BOOST-IN

Uptake of innovative and circular solutions for water

MARKET AND COMPETITIVE LANDSCAPE ANALYSIS OF SELECTED WATER AND CIRCULAR ECONOMY SOLUTIONS

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ABSTRACT	This deliverable serves as a comprehensive analysis for the market and competitive landscapes for selected WACES of the BOOST-IN project. It includes a narrative of ongoing themes and trends in the water sector, as well as the needs and restrictions currently experienced at EU and global scales concerned with water management, reuse and recovery of associated resources. Market metrics and key identified competitors are also examined in depth to highlight the opportunities and challenges facing selected WACES throughout marketization in light of the efforts of WP4 to promote market uptake acceleration.		

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LIST OF ACRONYMS

Acronym	Definition
APM	Asset performance management
BRL	Business readiness level
B2B	Business-to-business
CAGR	Compound annual growth rate
CE	Circular Economy
COD	Chemical Oxygen Demand
DPR	Direct potable reuse
EU	European Union
EUR	Euro
GDP	Gross Domestic Product
IPR	Indirect potable reuse
MFC	Microbial Fuel Cells
MF	Microfiltration
PHA	Polyhydroxyalkanoates
RO	Reverse Osmosis
SaaS	Software-as-a-service
SME	Small-medium enterprise
TRL	Technology readiness level
UF	Ultrafiltration
UN	United Nations
USD	United States Dollar
USP	Unique selling point
UV	Ultraviolet
UWWTD	Urban Waste Water Treatment Directive
VFA	Volatile Fatty Acids
WWTP	Wastewater Treatment Plant
WACES	Water Circular Economy Solutions
WE	Water Europe

WP	Work Package

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EXECUTIVE SUMMARY

This report is the **D4.1 Market and competitive landscape analysis of selected WACES, one of the deliverables associated to** the WP4 of the BOOST-IN project, the aim of which is to boost the uptake of innovative solutions in the water and circular economy sector. The D4.1 focuses on analysing the market and competitive landscape of selected Water Circular Economy Solutions (WACES).

The D4.1 includes an analysis of the market trends in circular economy water solution applications, such as water reuse, nutrient recovery, energy recovery, and material recovery (both inorganic and organic). It details the funnelling process used to pre-select the WACES for further analysis and then examines the market and competitive landscape of relevant solution categories, primarily water recovery and nutrient recovery.

The report highlights the growing importance of circular economy solutions in the water sector due to increasing water demand and resource scarcity. It discusses various technologies and market opportunities related to water reuse in agricultural, industrial, urban, and potable applications. Nutrient recovery from wastewater, including nitrogen, phosphorus, and potassium, is also examined, along with energy recovery methods including biomass, biofuels, and biogas production, as well as heat and electricity recovery. The deliverable also covers inorganic materials recovery, such as metals and salts, and organic materials recovery, like cellulose and high-value organics.

The funnelling process for selecting WACES involved evaluating submissions to the BOOST-IN call for WACES applications based on criteria such as Technology Readiness Level (TRL) and Business Readiness Level (BRL), as well as relevance to project scope and operation and/or ownership within Europe. Eleven WACES were ultimately selected for further market uptake services. The analysis of the market and competitive landscape reveals that many of the selected WACES face competition from existing key players. However, some WACES have unique selling points (USPs) that could allow them to find niche markets or form partnerships with existing competitors. The deliverable also identifies potential growth areas in various market segments, such as water recovery technologies and pathogen detection. The report concludes by emphasising the need for further research and collaborative efforts to support the market uptake of the selected WACES.

1. Market trends in circular economy water solution applications

As a critical resource to all life and an indispensable component of multiple industrial and economic processes, the importance of water cannot be understated. However, hydrologic cycles that naturally account for water renewal and purification have become significantly derailed by human activities and consumption, thereby grounding estimates made by the United Nations (UN) that by 2040, human demand for water will exceed available resources by 40% (Jeffries & Fall, 2020). With a particular focus placed on the European Union (EU), an estimated 11% of its citizens are already impacted by water scarcity (European Commission, 2024d).

Granted the magnitude of challenges presented by water demand, the need for circular economy (CE) solutions to account for reuse and recovery of water and associated resources will become ever more pressing to counteract environmental, economic and societal threats imposed by water scarcity and overexploitation of resources. As such, the Water Circular Economy Solutions (WACES) under consideration in the BOOST-IN project identified an array of water reuse and resource recovery solutions critical to successfully developing a circular water economy, inclusive of water reuse across a range of applications, nutrient recovery, energy recovery, high-value inorganics and high-value organics recovery, respectively. A synopsis of the connectivity between these various domains within the water circular economy are highlighted in **Figure 1.**

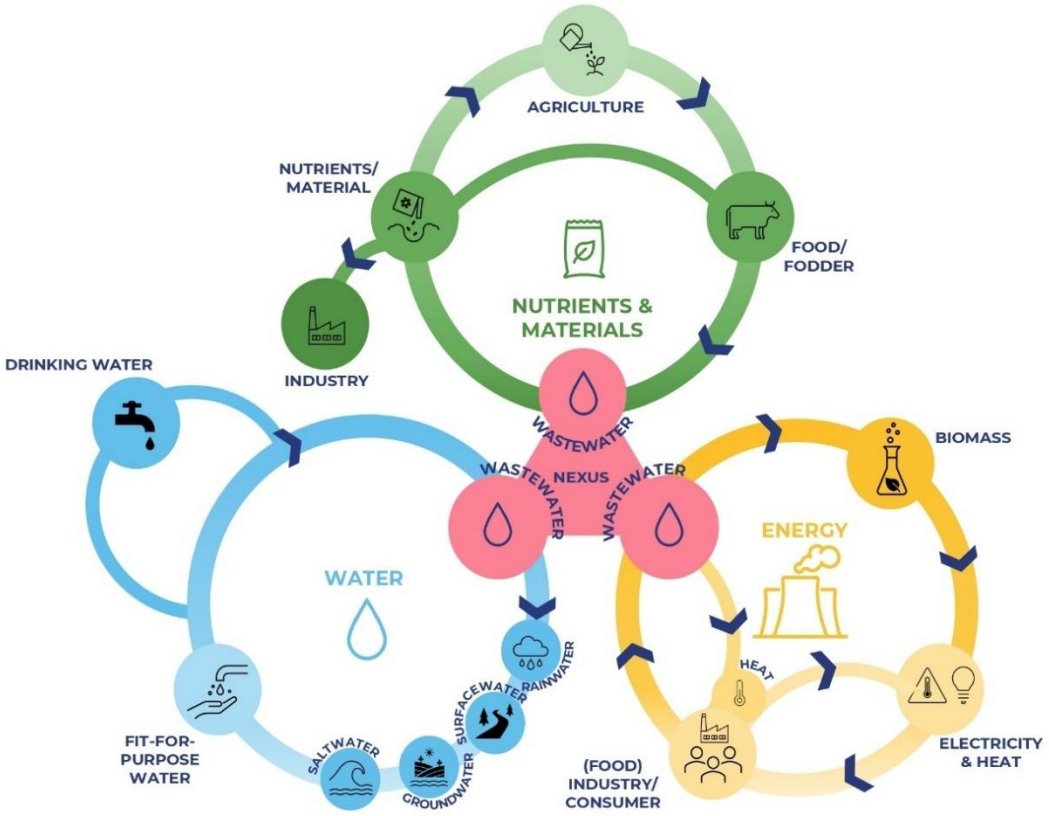

Figure 1. Main domains of water in the circular economy (Adapted from: Water in the Circular Economy, 2021).

