 20 trillion litres of water consumption could be saved in the energy sector by 2030 under the IEA's Net Zero Emissions by 2050 Scenario, with nearly 15% of coal-fired power generation replaced by solar and wind.

[4] The Guardian: Global fresh water demand will outstrip supply by 40% by 2030, say experts, 2023 [5] WWF: Water Scarcity, 2024
[6] PhysOrg: Is the world running out of water?, 2023 [7] UN: Water – at the center of the climate crisis, 2024 [8] IEA: Energy and Water – Exploring the interdependence of two critical resources, 2024

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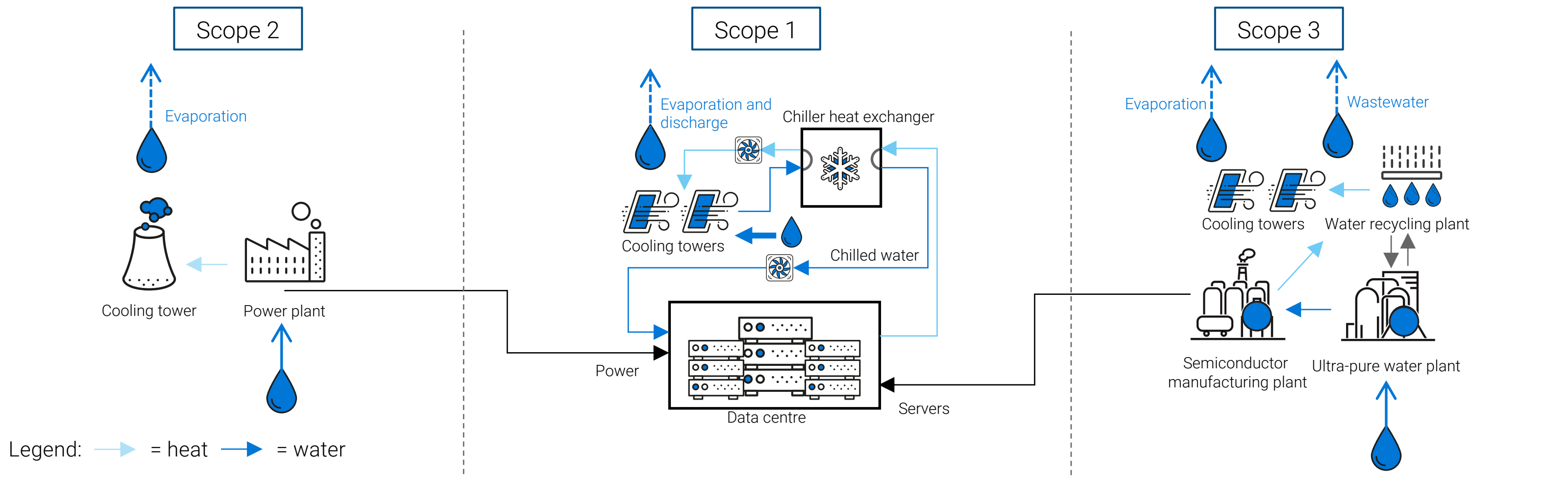
Generative AI is a significant new driver of further water demand

Every ChatGPT query triggers an ocean of calculations, necessitating clean water to cool the servers that crunch the numbers.

AI's direct and indirect water consumption



(Scope 2) Off-site water usage during power generation to cool the power plant is another demand driver. In 2023, US data centres had an indirect water footprint of nearly 800 billion litres due to electricity use.[10]

(Scope 1) Google data centres consumed around 20 billion litres of water in 2022, roughly equivalent to the annual water consumption of 2.5 million Europeans, or 1.2 million Americans.[9]

(Scope 3) There is also water consumption associated with AI supply chains. Semiconductors and microchips require large volumes of water in the manufacturing stage, with a single 12-inch wafer layer produced by TSMC consuming around 60% of the average person's daily domestic water use in Taiwan.[11]

Source: [9] Data Center Water Usage: A Comprehensive Guide - Datl Infra [10] Berkely Lab: 2024 United States Data Center Energy Usage Report [11] TSMC: Sustainability Report, 2023 and Statista

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Data centre water consumption forecast to hit 450 million gallons per day by 2030

The total water consumption by data centres (including water used on-site for cooling, and off-site for power generation) globally rose by 6% per annum from 2017 to 2022 and is estimated to reach 450 million gallons a day by 2030, according to Bluefield Research.

Academics suggest that AI demand will drive up water withdrawal, where water is removed from the ground or surface sources, to between 4.2 billion and 6.6 billion cubic metres by 2027, equivalent to five times Denmark's yearly water usage.[12]

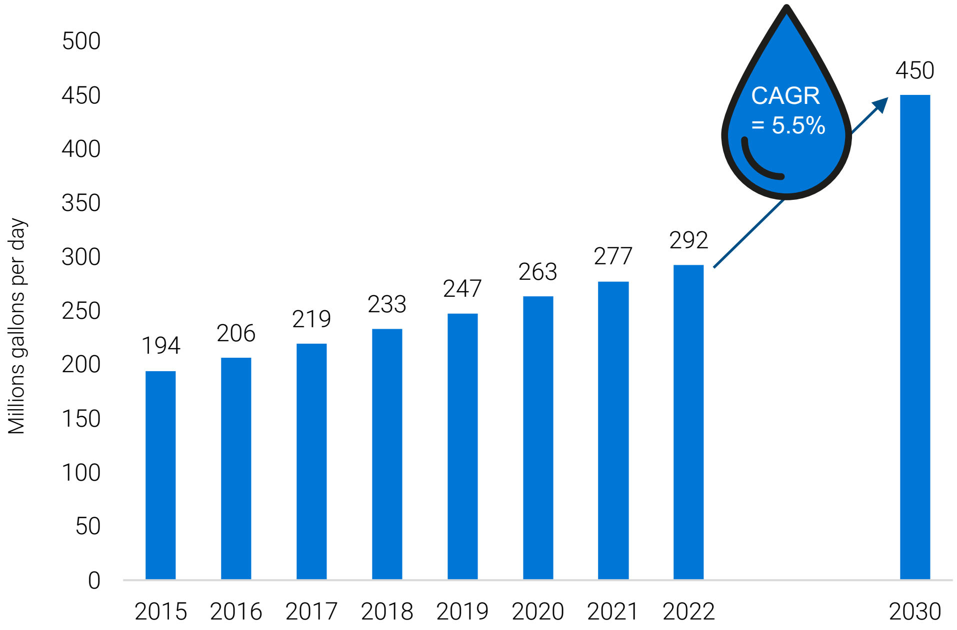
Generative AI (GenAI), which uses large language models (LLMs) to create text, images, and other outputs, requires the use of huge server farms that use chilled water to cool equipment by absorbing heat from the air. Once water has been used to cool data centres, some of it is recirculated to the cooling system several times before being discharged, while some evaporates in the cooling process.

However, it's important to note that not all data centres are created equally. For example, older facilities often use significantly more water than recent designs. Newer designs can include sustainability features from the ground up, including state-of-the-art water recycling systems and AI-driven predictive maintenance systems.

There's no doubt that data centres are needed for a raft of essential services, and that they have a vital role to play in unlocking productivity gains via AI. For example, data centres are now deemed as 'critical infrastructure' by the UK government given their essential services for hospitals, emergency services, financial systems etc.

The focus now is on making them more sustainable.

Global data centre water consumption expected to keep growing



Source: [12] AI boom sparks concern over Big Tech's water consumption

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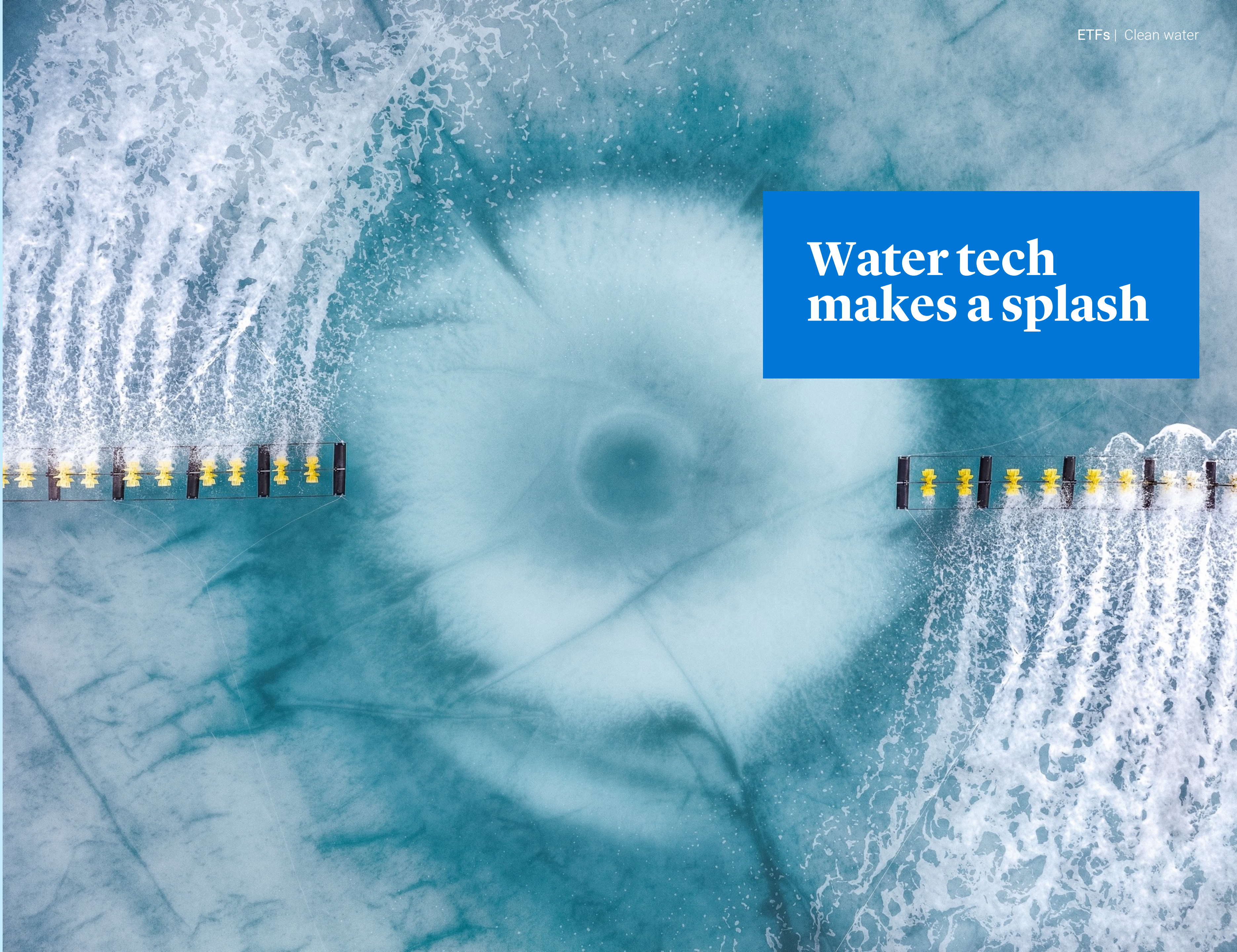