The following sections explore in further detail the state of play of each of these water reuse and resource recovery approaches in the EU and the rest of the world, associated technological solutions, and potential market opportunities for their CE development with respect to existing barriers to implementation.

1.1 Water reuse

To reduce pressure on existing supplies of freshwater, water reuse will become increasingly vital in meeting the needs of human systems. With chronic water-related stress affecting up to one third of the European territory, water pricing mechanisms have been seen as meaningful tools in reducing water consumption, thereby easing resource scarcity (European Environment Agency, 2021). However, technological fixes may be able to take a more significant role in promoting water resource circularity and more steadfast water conservation techniques.

As of 2020, up to a sixfold increase in treated water could be reused in the EU over current levels (European Commission, 2024d). Water reuse activities collectively hold particular significance to stakeholders given their ability to support efforts aimed at water resource conservation, energy production potential, and economic development (Cagno et al., 2022). **Figure 2** shows the multifaceted network of water reuse activities as they relate to various economic water uses which will be explored further in the following sections. These constitute water reuse activities across **agricultura**l, **industrial**, **urban** and **potable applications**.

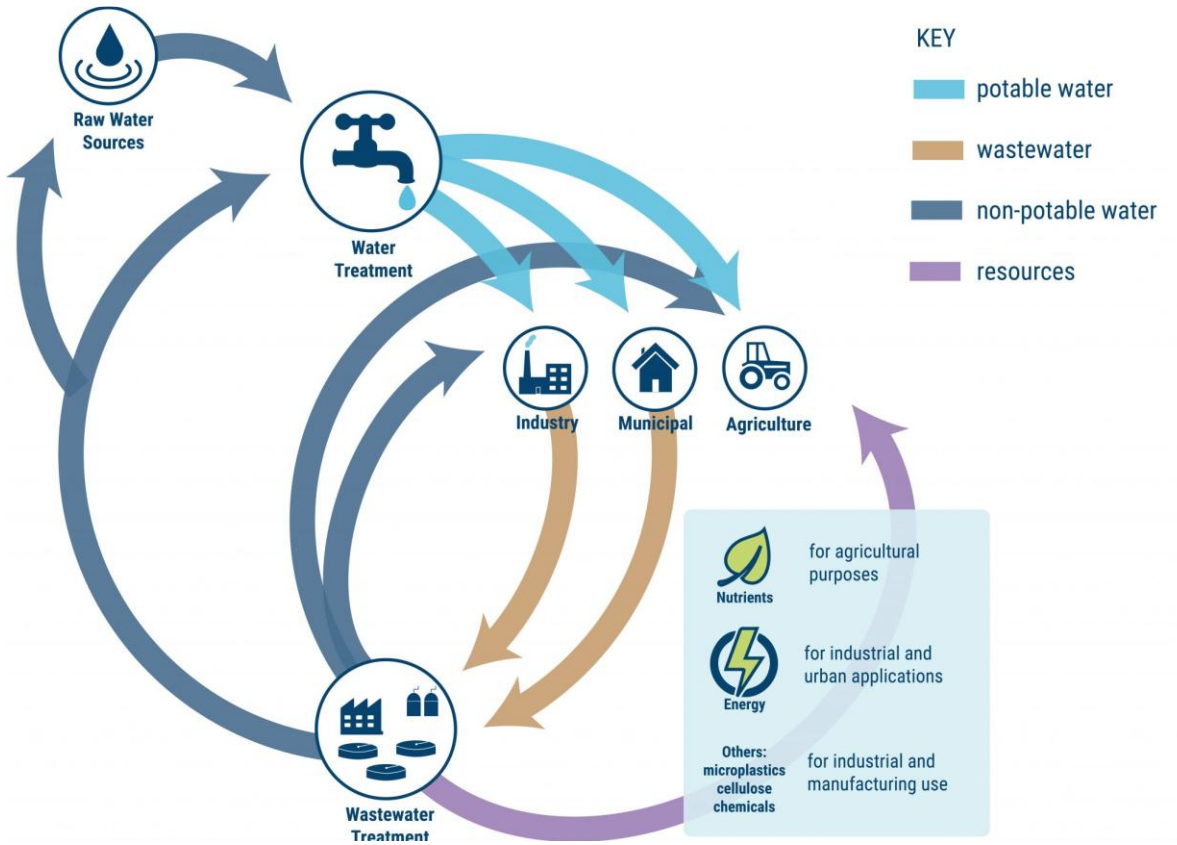

Figure 2. Water in the circular economy (From: Water Reuse Europe, 2020).

1.1.1 Agricultural water reuse

Agriculture, the second biggest water user in the EU, consumes 29% of available water resources (Burgueño Salas, 2024), soaring to rates of up to 70% globally (Amahmid et al., 2023). Water reuse, a method commonly used to address imperilled freshwater supplies, has historically been employed to contribute towards agricultural irrigation, albeit with varying degrees of success and threats posed to human health by way of waterborne pathogens (Shoushtarian & Negahban-Azar, 2020). Various technological solutions exist to treat and alleviate threats posed to health by way of parasitic pathogens present in wastewater that may be reused in agricultural settings, including **grey** and **green infrastructure** incorporating **lagoon aeration, activated sludge, constructed wetlands** and **stabilisation ponds** (Amahmid et al., 2023).

Aside from the significance of wastewater treatment technology in providing water suitable for agricultural uses, methods including **rainwater** and **fog harvesting** are seen as promising in handling seasonal variability in precipitation and are deployable at micro and macro scales (Qadir et al., 2007). Despite the promise of such technologies to contribute towards water reuse outcomes in agricultural operations, multiple EU Member States still ban the use of reused water for agricultural irrigation including Poland, Finland, Czechia, Austria, Slovakia, Lithuania and Latvia (WISE-Freshwater, 2024).

Geography is a major factor in determining applications for wastewater reuse across Europe, with northern regions using treated wastewater more in industry, while southern regions rely on it more for agricultural irrigation (Ricart & Rico, 2019). The EU's Circular Economy Action Plan designates the Water Reuse Regulation as being chiefly tasked with enhancing CE in agriculture, among other sectors, to reduce burdens on freshwater ecosystems (Interreg Europe, 2021).

As such, regulatory frameworks in place in the EU may serve as guiding pathways towards market entry for water reuse technology in agricultural contexts, making particularly strong headway in southern regions of the EU in reflection of current agricultural water reuse trends. To illustrate current levels of investment and outlooks for future growth in agricultural wastewater management investment, combined European and Central Asian capital expenditures for water and wastewater treatment in the food and beverage industry in 2024, which includes water reuse operations, equate to USD 209.2 million and are expected to increase to USD 226.8 million by 2029 (GWI Water Data, 2024a).

1.1.2 Industrial water reuse

Industry is the biggest user of water in the EU, which in 2020 was responsible for 45% of European water withdrawals (Burgueño Salas, 2024). In terms of annual wastewater generation, 25.5 million m^3 are estimated to come from industry in the EU (Procházková et al., 2023). Water used in industry is commonly exploited for cooling and boiler systems across applications, and as such, industrial wastewater is primarily concerned with contamination by way of fouling, scaling and corrosion (Meese et al., 2022).

Wastewater treatment systems to account for industrial wastewater must be tailored to pollution streams present in industrial waste given the variability in production processes that may leach a combination of chemical and biological pollutants (Bauer et al., 2020). **Electrochemical desalination** and **high-recovery reverse osmosis (RO)** are two overarching technologies that have broad application across industrial sectors given their ability to reduce water consumption and discharge volumes, appealing particularly strongly to the food and beverage industry (GWI Water Data, 2024c).

Treatment of wastewater from industrial sources must be taken seriously as more than 50% of water used in European industry returns to the environment, with only 60% being treated prior to being

discharged (Florides et al., 2024). Effective wastewater treatment and reuse must therefore be performed to ensure proper environmental and economic protections and long-term resilience. Procházková et al. (2023) postulate that reclamation of 80% of industrial wastewater in the EU per year would raise investment costs to 1.5% of the EU's gross domestic product (GDP) while raising energy consumption by 4.1%. As supported by Ricart & Rico (2019), northern regions of the EU currently practice industrial reuse more intensively than elsewhere in the territory, thereby highlighting a potential entryway to the market for industrial water reuse technologies.

1.1.3 Urban water reuse

In most EU countries, more than 80% of the population is connected to wastewater treatment infrastructure, with rates falling to lower levels in Eastern regions of the EU (Burgueño Salas, 2024b). The high reliance of European citizenry on public water systems enhances the need of public water infrastructure to continue to meet current demand while also adapting to the needs of an increasingly high-consuming future human population. Urban wastewater typically is generated in domestic settings with added contributions from industrial and rainwater sources (Zamparas, 2021). As of 2021, annual levels of reused wastewater in the EU amounted to an equivalent of only 2.4% of treated urban wastewater effluent at 1 billion m^3, coming up short of the total reuse capacity of about 6 billion m^3 (Berti Suman & Toscano, 2021).

Bauer et al. (2020) argue that industrial and urban wastewater streams should be combined and treated together to increase water reuse potentials, and that industrial wastewater should be applied in urban areas as urban wastewater reuse alone is not capable of accounting for infrastructural purposes in urban environments. The EU has further established regulations to ensure that urban wastewater treatment and reuse adheres to strong environmental guidelines under the Urban Waste Water Treatment Directive (UWWTD), thereby cutting pollution, reducing greenhouse gas emissions and contributing towards CE development (European Commission, 2024c). A depiction of the main challenges and opportunities presented by urban water reuse is shown in **Figure 3.**

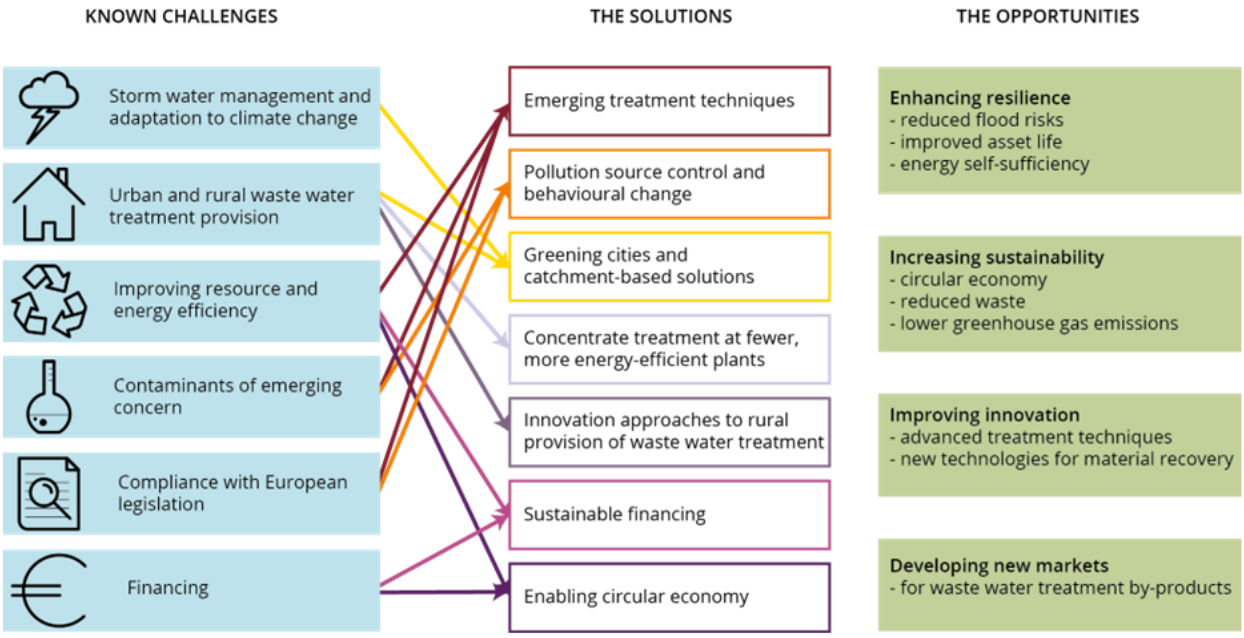

Figure 3. Challenges, solutions and opportunities of urban water reuse (From: European Environment Agency, 2019).

Current technologies employed for urban water reuse activities have frequently consisted of **secondary treatment measures**, intensifying to **tertiary treatment measures** for wastewater discharged into sensitive natural ecosystems as necessitated by the UWWTD (Interreg Europe, 2021). However, recent updates to the UWWTD indicates the need of implementing **quaternary treatment** for the removal of micropollutants from urban wastewater for all wastewater treatment agglomerations of over 150,000 population equivalents by 2045 (Water News Europe, 2024).

Given the variable nature of urban water uses and wastewater composition, a diverse assortment of technologies is used in combination to treat wastewater and account for emerging contaminants including pharmaceuticals and chemicals (European Environment Agency, 2019). Overall, these technologies may have the most success entering the market in Eastern regions of the EU where lower proportions of the population are connected to wastewater treatment infrastructure.

The urban wastewater treatment and water reuse competitive landscape is driven largely by cost with many minor actors and few large actors feeding into the commodity market, trending towards building reliance on locally produced commodity chemicals to keep transport costs minimal (GWI Water Data, 2024e). In Europe and Central Asia, combined spending on municipal and industrial wastewater management and reuse in 2024 was valued at USD 2.04 billion, growing to an expected USD 2.41 billion in 2029 (GWI Water Data, 2024e).

1.1.4 Potable water reuse

The vast majority of Europeans are also connected to public water supply (Burgueño Salas, 2024a). Concerning both direct and indirect potable reuse (IPR), wastewater treatment can assist in reducing water stress. Notable European facilities practicing IPR include Langford Scheme Recycling, the Torreele Water Reuse Scheme, and El Porto de la Selva Groundwater Recharge in the UK, Belgium and Spain, respectively(Santos et al., 2021). Meanwhile, examples of direct potable reuse (DPR) across Europe remain in earlier developmental stages as technology continues to improve and policy begins to account for shifting water reuse priorities. Specific examples of technological developments related to DPR include Blue Horizon Limburg, an endeavour falling under part of the NATALIE project that focuses on aquifer recharge, often a precursor to DPR. Another example is the Mörbylånga Municipality in Sweden that was awarded the Water Reuse Europe Innovation Prize in 2019, and that although not exhibiting DPR capabilities, demonstrates the potential for wastewater reuse as a supplementary drinking water source (Water Reuse Europe, 2019).