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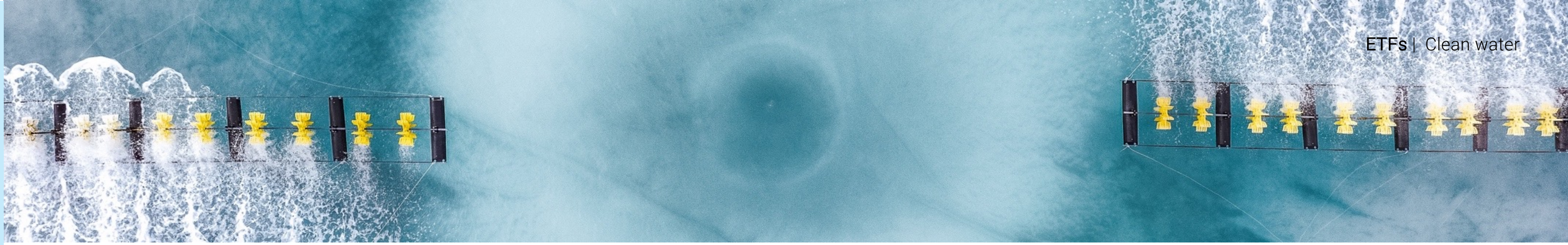

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Desalination holds the potential to alleviate water scarcity

Advanced desalination techniques, rainwater harvesting, water reuse systems, smart water management tools and leak detection devices could increase the water supply, reduce water waste and improve efficiency.

Progress is being made, but continued investment and implementation will be critical to turning the tide. This primer will focus on technologies that are either quickly emerging, rapidly developing, or are already broadly established.

Increase usable water supply: desalination is a fast emerging opportunity

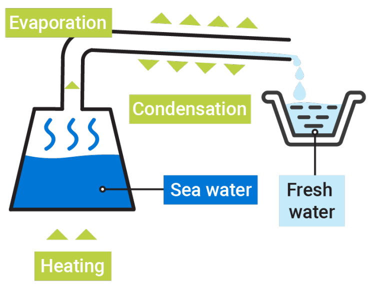
Given that only 3% of water on earth is fresh, turning abundant saltwater into usable fresh water is an obvious way of addressing water scarcity. Desalination is becoming more attractive as it becomes more cost-competitive, technology scales up and fresh water supply dwindles.
Desalination processes can be mechanical (mechanical vapour compression and reverse osmosis), thermal (i.e. simple stills, multi-effect distillation, multi-stage flash evaporation, thermal vapour compression), or electrical (electrodialysis).

Reverse Osmosis (RO), a mechanical process that uses pressure, is the most used process and consumes less energy than the rest, as it is based on the use of semipermeable membranes that allow water molecules (smaller) to pass, but not salt molecules (bigger). Feed water is pumped at high pressure and forced across the membrane. Recycled water is collected, while concentrate (rejected water) flows separately.

Thermal process

Thermal processes include distillation, an energy-intensive process in which water is boiled in a still that collects and condenses steam used for fresh water. Solar distillation uses evaporation of water in large facilities requiring a lot of space.

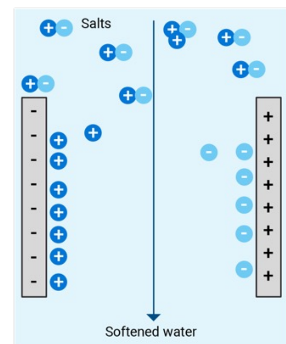
Multi-stage flash desalination (MSF) is heavily used in the Middle East and involves seawater being heated and condensed in multiple stages.



Electrical process

An electrical method is electrodialysis, which consists of moving water through electrically charged membranes that trap the salt ions dissolved in the water and separate them from fresh water.

Electrodialysis can end up being more energy efficient than RO with low salt concentrations, because the higher the concentration, the higher the energy consumption. Electrodialysis is also preferred with very high concentrations that RO cannot separate.



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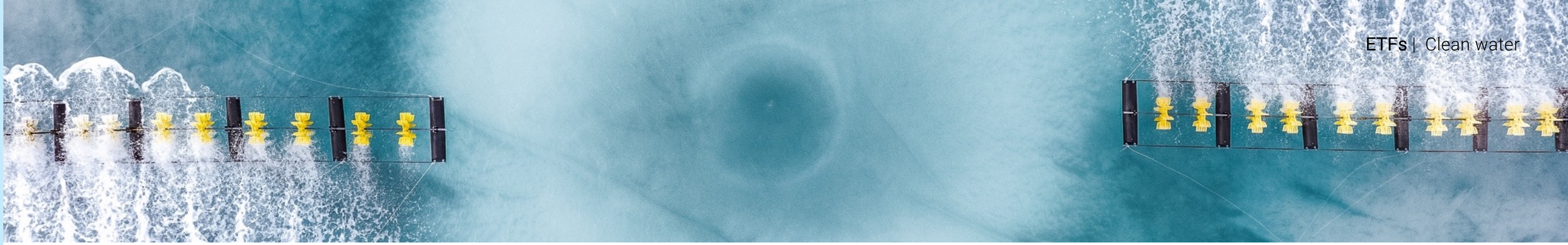


Desalination components: take a deep dive

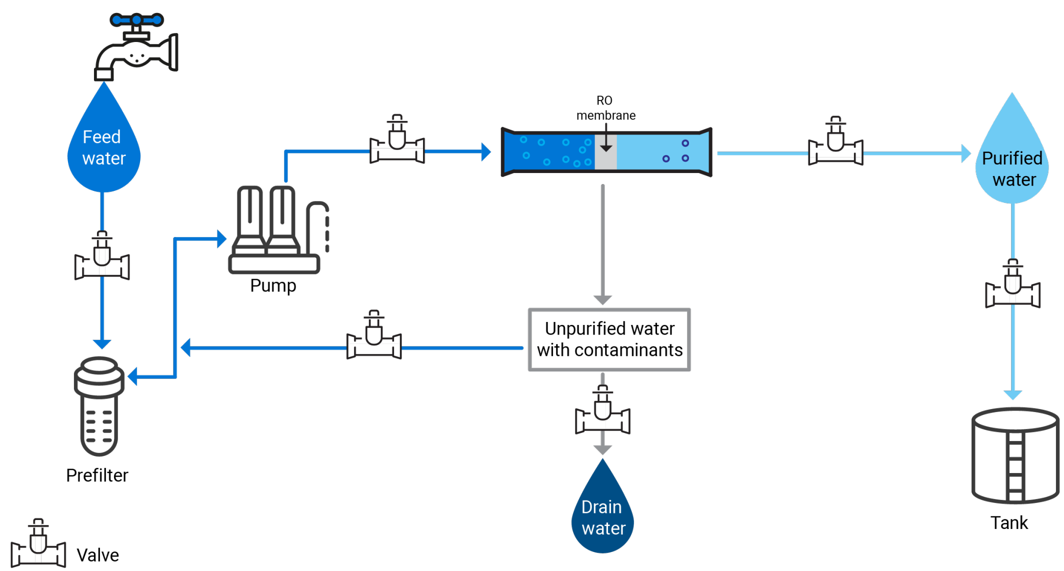
Processes such as RO require pipes and valves. There are many types of valves, but their common objective is to monitor pressure and control the flow of water. Some valves are electromagnetic (solenoid valves), others are controlled by a manual or electrical level (ball and butterfly valves), and some are automatic, based on flow pressure. Valves are essential for plant efficiency and reliability.[13]

In a desalination system, initially a feedwater valve controls the inflow of feed water. As water gets pumped towards the RO membrane, a valve monitors pressure, and from the RO membrane a check valve helps water flow through to prevent backflow. At this point, four valves direct water into four different routes. First, a sample valve lets a small quantity of purified water flow into a sample to be tested; secondly, a distribution valve lets the excess purified water flow into tanks; then a reject drain valve recirculates water into the system and finally a recirculated reject valve drains unpurified water. A float valve prevents the tanks with excess purified water from overflowing.