The scope of understanding potable water reuse capacities and potentials is relatively limited given that potable reuse as of 2020 only accounted for 2.3% of total water reuse worldwide (Yang et al., 2020). The impact of social barriers may be in part to blame for the comparatively limited rollout of such solutions in the EU to date, whereas such solutions exist in higher abundance in other regions of the world including Australia and the United States (Diamanti, 2022).

Although no single technological solution is deemed suitable to address the emerging contaminants that embody the complex and multifaceted nature of environmental threats posed to modern water supplies and aquatic ecosystems, **coagulation** and **flocculation** are broad solutions that harness the ability to trap suspended solids, pathogens and other microcontaminants through precipitation, and enhance overall clarification processes, respectively (GWI Water Data, 2024f).

RO is increasingly regarded as a necessary counterpart of holistic wastewater treatment systems, particularly for potable water reuse (Paranychianakis et al., 2015). To further the robustness of RO treatment of wastewater for potable water reuse, **ultraviolet (UV) disinfection** and **UV-based advanced oxidation** are frequently employed to subsequently aid in degrading contaminants present in water (Jeffrey et al., 2022).

Microfiltration (MF) and **ultrafiltration (UF)** are further mechanisms combined with RO that have the capacity to treat municipal and industrial wastewaters for a multitude of end uses including potable reuse, boasting advantages such as high micropollutant, dissolved solids, and pathogen removal rates when performed following pre-treatment processes that have the capacity to attenuate energy consumption and operation costs (Lazarova, 2024).

As of 2024, the combined European and Central Asian water treatment chemicals industry and their related operational expenditures was valued at USD 2.07 billion, with further growth forecasted to take place with respect to services provisioning from key chemical suppliers as drinking water quality becomes an increasingly pressing concern (GWI Water Data, 2024f).

1.2 Nutrient recovery

Nutrient recovery is frequently cited as a method for attaining sustainable development and closing the loop of water-nutrient management (Pausta et al., 2024). These processes typically take the form of **phosphorus**, **nitrogen** and **potassium (potash) recovery**, and it is estimated that 13.4% of global fertilizer demand could be met through the recovery of these three vital nutrients in agricultural systems (Qadir et al., 2020). This is important to consider when quantifying the vast amounts of these nutrients consumed as fertilizers, standing in 2018 at values of 106 Mt nitrogen, 46 Mt phosphorus and 38 Mt potassium (Giberti & Dereli, 2022).

Nitrogen permeation from agricultural landscapes into groundwater and surface waters can lead to pollution of water resources, threats to quality of drinking water, and degradation of aquatic ecosystems, frequently when combined with phosphorus pollution (Klages et al., 2020; Yu et al., 2019). Knowledge of complex nutrient cycles is required to assist in the development of nutrient budgeting mechanisms that could in turn alleviate environmental pressures associated with nitrogen - and phosphorus-induced pollution of water resources (Zhang et al., 2020).

1.2.1 Nitrogen recovery

Nitrogen discharge from domestic and industrial wastewater effluent causes ecological degradation and biodiversity loss in aquatic ecosystems by way of eutrophication and dissolved oxygen depletion, in addition to nitrate leaching which can cause deleterious health impacts (Zhou et al., 2023). When performed appropriately, the employment of specific technologies for the treatment of wastewater and removal of nitrogen can result in significant reductions in energy consumption and greenhouse gas emissions (Rahimi et al., 2020). Van der Hoek et al. (2018) classify nitrogen reuse and recovery strategies as categorized by:

- their ability to **recovery nitrogen directly from wastewater;**
- their **concentration of N in wastewater** to bolster recovery capacities;
- their **treatment of urine or sludge**, and

- their **inclusion of nitrogen into biomass**.

A schematic of the four main nitrogen reuse and recovery strategies and their associated technologies are highlighted in **Figure 4**.

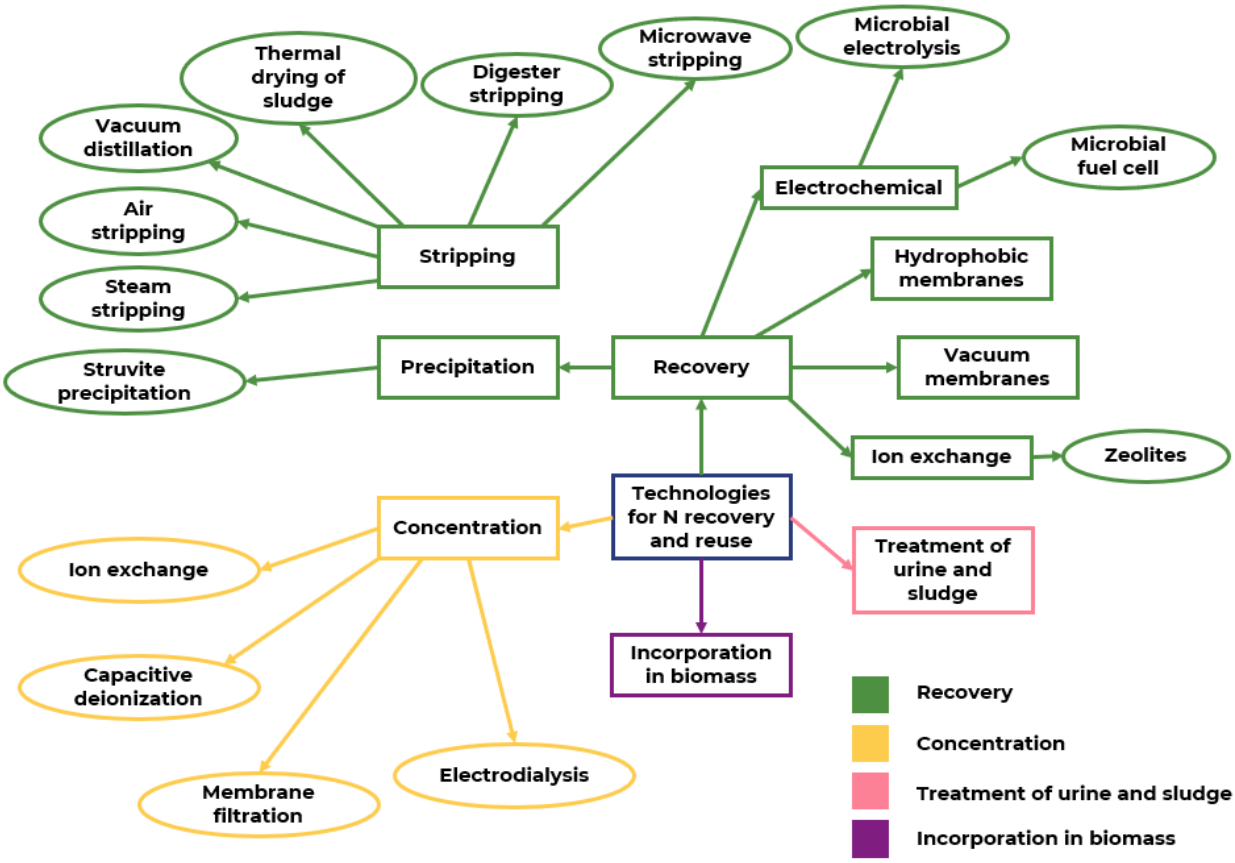

Figure 4. Strategies and technologies enabling nitrogen reuse and recovery (Adapted from: van der Hoek et al., 2018).