Pipes are also an important component of desalination systems because they need to resist sea water corrosion, high pressures and temperatures, UV alterations and wear due to solvents, oil, climate and time. Pipes are also subject to scale build-up from calcium and magnesium, pre-treatment chemicals, and chlorine. Leaching, where impurities leave the pipe and contaminate the water, is another potential issue.

Research into specialist materials is focused on finding advanced solutions that resist both corrosion and leaching. Pipes are regularly monitored for wear and tear to prevent unwanted failures and help plan capital spending.

Valves are essential components for water technologies



[13] Water Technology: [Understanding reverse osmosis valve functionality](), 2018

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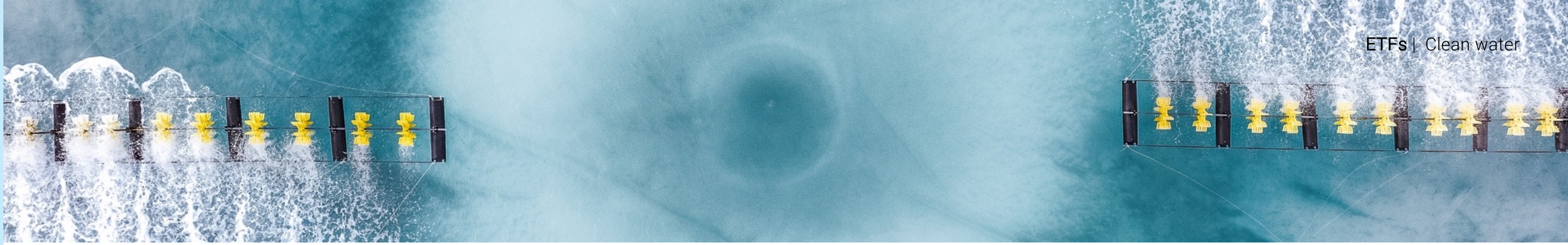

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Desalination: existing plants and applications

Desalination plants tend to be located in high-income countries, small island nations or countries where there is no alternative to access fresh water. There are currently ~16,000 desalination plants globally, half of which are in the Middle East (mainly Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain and Israel), accounting for about 70% of worldwide capacity. Others are in North Africa (mainly Libya and Algeria), which uses about 6% of worldwide capacity, and in the US (California and parts of Florida).[14]

Desalinated seawater is not only produced for domestic/municipal use, but also for agricultural irrigation and processes that require very high-water quality, like that used in boilers to avoid scale build-up. Other examples include the manufacture of pharmaceuticals, semi-conductors and hard disk drives.

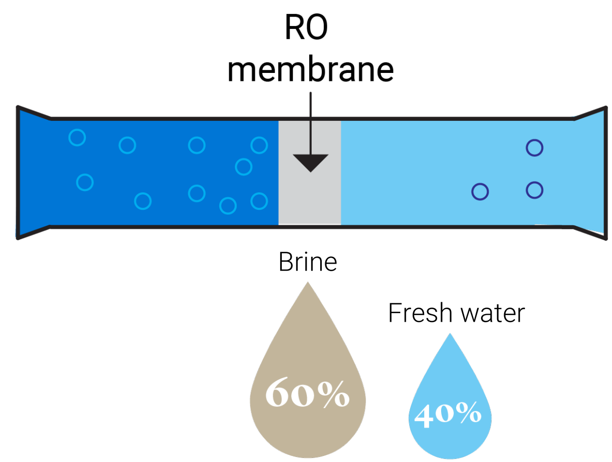
Future expansion of desalination

Desalination has two major drawbacks: energy intensity and leftover brine. While the former is being addressed by renewables, the latter is creating concerns around marine life and pollution in the food chain. Brine is a concentrated water mixture of salt and metal compounds that are separated from fresh water, and its discharge into the sea has negative consequences on the environment and marine ecosystems. A wide variety of metals can be found in brine. Recovery is still largely uneconomic, although technology is improving in an effort to monetise brine output.[15]

The amount and quality of brine discharge depends on the type of desalination. For example, RO in the US generates a quarter as much brine as the thermal technologies used in the Middle East.

On average, a desalination plant using RO has a recovery ratio of 40%, which means an output of 40% water and 60% brine.[16] There is also a difference between brackish water, whose salinity level is between that of fresh and seawater, and seawater feed, as the latter contains more dissolved solids and results in higher energy costs.

Reverse osmosis recovery ratio



[14] USGS: Desalination, 2019
[15] Academic paper: Metals Recovery from Seawater Desalination Brines: Technologies, Opportunities and Challenges, 2019
[16] Academic paper: Sustainable brine management from the perspectives of water, energy and mineral recovery: A comprehensive review, 2021

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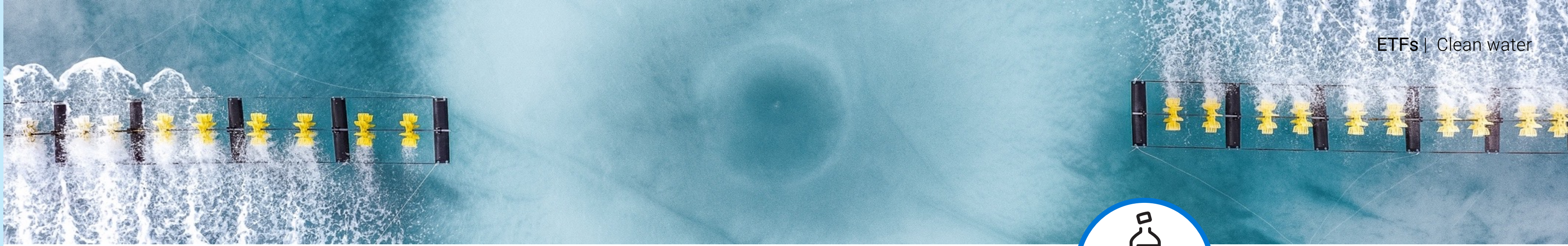
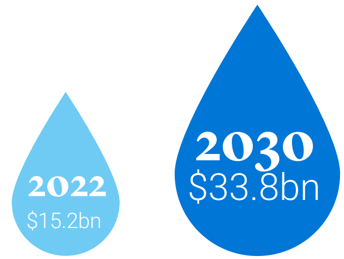


Desalination: growth and outlook

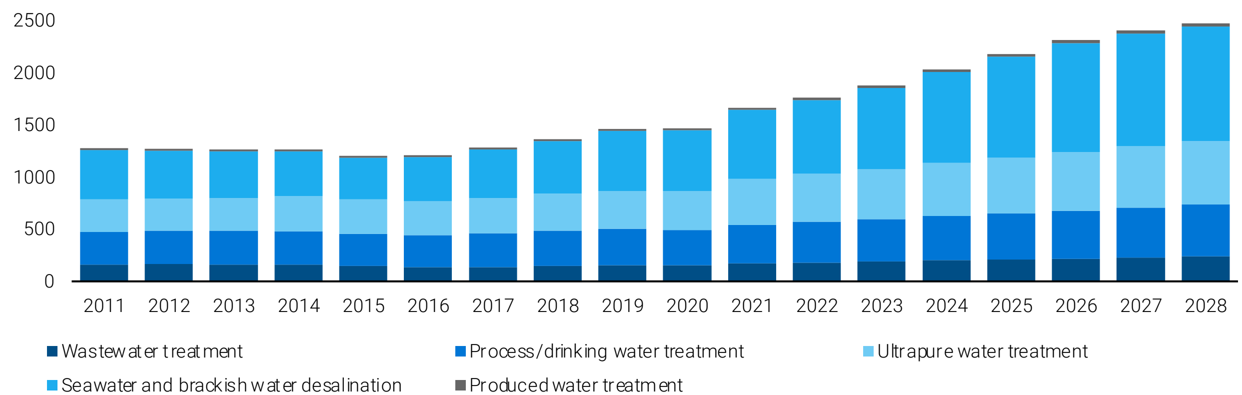
The seawater and brackish water desalination markets continue to grow. GWI expects capex to rise to $9.4 billion in 2027 from just under $6 billion in 2022, and opex to increase to $13.4 billion from $10.6 billion in 2022. Key markets are the Gulf Cooperation Council (GCC), including Saudi Arabia, the UAE, Kuwait and Qatar. Egypt is another growing market as it tries to reduce dependency on the Nile, and California and Texas for brackish and surface water desalination. Saudi Arabia is by far the market with the largest 2018-2027 capex.

The desalination market is expected to grow at about a 10% CAGR. [1]

Market size growth



Spending by application



[1] Source: GWI, Straits Research, Transparency Market Research, Precision Business Insights, Data Intelligence, 2023.

Rainwater harvesting

Rainwater harvesting offers several advantages:

- Significantly reduce water bills
- Reduce need for imported water
- Help utilities reduce peak demand in the summer months
- Serve as a backup for emergencies
- Reduce stormwater runoff (hence reduce contamination of water)
- Good source for plants because it is chlorine free
- Does not need to be treated like municipal water so reduces energy requirement to pump it
- Is not hard so there is no scale build-up

On the other hand, installation is relatively complex as it must account for different levels of rainfall and there is potentially the need to excavate to install a capture tank. Questions remain around the costs and incentives for installation before this technology can be scaled up.