Alongside **membrane-based recovery systems**, **ammonia air stripping**, and **bioelectrochemical systems**, **ion exchanging** and **absorption-based methods** for nitrogen recovery from wastewater are highly successful because of their high capacity for nitrogen removal, simple applications, low environmental impact, and the utilisation of a zeolite absorbent (i.e., absorption-based methods) that can be re-applied directly to agricultural fields (Sengupta et al., 2015).

Biological recovery of nitrogen from wastewater streams also comes in diverse forms that all have the potential to harbour significant economic and environmental benefits. Biological nitrification processes to remove nitrogen from wastewater can be both more affordable than chemical alternatives, and when taking the form of **annamox**, **aerobic deammonification** or **simultaneous denitrification**, for example, can also require a comparatively lower energy input than conventional alternatives (Rahimi et al., 2020). Nevertheless, these very same technologies are also responsible for intermediary production of N_2O emissions, therefore instigating the need for recovery technologies that can lower environmental impact (Jönsson et al., 2024).

Whilst certain technologies present high capacity for nitrogen recovery, with **hydrophobic membrane filtration** and **vacuum membrane filtration** each resulting in 75% recovery, Van der Hoek et al. (2018) argue that a combination of technologies utilised in parallel is necessary for ensuring high nitrogen recovery rates while providing sustainable solutions that allow for innovation and adaptation. This may also ensure that stringent environmental regulations within the EU become more attainable.

In terms of market insights concerned with the global nitrogen market, of which nitrogen recovery can be expected to play an increasingly important role, Europe is undergoing a projected compound annual growth rate (CAGR) of 6.7% from 2023-2030, reaching an estimated revenue of USD 14.05 billion by 2030, and already composing 20.8% of the total global nitrogen market as of 2022 (Grand View Research, 2024).

1.2.2 Phosphorus recovery

Market development of new technologies to recover nutrients can be bolstered through the adaptation and development of regulations, such as those in the fertiliser industry, with recovery of phosphorus requiring particular attention in wastewater recovery efforts given its non-renewable nature (Rosemarin et al., 2020). Phosphorus can be relatively easily recovered from wastewater by way of biological removal or chemical precipitation (Lorick et al., 2020). With respect to phosphorus recovery as a standalone component of wastewater streams, **physical filtration with sand** can serve to recover solid organic phosphate, whilst **chemical precipitation incorporating tertiary infrastructure**, **high-temperature acid hydrolysis**, **ion exchange** and **biological assimilation** can further aid in recovering phosphorus resources from wastewater (Sengupta et al., 2015).

Nitrogen and **phosphorus together** are perhaps the two most common constituents of fertilisers including **struvite** and **diammonium phosphate** to be found and targeted for recovery in wastewater streams (Theregowda et al., 2019). Alongside biological solutions, **struvite precipitation** is a chemical process that can recover nutrients from a range of wastewater sources, being particularly targeted for its ability to remove ammonium-nitrogen (NH_4-N) and phosphorus (Darwish et al., 2016). Struvite is particularly prized as it contains a concentration of phosphorus similar to that of non-renewable phosphate rock. The process for struvite recovery from wastewater is shown in **Figure 5**.

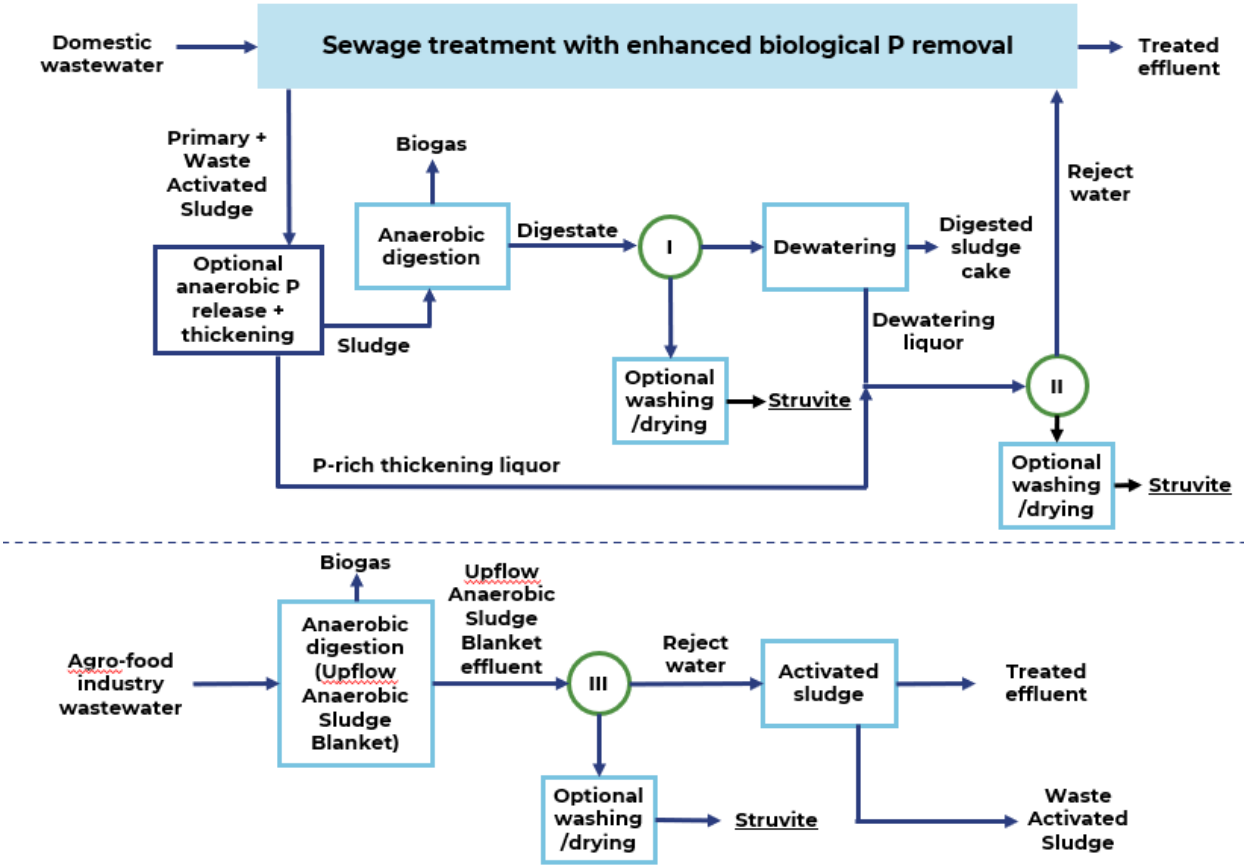

Figure 5. Main methods of struvite precipitation from wastewater (Adapted from: Muys et al., 2021).

With the high degree volatility in the global phosphorus market, where the cost of phosphate rock rose from USD 44/ton in 2008 to USD 320/ton in 2023, light is shed on market entry opportunities for a range of phosphorus recovery technologies, especially where cost-benefit analyses are undertaken to demonstrate how the sale of phosphate products generated through nutrient recovery activities can outweigh costs of operating recovery facilities (Zhu et al., 2023).

1.2.3 Potassium recovery

While perhaps not receiving the same critical attention as phosphorus, potassium is a finite resource, the global reserves of which are projected to run out in the next 90 years (Wiśniowska, 2021). Macura et al. (2024) highlight an **existing knowledge gap with regard to potassium recovery** processes and methods, either on its own or in combination with nitrogen and phosphorus relative to these other nutrients. Nevertheless, potassium recovery from wastewater still holds much promise due to the element's incorporation in minerals known as potash, including potassium chloride and potassium magnesium sulphate, its necessity in contributing towards plant growth, and its integration into fertilisers at rates of up to 95% (Wiśniowska, 2021).