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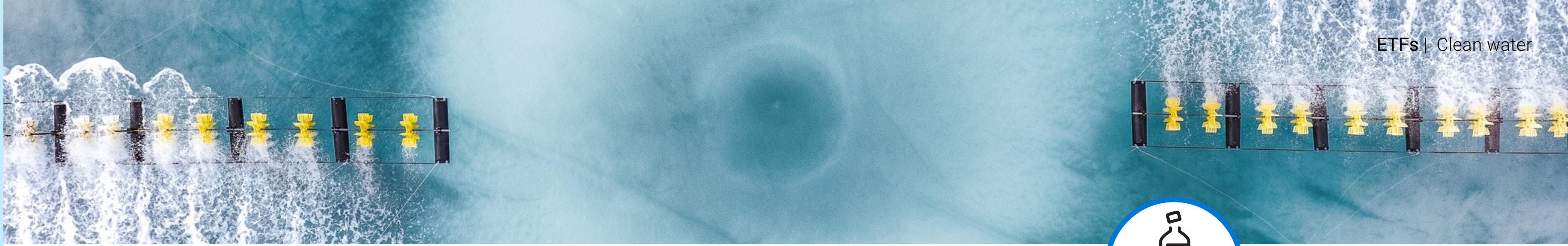

Improving water quality and increasing reuse: Water treatment technologies

Water treatment is the process of improving water quality. This most commonly becomes drinking water and industrial water, or it is safely returned to rivers, lakes and oceans.[17]

Wastewater treatment for reuse plays a central role as "part of the solution to water scarcity and pollution problems," according to Jennifer Sara, Global Director of the World Bank's Water Global Practice.[18]

The water used in municipal or industrial processes, or in replenishing environmental sources, must meet specific parameters. For instance, the Environmental Protection Agency in America has set legal limits on more than 90 different contaminants to ensure drinking water remains safe.[19] Industrial facilities must also ensure that the quality of water is acceptable for fabricating, processing, washing, diluting, cooling or transporting a product.

The use of recycled wastewater, also known as grey water, for irrigation is becoming more common, especially in drought-prone and water-scarce regions. Proper treatment and monitoring are required to ensure water quality and avoid potential health risks.[20]

How is recycled wastewater used?

Do you know water?

Green water
Water stored in soil available for evapotranspiration by plants

Blue water
Rivers, lakes, wetlands, groundwater and water storage

White water
Glaciers, snow and ice

Grey water
Wastewater with contaminants, excluding human waste

Black water
Wastewater exposed to human defecation and other contaminants

[17] SafetyCulture: A Guide to Understand Water Treatment, 2024 [18] Idrica water technology: Water Trends in water reuse for 2023: Water, from waste to resource, 2023
[19] Sensorex: Three Main Types of Water Quality Parameters Explained, 2024 [20] H2O Global News: Innovative Water Technologies Solutions To Global Water Crisis, 2023

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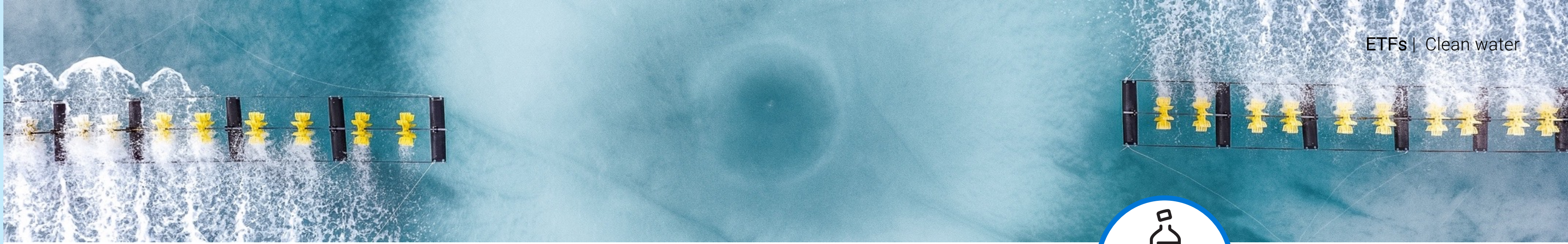


Water treatment technologies

The growing need for greater conservation and reuse of water worldwide has led to the development of innovative water treatment technologies. While this paper will focus on innovations in filtration membrane technologies, others commonly found in the market include:

Physical-chemical treatments

They focus primarily on the separation of suspended particles, which is mainly achieved through chemical additions used to treat water for suspended solid removal.

Adsorption

Adsorption of pollutants via a solid material (adsorbent). For example, advanced carbon utilises adsorption to primarily remove organic matter from water and wastewater streams.

Dissolved solids removal

Technologies that remove dissolved salts, minerals and other materials from water. For example, ion exchange is used to remove unwanted dissolved ions in water and wastewater, a common pollutant in water.[21]

Biological treatment

Use of naturally occurring bacteria to treat organic contaminants in water. It is prevalent in the food and beverage and pulp and paper industries, both of which produce wastewater streams with high carbon or nitrogen content.

Disinfection

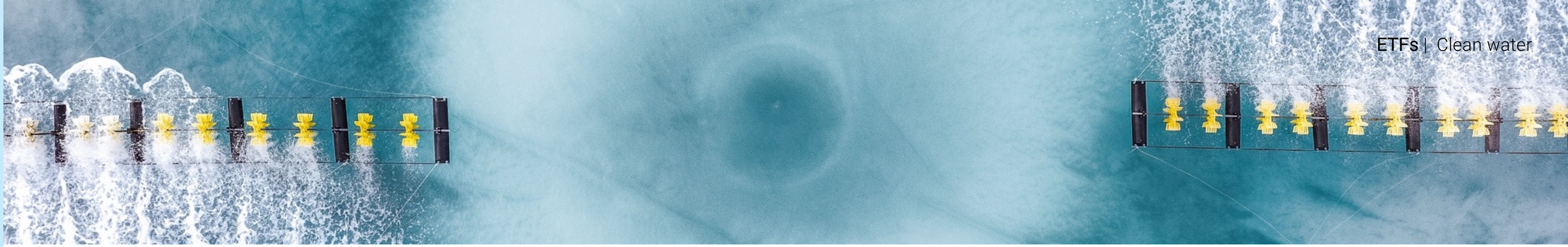
Any processes in which microorganisms are destroyed or deactivated, resulting in the termination of their growth and reproduction. These processes are used as a final step in water reuse applications.

Have you heard of ultrapure water?

Ultrapure water is water that has been made as close as possible to pure H2O. If humans were to only drink ultra-pure water, we would lose many important electrolytes and become unwell. Ultrapure water is used in the semiconductor and pharmaceutical industries, and work in the laboratory, where contamination via dissolved particles would prove problematic.[22]

Future growth is expected to be driven by the semiconductor industry, with 8% year-on-year growth predicted over the next decade, amid AI and data centre requirements increasing, and pharmaceutical industry expansion with the rising population.[23]

[21] AtlasScientific: Ion Exchange In Water Treatment [22] ELGAVeolia: Ultrapure Water [23] CDP: Water security needs to step into the limelight at COP28



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Water treatment technologies in focus: membranes

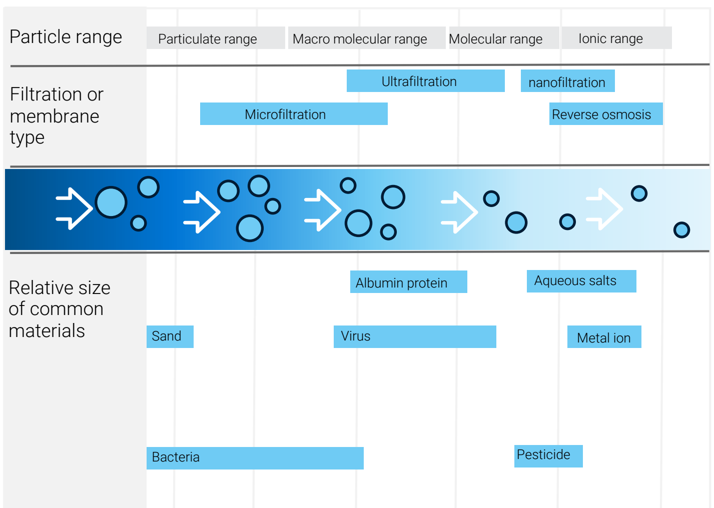
Among all the water reuse methods, membrane technologies are particularly notable.

Membrane technology includes a variety of liquid filtration and separation processes (from largest to smallest pore size): micro-filtration (MF), ultra-filtration (UF), nano-filtration (NF) and reverse osmosis (RO). Because it does not require a heat source, membrane separation tends to use far less energy than other similar processes.

Ultrafiltration and microfiltration remove bacteria and pathogens, while graphene-enabled adsorption targets emerging contaminants like antibiotics, drugs, "forever chemicals" called PFAS and heavy metals. Tightening wastewater discharge regulations in China and India, and stricter drinking water standards in the US, are driving growth.

As well as increasing demand, membrane growth is also driven by replacement demand because membranes face surface problems with scaling and fouling. Treatment solutions include antiscalants, cleaners, biocide control agents, membrane coagulants, chlorine scavengers and membrane preservatives (Kurita). Additionally, membranes themselves can become contaminated with bacteria, so filtered water might have to be treated.

Membrane separation technologies



[24] Filtration+Separation: 10 current trends in filtration and separation, 2023
[25] Straits Research: Membrane Separation Technology Market, 2022

New materials such as graphene or biomimetic membranes that echo nature could drive the next wave of water technology innovation.

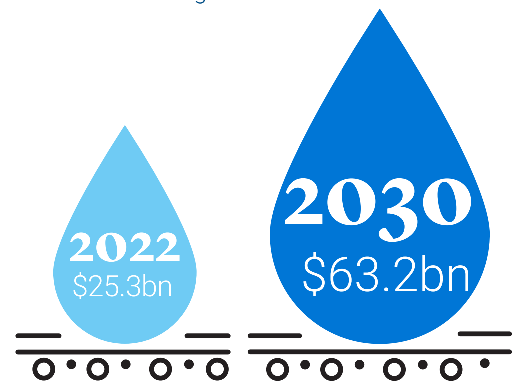
Apart from being even finer and more precise, membrane technology will also become increasingly digitalised. AI can be used to monitor and optimise filtration systems in real time.