Conventional methods for potash production involves cultivating it from evaporated seabeds, bitterns or mining, but recovery methods will become increasingly necessary in light of climate change interferences

with production methods, taking the form of methods employing chemical precipitation such as selective precipitation of potash using tartaric acid on biomethanated spent wash (Khatri & Garg, 2022).

Potassium struvite recovery is a viable technique to support nutrient recovery efforts, encapsulating technologies including **bubble column reactors with draught tubes**, **crystallization reactors**, or **draft tubes with baffle reactors to process urine** to enable simultaneous recovery of both potassium and phosphorus (Yesigat et al., 2022).

By investing in potassium recovery technologies, the EU may be able to protect against intermittent price spikes for potash, as well as reduce its reliance on foreign imports of potassium from countries including China, Russia, Belarus and Canada that produce up to 80% of global potash and leading the global potassium market that is valued at USD 15 billion (Maslin, 2024).

1.3 Energy recovery

In a further approach, wastewater treatment can be utilised for renewable energy recovery in a step towards attaining a robust CE (Fu et al., 2017; Zarei, 2020). Difficulties to commercialisation and low public acceptance typically result in barriers to implementation (Chrispim et al., 2019). This is important to take into account when considering that plans for completely new water and wastewater treatment plants (WWTPs) are typically more straightforward to implement than retrofitting previously constructed facilities (Bertanza et al., 2018). Energy recovery opportunities are typically exploited through technological solutions including **thermal pretreatment**, **biogas**, **biodiesel** or **hydrogen production**, or **thermal energy** production in WWTPs (Zarei, 2020).

Resource recovery from wastewater for energy production purposes has become increasingly popular in making strides towards the clean energy transition. Three main avenues for energy production from wastewater treatment include **biomass-derived hydrogen production**, **biogas production** by way of anaerobically digesting sewage sludge, and **microbial wastewater treatment** to produce methane (CH_4) (Shi et al., 2024).

1.3.1 Biomass

Biomass has become a popular energy source in light of overarching challenges including rising energy prices and climate change, especially due to its versatility in renewable energy generation given its ability to produce solid, liquid and gaseous biofuels (Salgueiro Fernández et al., 2024). Incorporating organic material from forestry and agriculture, as well as biological waste, the EU produced 2.1 Mtoe of biomass in 2021, forming a total of 59% of the EU's total renewable energy consumption that same year (European Commission, 2024b).

Wastewater from agricultural, food, pharmaceutical, livestock, and textile industries, as well as municipalities can be nutrient rich, ultimately becoming prime resources in **microalgal bioremediation** (Mehariya et al., 2021). Microalgal bioremediation methods are shown to be effective for biomass production and in wastewater treatment, accounting for the treatment of COD, NH_3-N and orthophosphate in domestic wastewater (Alazaiza et al., 2023). The microalgae in question convert CO_2 and sunlight into biomass that serves as a favourable tool in eventual biofuel production given the renewability and short life cycle of the algae (Mehariya et al., 2021). Aside biofuels, assimilated biomass can produce exploitable bioproducts including biofilms and biopolymers, and thermal processing can lead to the production of heat and electricity (Velasquez-Orta, 2023). Algal biomass cultivated at a scale to account for global domestic wastewater streams could amount to a total production value of 23.5 billion tons of oil (Geremia et al., 2021).

The EU's employment of modernised biomass boilers and stoves has been one of the leading causes of solid bioenergy consumption growth projections up to 2030, albeit to a lesser extent than improved efficiency cooking and heating stoves in developing countries (International Energy Agency, 2024a). Europe may be able to further capitalize on progress it has already made with regards to bioenergy consumption by accelerating roll-out and exploitation of technologies to recover biomass from wastewater. This will aid in promoting environmental resilience whilst further contributing towards economic robustness of EU biomass production and manufacturing, a figure already currently valued at EUR 800 billion when considered in monetary rates observed in 2015 (European Commission, 2023).

1.3.2 Biofuels

Algal biomass derivatives of wastewater streams can be converted to biofuels by way of lysis and hydrolysis followed by fermentation, the most abundantly used byproduct of which is bioethanol, accounting for 82% of the market share of commercialised biofuels (Velasquez-Orta, 2023). Microalgal biomass is capable of producing a diversity of biofuels including biodiesel, bioethanol, biogas and biohydrogen (Geremia et al., 2021). Of ever-increasing interest in biofuel recovery and generation are microalgae biorefineries, operations that produce compounds required for biofuel production while also offering alternatives to more conventionally used methods for treating wastewater, all while operating with reduced costs and energy consumption (Mehariya et al., 2021). Biofuel produced in a biorefinery model is foreseen to become increasingly competitive against crude oil given reductions in production costs of up to 30% for biofuel that will occur through the co-production of value-added bioproducts (Garkoti et al., 2023).

Algal biofuel production presents a strong case for economic and environmental sustainability given its use of wastewater to serve as an attractive environment for cultivation and growth of algae, as well as the continuous provisioning of nutrient inputs by way of nitrogen and phosphorous (Pittman et al., 2011; Velasquez-Orta, 2023).

EU Member States are legally obliged to source a minimum share of 3.5% of their renewable energy utilised in transport from biofuels (European Commission, 2024a). As one of the largest global consumers of biofuels, the EU has also made great strides in producing almost 300,000 barrels of biofuel per day (Statista, 2024c). Growing from a value of USD 45.2 billion in 2017, Europe's biofuel and biodiesel market is projected to be worth USD 70.7 billion by 2026 assuming a CAGR of 5.18% (European Commission, 2023). This projected growth may be able to offset current trends showing that 40% of biodiesel fuel stock was imported to the EU in 2022 while also remaining more expensive than gasoline and diesel fossil fuels (International Energy Agency, 2023).

1.3.3 Biogas

Anaerobic sludge digestion is the most commonly employed process for biogas production (Kehrein et al., 2020). Anaerobic digestion more broadly, sourcing waste by way of WWTPs from domestic, industrial, and agricultural sources, are shown to be the most effective technological solution in recovering resources from organic waste (Kweinor Tetteh & Rathilal, 2021). Although anaerobic digestion is commonly conceptualised as being used for biogas generation in the form of CH_4 and CO_2, it can be used to produce heat and electricity (more detail in **section 1.3.4** and **section 1.3.5**) as well (Bachmann, 2015). Heat and electricity may be produced by biogas by refining and pressurizing it for uses including gas grid injections and automotives, or in combined power and heat units (Haandel et al., 2024).

In fact, the multifaceted benefits of anaerobic digestion are such that biogas generation from wastewater can produce up to 10 times the amount of energy needed for its own treatment processes on site (Kweinor Tetteh & Rathilal, 2021). This is important to take into account when considering the vast gains expected to take place in Europe alone in terms of biogas production in the next couple decades.

By 2040, Europe is projected to produce up to 111 billion m^3 of biomethane, of which 74 billion m^3 will be derived directly from anaerobic digestion, a further 12% of which will be the direct result of anaerobically digested industrial wastewater (Alberici et al., 2024). Concerned with the generation of heat and power from biogas alone, Europe is expected to reach an economic value of USD 26.6 billion by 2030 (Statista, 2024a).