Pressure, flow rates and other variables can be controlled to maximise filtration efficiency. AI enables the development of filtration systems that can better adapt to specific requirements.

Possibilities range from adapting to different particle sizes to considering the specific chemical properties of the substances to be filtered.[25]

The global membrane separation technology market size was valued at $25.3 billion in 2022. It is expected to reach $63.2 billion in 2030, growing at a CAGR of 12.1% during 2023-2031,[25] driven by growing restrictions on untreated wastewater discharge and rising adoption in the food and beverage industry.

Market size growth



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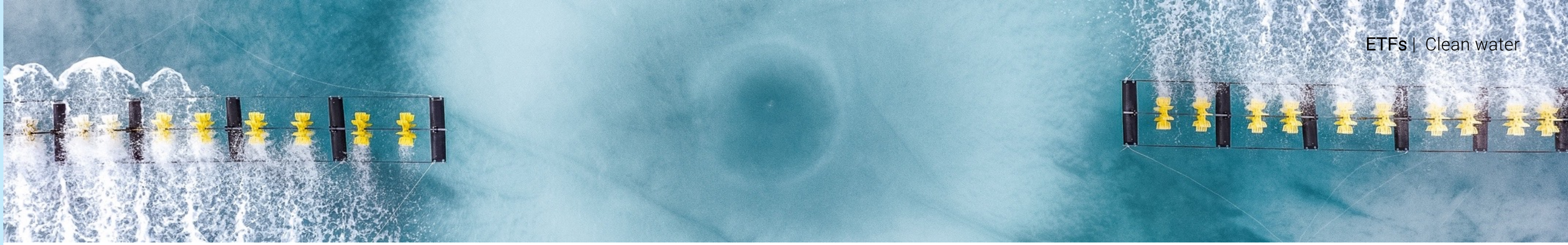


Water technologies for AI in focus: water-based cooling solutions

Data centres are cooled with a variety of systems, and operators often adopt different solutions across their global sites. There is no 'one size fits all' solution, as the local climate dictates which systems are appropriate. While some data centres are shifting to alternative methods of cooling, evaporative cooling towers remain common, which cool air by evaporating water. Millions of gallons of water each day are evaporated in these cooling systems. [26]

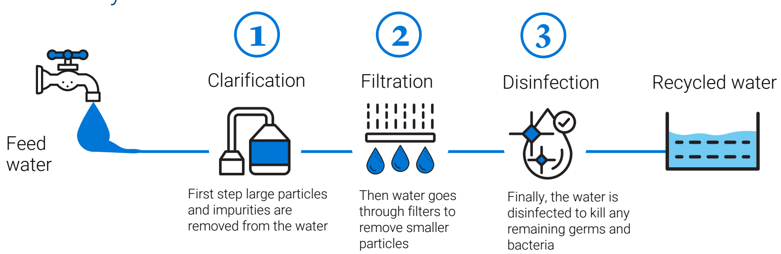
When water-based cooling systems must be used, withdrawals can be reduced with alternative water sources.

While potable water is the most common water source for data centres, there is increasing interest in sources such as collected rainwater, seawater and recycled municipal wastewater, especially in water-scarce regions.

Some cooling systems are designed to recirculate water to minimise waste by harvesting rainwater and greywater, or recycling water for local community use. For example, Google's data centre in Hamina, Finland, was the first to use an advanced sea water cooling system.

Various water treatment technologies are set to benefit from this trend, such as media filtration and membranes, reverse osmosis and disinfection.

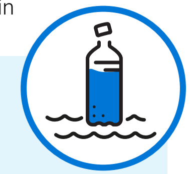
How is recycled wastewater used?



Smart water management could also increase efficiency. Transitioning from traditional cooling to targeted cooling that focuses on individual rows of servers may be effective. Additionally, Google uses AI and machine learning to train deep neural networks in its data centres to optimise energy consumption

Source: [26] Lenovo Story hub [27] Microsoft AKCP

How are data centres cooled?



Data centres are cooled with a variety of systems, and operators often adopt different solutions across their global sites. [27]

Cooling system	Description	Water usage	Limitations
Open cooling tower	Relies on water evaporation. Water is circulated through the server rooms using pumps to absorb heat from the data centre. The cooling towers then cool this heated water by exposing it to air, which causes some of the water to evaporate.	High to medium	Water intense
Adiabatic cooling	Combines air cooling and optional water evaporation to increase cooling efficiency. Air is circulating through the server rooms to absorb heat. Heated air passes through a heat exchanger, where it is cooled by the outside air that has been cooled through water evaporation.	Medium to low	Works best in dry climate
Free air cooling	Uses outside air year-round. Free air cooling involves vents and louvers to bring in cool outside air and expel warm air from the data centre.	None	Only applicable to cold regions

Key risks

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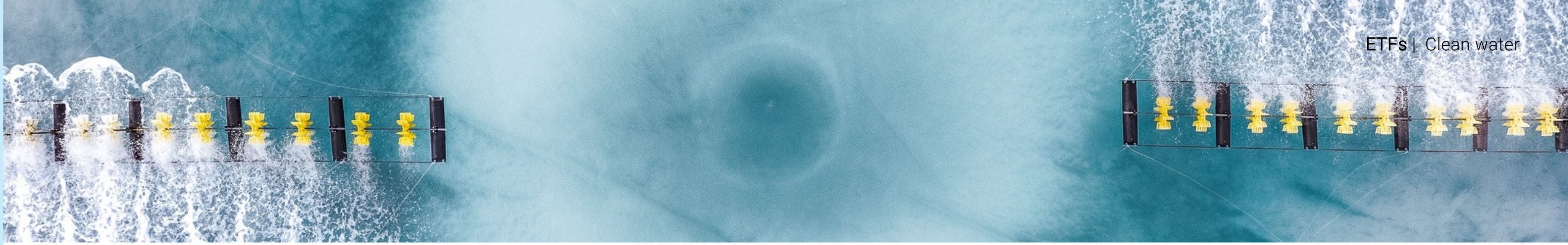

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Water technologies for AI in focus: solution providers

As the complexity of the sector's water quality needs increases, opportunities for outsourcing water treatment are growing, creating opportunities for solution providers. Below are some examples:

Ecolab*-Data centre water management solutions

Ecolab is a global leader in water treatment, hygiene, and infection prevention solutions, with a particular focus on the industrial sector.

The company highlights the Global High-Tech and Ecolab Digital as key growth drivers moving forward. Ecolab Digital leverages AI to deliver insights and performance optimisation. Meanwhile, Global High-Tech, which includes cooling for data centres and water circularity for microelectronic fabs, is generating strong new business for Ecolab.

Ecolab's 3D TRASAR Cooling Water programmes integrate smart sensor technology and industrial water treatment technology to optimise cooling systems. The company has enabled a central water treatment plant, dedicated to more than one million square feet of office space as well as the on-site data centre cooling, to save 2.9 million gallons of water annually translating to $15,532 in yearly savings. [28]

Xylem*-Data centre water treatment solutions

Xylem is a global supplier of water equipment specialising in pumps, analytical instrumentation, and wastewater technology.

The company noted that even with high interest rates, end market demand has remained resilient across the board and the increase in domestic manufacturing and data centre build outs are expected to increase power demand resulting in increased water treatment demand.

Xylem offers advanced water treatment solutions for data centres as well. A global hyperscale data centre utilising Xylem's solutions has achieved a 40% reduction in water consumption compared with traditional sand filtration methods and a 50% decrease in cooling tower maintenance. [29]

Organo*-Ultrapure water production

Organo specialises in process water and ultrapure water production, primarily serving the power and microelectronics industries in Taiwan and Japan. Over 60% of its sales come from the semiconductor-related water treatment business. Since installing its first water treatment facility in the early 2000s, Organo has been responsible for ultrapure water production and supply at nearly all TSMC*'s plants.

In ultrapure water facility maintenance, high-value-added, high-performance materials such as ion-exchange resins and water treatment membranes are typically used. On the other hand, in wastewater treatment, in addition to these, many consumables such as chemicals and functional water are used. As such, ultrapure water facility maintenance tends to have higher margins than wastewater treatment.

[28] Source: Ecolab company website. [29] Xylem company website

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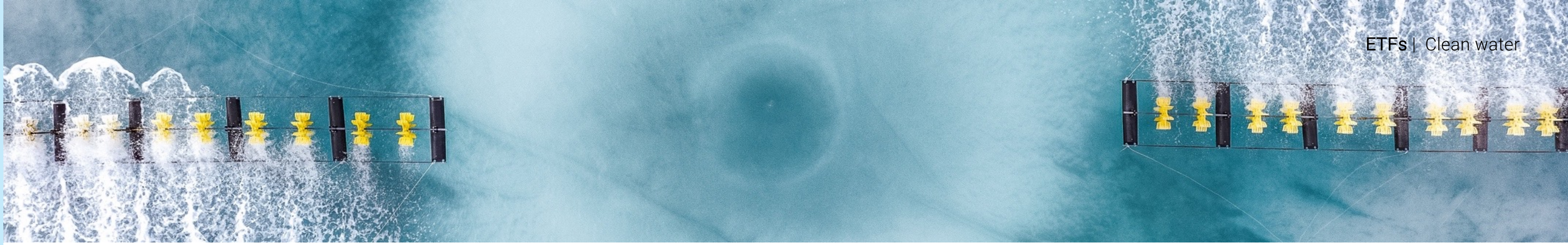

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Improving water consumption efficiency: water management technologies

In addition to increasing the quantity and quality of usable water, it is critical that water use becomes more efficient. With enhanced monitoring and advanced modelling systems, water providers are increasing turning to digital solutions to improve the resiliency and flexibility of water networks. This isn't just about conservation; utilities around the world are increasingly needing to implement solutions to reduce 'non-revenue water' (NRW), which is water lost in the system before reaching paying customers.

The first step in assuring a resilient water network is leak detection and rectification. Advanced acoustic sensors installed along piping can detect and report leaks in real time, providing operators with essential information to plan and respond to leaks before more serious issues arise. Given their ability to detect leaks across a long distance, over 300 feet of pipe per sensor, acoustic sensors have become an essential tool for managing efficient water distribution.

The data provided by sensors paints an important picture for water providers, but for a fully robust system a holistic view is required. Digital hydraulic models of entire water distribution networks provide operators with a rich set of information to plan, manage and react to events. There are broadly two types of digital models:

Offline model

Still the most common type, an offline model involves the prediction of network impacts based on historically observed data from sensors, flow monitors, or spill reports. Offline models are then calibrated based on real-world experience to provide a more accurate picture of the network over time.

Online model

Offering a much richer and more dynamic view of a water network, online models leverage real-time data from live sensors and monitors, often combined with weather, tidal, or other environmental data.

Online models are now leveraging AI and machine learning to provide alerts in advance of events taking place, enabling operators to act by diverting water or wastewater flows away from problem areas and make full use of infrastructure such as storm tanks or even latent capacity in the pipe network. In many cases, smart valves and pressure meters can react automatically to maintain balance in water systems and reduce water loss. Given the direct relationship between the over-pressurisation of pipes and increases in leakage, this type of monitoring is critical in reducing NRW loss for utilities managing ageing infrastructure.

It's not just issues of too much water which can be managed with digital solutions, as increasingly issues of too little water are also being addressed. Managing drought conditions effectively by scenario testing using detailed 'digital twins' is already proving vital as climate change impacts weather and rain patterns across the globe.

The global digital water solutions and services market is projected to grow at a CAGR of around 12.7% between 2023 and 2028, owing to solutions that save water efficiently and effectively.

Source: Global Digital Water Solutions and Services Market Research Report Feb 2023 https://www.marknteladvisors.com/research-library/digital-water-solutions-and-services-market.html#:~:text=The%20Global%20Digital%20Water%20Solutions%20and%20Services%20Market,such%20solutions%20to%20save%20water%20efficiently%20%26%20effectively.

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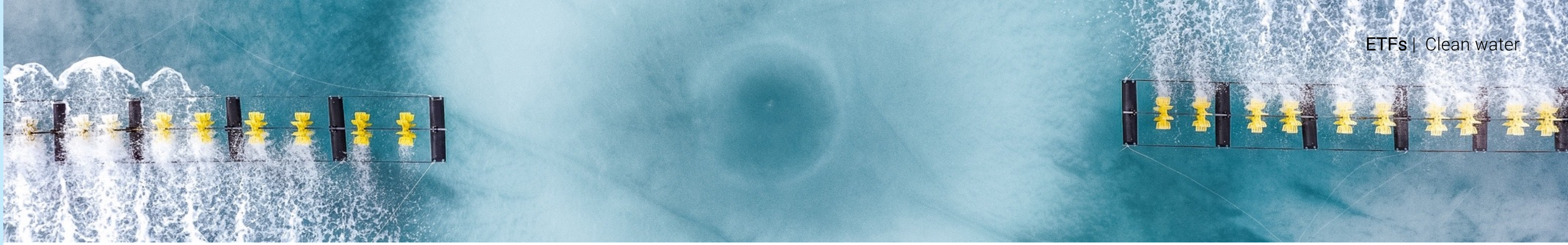

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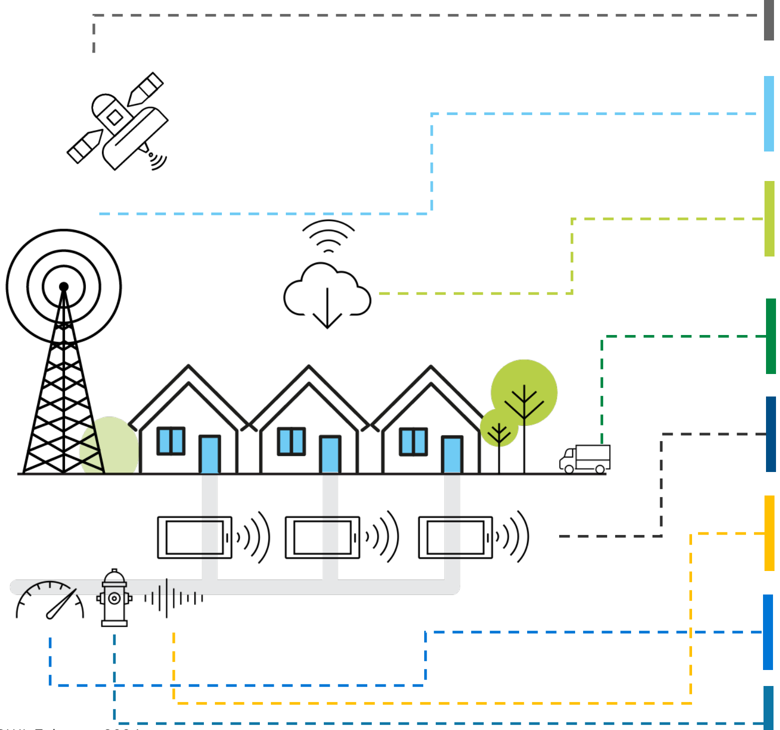
Managing leaks to avoid fresh water waste

Each technology performs a vital role in helping control leakage, whether its activity is finding leaks or managing pressure to reduce the risks of leaks and bursts in the first instance. Integrating these technologies could reduce non-revenue water to below 10%.

The leakage toolkit in action



Satellite
Photos taken by satellite can be used to find leaks by looking for new and abnormal patches of vegetation, and imagery can be examined for the spectral signatures of potable water in the soil

Telecommunications
Underground physical assets can be connected to telecoms so they can be installed permanently and transmit data remotely

Smart analytics
Platforms combine and analyse data from all these physical assets to produce actionable insights that help utilities operate the network as efficiently as possible

Conditional monitoring
Technologies are now available to inspect the state of pipes and determine the risk of leakage

Smart meters
Precisely monitor consumption and transmit data, so they can be read remotely

Acoustic logger
The most commonly used tool for active leak detection, they listen for noises in the pipe that may indicate leakage

Pressure sensor
Can sample the flow 128 times a second to identify pressure waves that may damage pipes

Pressure control
Advanced analytics services enable utilities to dynamically adjust control valves

Source: GWI, February 2024

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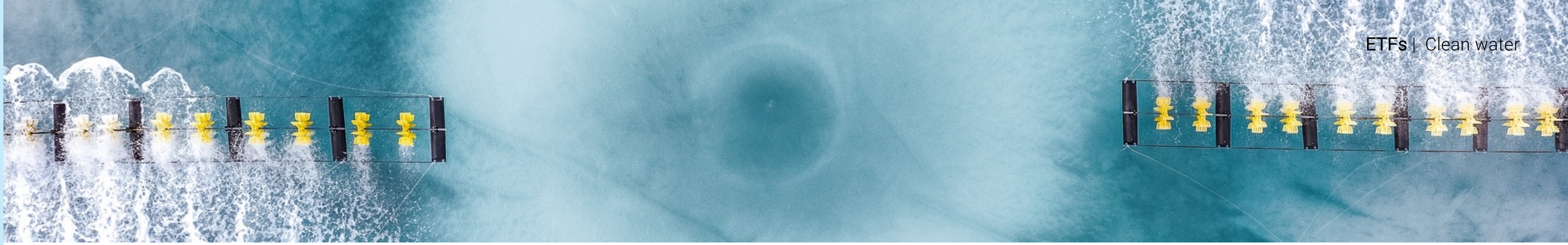

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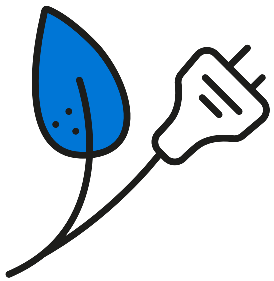
The future of water infrastructure

With all the technologies referenced in this paper, what does a fully integrated and future-proof system really look like? Net zero, smart and self-sustaining.

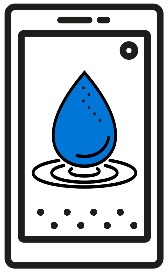
Net zero

Powered by 100% renewable energy, many of the areas across the globe that are potentially most impacted by climate change and water scarcity are also those which have the potential for high levels of solar and wind power generation. By bringing together the latest efficiencies in renewables and technologies like high-efficiency RO for desalination, the opportunity exists to dramatically alter the landscape for water availability worldwide.



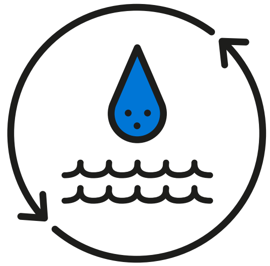
Smart

Truly smart systems can target levels of efficiency and loss prevention that would be unimaginable historically. In many global cities, 30-60% of all water is lost due to old or faulty infrastructure. Smart systems being deployed today are targeting a loss rate of 3%, a step-change in efficiency.