1.3.4 Electricity

In anaerobic digestion processes, the largest share of organic material produced following wastewater treatment is biogas, ultimately exploitable in electric energy generation that can be sold into the grid or used on site in WWTPs (Haandel et al., 2024). Following a series of biochemical reactions where organic compounds are transformed into biogas, biogas can be converted to electricity with the use of various technologies including diesel engines, steam turbines and in fuel cells (Angenent et al., 2022; Kabeyi & Olanrewaju, 2022). A schematic of the electricity generation process resulting from anaerobic digestion of wastewater influent is depicted in **Figure 6.**

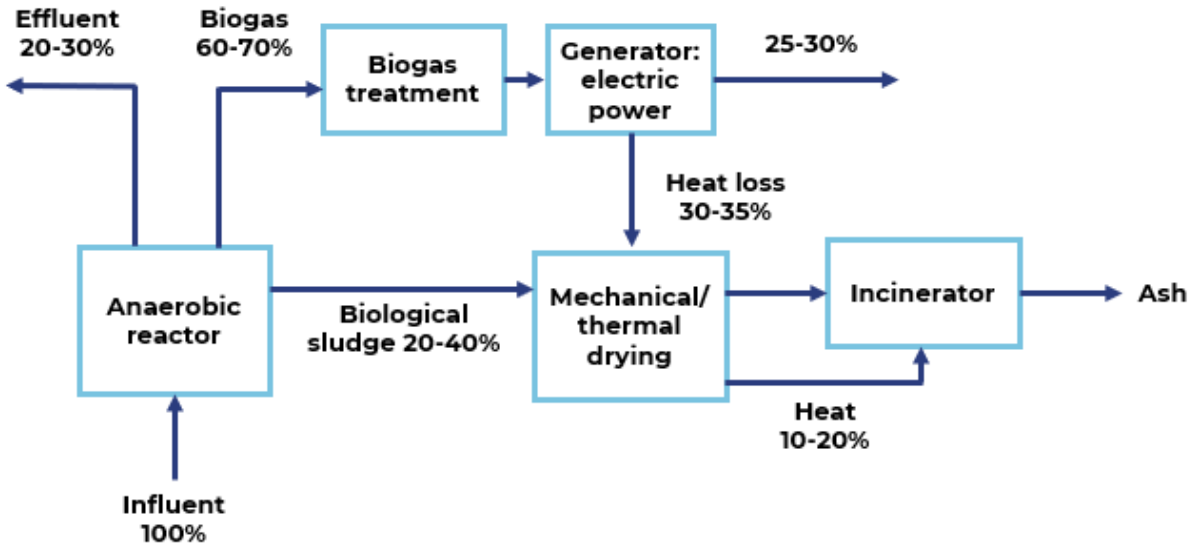

Figure 6. Influent wastewater organic material distribution in anaerobic digestion processes. Percentages are estimations under normal operating conditions (Adapted from: Haandel et al., 2024).

Microbial fuel cells (MFC) hold promises for renewable electricity generation given their exploitation of biochemical energy held within the bonds of organic compounds by way of micro-organisms that metabolise organic substrates, often sourced from organic wastewater and sewage (Bazina et al., 2023). Micro-organisms operate in an anaerobic treatment process as they oxidize organic matter on an electrode and pass produced electrons to an anode, ultimately generating an electric current with water as a byproduct (Logan, 2005). Electricity production by way of MFC in wastewater treatment processes

presents a mix of benefits and drawbacks, notably being that although wastewater treatment and production of renewable electricity can occur simultaneously, electricity generated from individual MFCs is difficult to take advantage of given low voltage outputs and internal resistances (Koffi & Okabe, 2020).

Electricity generation from biomass generated USD 11 billion in 2022 (Statista, 2024b). Nevertheless, there is plenty of opportunity for electricity generation from wastewater in the EU to grow, given that at present, only 5.9% of electricity is sourced from bioenergy sources and other minor renewables combined (Brown & Jones, 2024).

1.3.5 Heat

Aside for the purpose of electric power generation, anaerobic digestion can be used to produce heat by way of combusting biogas originally produced through the transformation of sewage sludge biomass into biogas through anaerobic decomposition (Bachmann, 2015; Abusoglu et al., 2021). The efficiency of electricity production from the combustion of biogas falls between 35 to 42%, with the rest being converted to thermal energy that will be used onsite at anaerobic digesters (Uddin & Wright, 2023). However, heat may also be transported to district heating via district heating transmission networks following combustion of biogas in biogas engines (Abusoglu et al., 2021). A schematic of the process by which heat is produced and transferred through district heating networks is depicted in **Figure 7.**

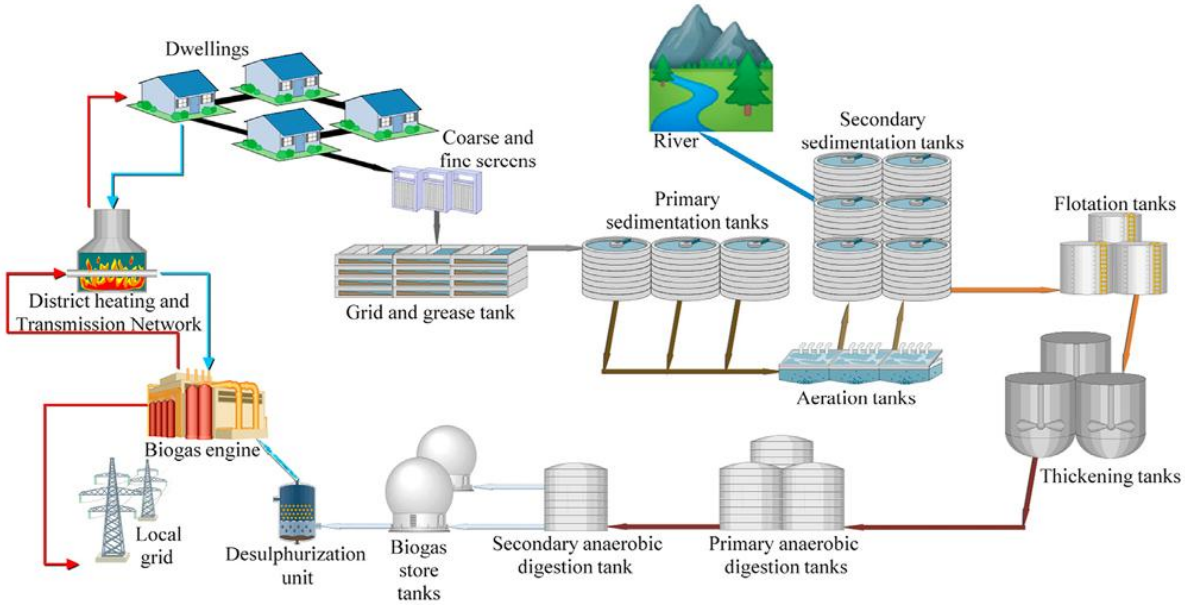

Figure 7. Heat recovery processes to enable district heating from WWTP-based biogas engine driven cogeneration (From: (Abusoglu et al., 2021).

Thermal energy in wastewater is a direct result of household and industrial heating of water, with minor contributions made from microbial reactions throughout wastewater treatment processes (Kehrein et al., 2020). With domestic and industrial wastewater boasting large quantities of thermal energy that are often lost to sewer systems, installation of **heat pumps** and **heat exchangers** extending from end-users to water treatment processes holds the potential to capture discharged heat and reuse it to heat buildings (Nagpal et al., 2021).