Self-sustaining

By managing the full cycle of water usage, including recycling wastewater for reuse, it is possible to create closed systems that maximise overall efficiency. These networks will create additional valuable outputs: salts or other minerals from seawater such as sodium hydroxide and gypsum, or fertiliser or energy from biomass. Capturing the potential in these outputs can create additional value for a system and promote long-term self-sustainability.



Source: Neom, 2023

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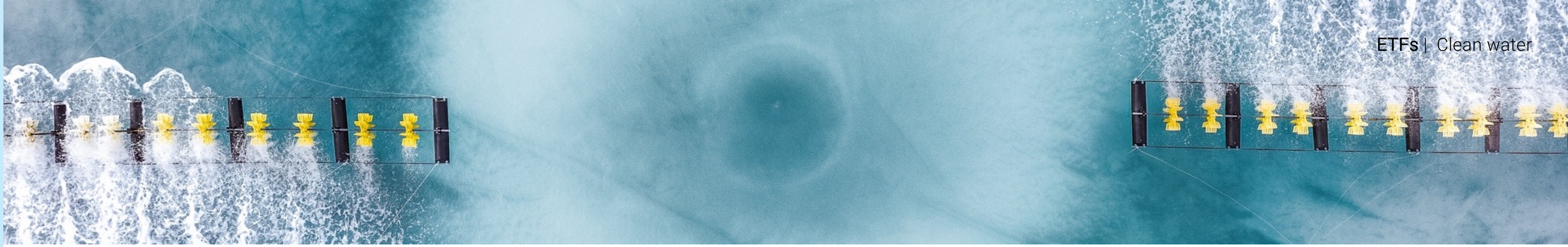


AI empowering the full water ecosystem: a smart future

Predictive maintenance to prioritise key infrastructure upgrades

Ageing infrastructure will continue to deteriorate unless we adopt smarter management strategies. Predictive AI allows utilities to swiftly identify potential weak points, prioritise maintenance, and prevent failures before they happen.

For example, Itron, Inc*. and VODA.ai* are collaborating to simplify how water utilities identify and predict which pipe assets need to be replaced, rehabilitated, or contain lead. Itron will introduce Pipe Asset Management, a solution that helps utilities reduce costs associated with pipe replacement decisions by combining detailed meter data from Itron and VODA.ai's* AI engine. [30]

Ensuring constant clear water distribution

To maintain a constant, consistent supply of water even when repairs are under way, AI algorithms can analyse flow data in real time and send insights to utilities, so that they can adjust water flow and pressure to minimise water losses and enhance network performance.

Metering companies are increasingly looking to build out AI and analytics capabilities to improve data analysis and reliability. There is now software available using AI to automatically obtain the required meter information (such as serial numbers and readings) using a photograph taken by customers and/or engineers.

Water quality monitoring for utilities

AI-powered sensors continuously monitor water quality in real-time. These sensors detect changes in parameters such as pH levels, turbidity, and the presence of contaminants. AI algorithms analyse this data to identify potential hazards and ensure that water remains safe for consumption.

Smart irrigation systems

AI-driven irrigation systems use data from weather forecasts and soil sensors to optimise watering schedules. This ensures that crops receive the right amount of water at the right time, improving agricultural efficiency and conserving water.

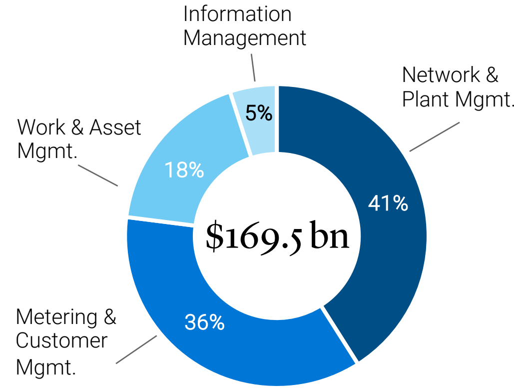
Facilitating global project planning

AI can assist in managing water resources more efficiently. By analysing data on water availability, usage patterns, and population growth, AI algorithms can help authorities make informed decisions on water allocation and infrastructure planning, especially when navigating water scarcity.

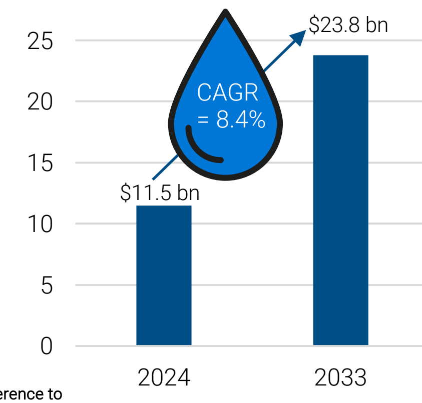
Incorporating AI in industrial water treatment

Similar to the above to utilities, benefits of incorporating AI into water treatment include real-time monitoring & remote control, predictive maintenance, and process optimisation. There is robust demand for digital water solutions in the North American market, with the market expected to expand from $11.5 billion in 2024 to $23.8 billion by 2033.[31]

North American cumulative digital water spend by technologies 2024-2033



North American digital water solutions market outlook



[30] Source: Company announcement [31] Bluefield research, 2022

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Water is a prerequisite for economic growth

This paper has showcased technologies that could increase water availability, improve water quality and boost efficiency. Given water's importance in our everyday lives, the value of these technologies is obvious, but how should investors view the potential opportunities?

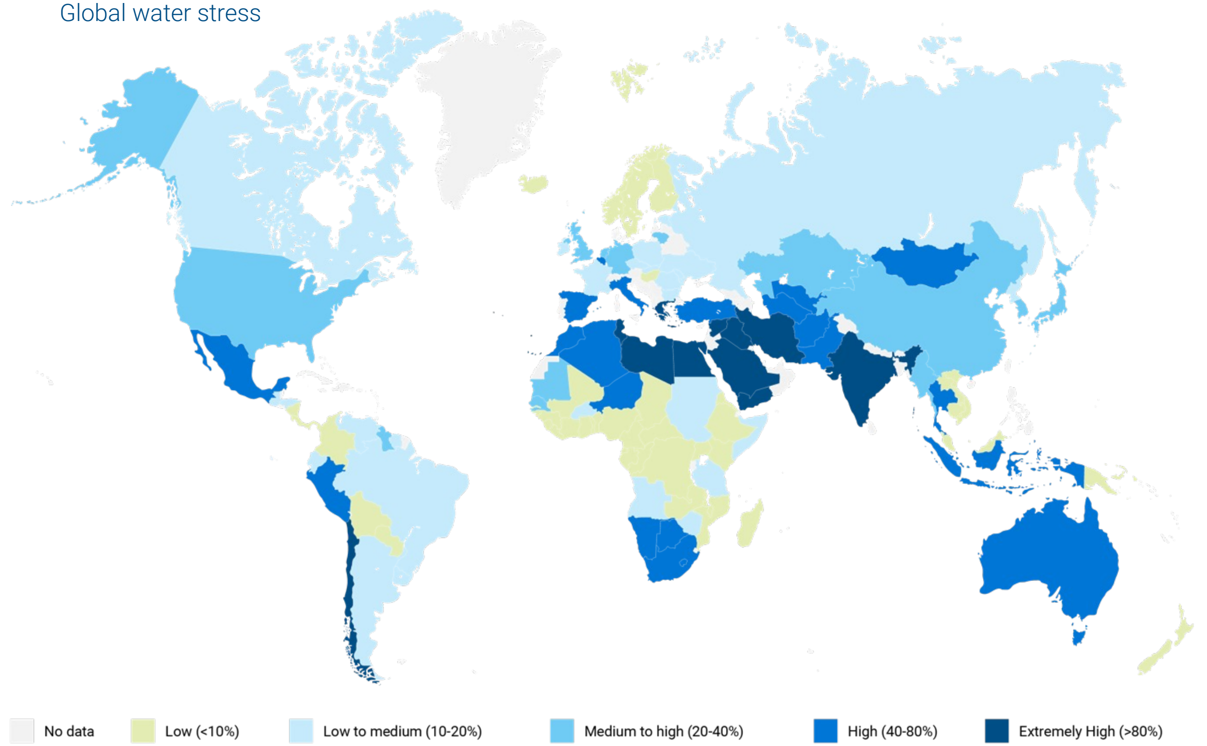
Economic growth is a thirsty business. A lack of access to clean water is both a humanitarian crisis, and a profound barrier to economic growth. So long the growth engine of the global economy, it is estimated that economic growth rates in emerging regions could fall by as much as 6% over the next 30 years due to a lack of clean water access.[33]

Geopolitical risks across the Middle East (Tigris-Euphrates rivers), India and Pakistan (Indus River) and northeast Africa (Nile Basin) are driven by water scarcity.

Water and climate change are also inextricably linked, with rising temperatures exacerbating stress on existing water management systems. Ninety per cent of natural disasters are water related,[32] including floods, droughts and storms, making further investment in the sustainable management of water resources a key mitigant in reducing the impact of climate change.

Based on WRT modelling, 33 countries face extremely high water stress by 2040.[34]

Global water stress



[32] The World Bank: Water overview, 2024 [33] World Economic Forum: Liquid asset: why we won't solve the climate crisis without fixing water, 2023. [34] World resources institute

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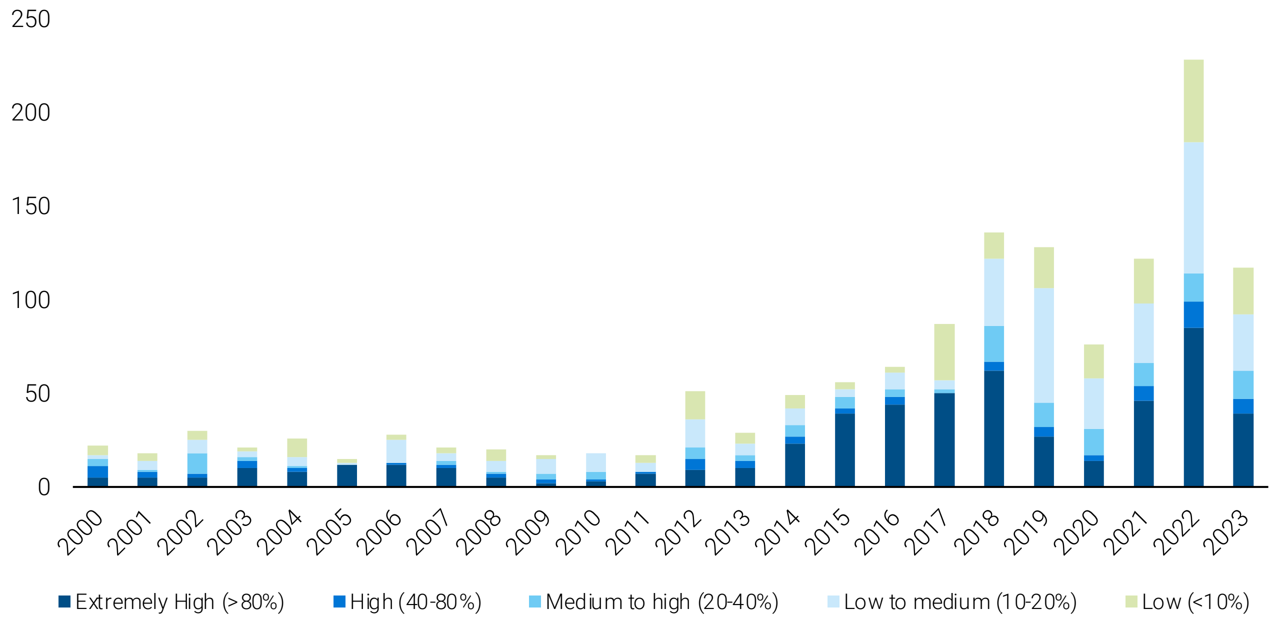
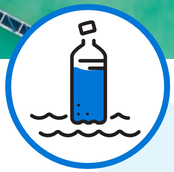
Disputes over the control of water resources are on the rise

Global water conflicts



Data is on Worldwater.org 2023-117 conflicts, 2022- 228 conflicts, 2021-112 conflicts



Did you know?

Given the importance of water as a key input for a variety of industries, it should be no surprise that industrial users and investors are keen to directly hedge the price of water.

This is now possible with the launch of the Nasdaq Veles California Water Index Futures on the CME in 2020. Representing the largest single market in the US for water, California, the futures enable market participants to access the price of the commodity itself.

Water futures are historically not very liquid and will need to gain further traction before we see water entering such broad commodity indices as the Bloomberg Commodity Index (BCOM).[36]

[35] World Resources Institute: Ranking the World's Most Water-Stressed Countries in 2040, 2015 [36] CME Group: Nasdaq Veles California Water Index, 2024

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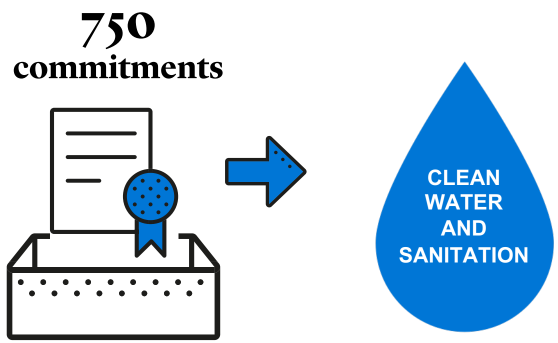
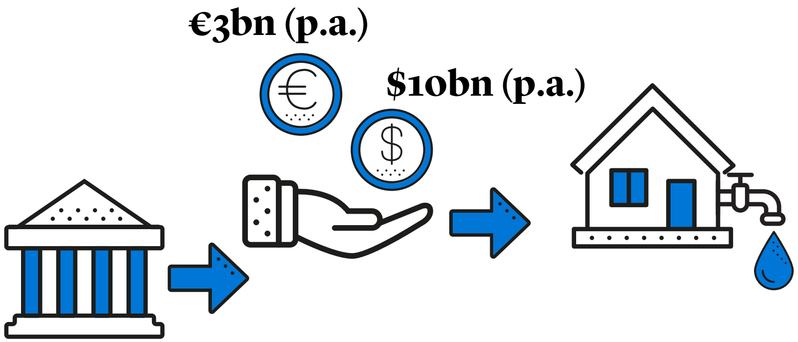
International organisations are raising awareness of water challenges

Given the mounting crisis, it is no surprise that the public and political focus on water is increasing. The UN Water Conference in March of 2023 was the first UN water conference in almost 50 years, and signed up over 750 voluntary commitments, pledges and actions from public, intergovernmental, private, and civil actors to Water Action Agenda. The United Nations' SGD6 goal (Created in 2015) focuses on water and sanitation.[37]

Europe and North America have well-established regulations on water and wastewater. China and India, meanwhile, are catching up with regulations to remove micropollutants from drinking water and prevent environmental damage from untreated sludge.





Bulk investments are reforming the water industry

On average, the European Investment Bank finances €3 billion of water infrastructure projects every year, although about 30% of those are outside the European Union,[38] including in some of the world's poorest, drought-stricken countries in Africa, Asia, Latin America and the Middle East.

In the US, the Bipartisan Infrastructure Law is delivering more than $50 billion to the Environmental Protection Agency (EPA) through to 2026 (~$10 billion p.a.) to improve drinking water, wastewater and stormwater infrastructure - the single largest investment in water that the federal government has ever made.

[37] McKinsey: COP28: Food and water, 2023 [38] European Investment Bank: Maximising scarce resources: EIB updates its water sector policy, 2023

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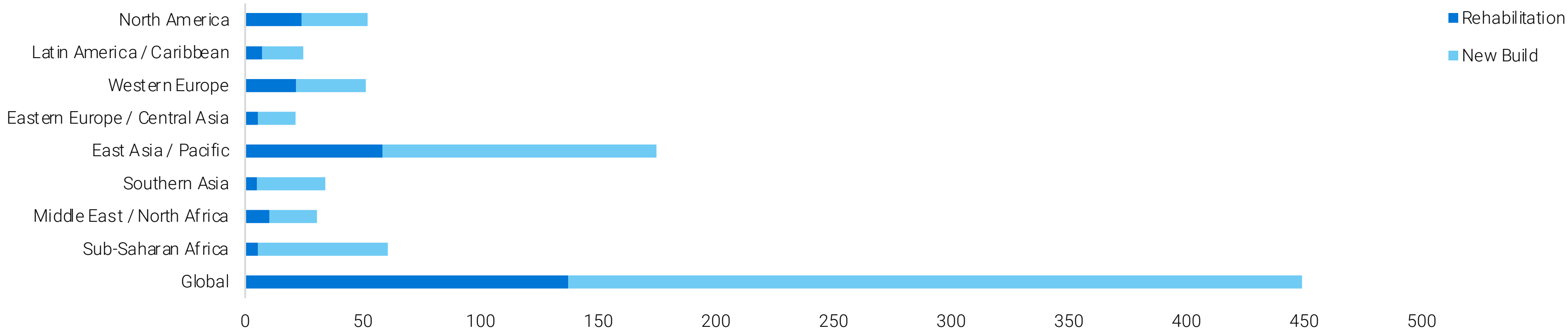
On the utilities side, water efficiency and water treatment will be under the spotlight going forward

The European market can be considered quite mature, on the back of the goals set by UK regulator Ofwat and EU standards on water quality. Utilities are already adopting digital solutions to improve distribution networks and model water flows. The North American market is going through a levelling-up agenda that aims to bridge the gap between well-funded organisations and smaller local utilities. Latin America presents opportunities for digital technologies due to regulatory targets around scarcity and net water loss. The Middle East and Africa can benefit from the establishment of desalination technologies and the expansion of water infrastructure. In East Asia and the Pacific, China, Australia, Singapore and South Korea are experiencing growth in digital technologies around water conservation and smart metering.

Global and regional water investment requirements to 2030



On the technology side, fluid handling and wastewater management are key areas of growth, in our view

The water tech market is projected to grow by 32% from 2022 to 2028, with the majority of total expenditure by technology concentrated in fluid-handling equipment such as pipes, pumps and valves. The areas with the fastest expected rates of growth in the next ~5 years are biological treatment (27% growth by 2028) and physical/chemical treatment (28% growth by 2028), supported by demand for nutrient removal and advanced treatments such as reverse osmosis. The shift towards a circular economy is creating momentum in sludge treatment, which is expected to grow 50% by 2028.[39]

Municipal and industrial buildout in the Middle East is creating opportunities within desalination, energy and municipal wastewater. Growth areas in the region are aerobic treatment, oil-water separation and RO, along with the required pumps and valves. India is also a growing market. East Asia, Europe and North America are the areas with the highest technology expenditure.

[39] Source: GWI, December 2023

Key risks

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Innovative water technologies, supported by key components, are shaping the future of the clean water industry.

Against a backdrop of worsening global water scarcity, this is leading to growth across the water value chain, creating potential opportunities for investors.

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The value of an investment and any income taken from it is not guaranteed and can go down as well as up, and the investor may get back less than the original amount invested.
Past performance is not a guide to future performance.

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