In terms of the total renewable heat generation in Europe in 2022, 83% was derived from primary solid biofuels, while industrial waste, geothermal sources, liquid biofuels, biogas and solar thermal comprised the remaining 17% (International Energy Agency, 2024b). Given that 40% of energy in the EU is consumed by buildings, which are further responsible for up to 36% of CO_2 emissions in the EU (Wehbi et al., 2022), **heat recovery technologies** have a strong springboard for further development at the European level. Environmental and economic benefits may be further enjoyed through wastewater heat recovery given the role that recovered heat can play in contributing towards powering anaerobic digestion and sludge drying processes (Pongrácz et al., n.d.)

1.4 Inorganic materials recovery

1.4.1 Metals recovery

Heavy metals occur naturally on Earth but are toxic to living organisms, thereby necessitating the regulation of heavy metal contamination in drinking water across the globe (Verma et al., 2023). Mining is a major cause of environmental deterioration, particularly due to discharge of generated wastewater used in mining operations that contain trace metals into the environment (Dudka & Adriano, 1997). Despite the environmental risks they pose, metals present an opportunity to support the green transition through their role in the production of renewable energy technologies, including selenium, silver and tellurium in photovoltaics and dysprosium in wind turbines, as well as numerous other metals involved in the manufacturing and operation of renewable technologies including geothermal, hydropower and biomass energy (Jowitt et al., 2020) (Moreau et al., 2019).

High levels of demand for metals across multiple industries and sectors underscore how metal supplies are finite and non-renewable over human timescales (Jowitt et al., 2020). To combat metal supply deficits in the coming decades, metal recovery from wastewater is becoming increasingly important as part of the circular economy transformation. Furthermore, metal recovery and reuse of mine water can significantly reduce environmental harm inflicted by mining operations from breaches of polluted water into surrounding ecosystems, although questions concerning cost, energy consumption and greenhouse gas emissions remain (Miller et al., 2022).

Current innovations geared towards developing a CE approach to metal recovery from wastewater focus on concepts including **mobilisation of metals** by way of **bioleaching by chelation**, **acidification and oxidation**, in addition to immobilisation of metals by way of **bioprecipitation** and **bioaccumulation**, altogether overshadowing previously devised techniques of biomining and bioremediation that ignored concepts of circularity (Puyol et al., 2017). The value of metals recovered from wastewater to fulfil industrial niches and meet consumer demands also offers the prospect of offsetting the cost of wastewater treatment processes (Dudka & Adriano, 1997), thereby making further strides in developing CE frameworks.

A market gap exists for technologies seeking to remove and recover trace metals from wastewater. Higher levels of metal recovery efficiency are still to be achieved, which is overall important to consider in light of the fact that commodity prices continue to rise, and environmental damages inflicted from mining pollution continue to have a major impact, with acid mine drainage alone costing USD 100 billion in remediation needs worldwide (GWI Water Data, 2024d).

1.4.2 Salts recovery

High-salinity wastewater is accompanied by an array of environmental challenges and technological opportunities (Guo et al., 2023). Desalination technology frequently deals with the production of

freshwater from salt - or brackish water sources, combining the use of a multitude of solutions that may take the forms of **evaporation** and **condensation** technologies, as is used with **mechanical vapor compression** or **multi-effect distillation**, to name a few, as well as **filtration technologies** including **RO** and **membrane distillation**, or **crystallization technologies** such as **secondary refrigerant freezing** (Curto et al., 2021). Environmental impacts of desalination can be manifold, and all depend on the type of technology being employed, the qualities of water being processed, and the management techniques of waste brines (Elsaid et al., 2020).

Outside the scope of saltwater desalination, salt production is largely attributed to chemical and food processing industries, with purification and evaporation of brines being used as main methods for extracting salts for industrial purposes in a process that creates bittern, the end uses of which are shown in **Figure 8** (Bagastyo et al., 2021). Many salt ions including Na^+, Cl^-, Mg^{2+} and Ca^{2+} can be feasibly extracted from brines, thereby contributing towards achieving CE objectives in the water sector, whilst scarce metal extraction, including that of lithium, cesium and rubidium remains only possible at laboratory scale (Wang et al., 2023).

Recovered minerals	Areas of application
Na^+ as NaCl, Na_2CO_3, Na_2SO_4, NaOH, NaOCl, $NaClO_4$	Basic feedstock for chemical processes, pH adjustment, food and industrial processes, Chlor-alkali production, water treatment, chemical industry, surfactant manufacture, glass manufacture, disinfection, paper bleaching, poor chlorine, road de-icing
Mg^{2+} as $MgCl_2$, $MgSO_4$, $MgCO_3$, $Mg(OH)_2$ slurry, $xMgCO_3{*}yMg(OH)_2{*}zH_2O$	Water and wastewater treatment, animal feedstock, feedstock for magnesium metal production,fire retardant and refractories, acid neutralization, filler for paper manufacturing, rubber and paint,aluminum, steel, fertilizer, textiles
Ca^{2+} as $CaCO_3$, $CaSO_4$, $CaCl_2$	Paper coating pigment, filler for plastics and rubbers, special inks, paints, and sealants, wastewater treatment, pH buffering, dust suppression, road base stabilization, soil amendment, cement/concrete stabilizer, construction industries
K^+ as KCl, K_2SO_4, $KNaSO_4$	Potassium fertilizer
Br_2	Fire retardant, agriculture, well-drilling fluids, petroleum additives (anti-knock gasoline)
B^{3+} as $B(OH)_3$	Glass and porcelain industries, medicine (boric powder), leather processing, adhesive, corrosion inhibition, rocket fuel, dehydrating agent, soaps and detergents, bleaches, fire retardants, fertilizers
Li^+ as Li_2CO_3, LiOH, LiCl, Li metal, other Li compounds	Batteries, ceramics and glass manufacturing, lubricants and greases, pharmaceutical products, metallurgy, air conditioning
Rb^+	Fiber optic, lamps, night vision devices, laser technology, radiation therapy, medical device sterilization, satellite navigation, etc.
Cs^+	Photoelectric devices, atomic clock, fuel cell electrolyte, ion rocket propellant, etc.

Figure 8. Industrial uses for minerals recovered from bittern (From: Bagastyo et al., 2021).

Whereas conventional desalination techniques incorporate concentration and crystallization processes to perform salt recovery, Guo et al. (2023) suggest that innovation in salt recovery technology should focus on new membrane material development, high-efficiency and energy-saving physicochemical and biochemical processes, lower operational costs, and development of salt-tolerant micro-organisms. Whilst Europe is responsible for an estimated 5.9% of the total 51.7 billion m^3 of brine produced globally each year, it may begin to take fuller economic advantage of this through salts recovery as it seeks to offset imports of critical raw materials, such as magnesium, into the EU from China and Russia in an effort to bolster its own circular economy (Tsalidis et al., 2020). Global operational expenditures for the desalination market in 2024 amounted to USD 1.48 billion, of which Europe and Central Asia comprised only USD 0.14 billion (GWI Water Data, 2024b).

1.5 Organic materials recovery

1.5.1 Cellulose recovery

Cellulose in wastewater is typically a result of toilet paper usage, disposal and degradation (Palmieri et al., 2019). Municipal wastewater treatment as a sector is expected to play an increasingly important role in CE attainment given its stake in achieving cellulose recovery from wastewater streams (Glińska et al., 2020). Whilst **rotating bed filters** are a popular technology for cellulose recovery from wastewater given their reliability and simplicity, sieving is seen as being more economically viable given lower costs associated with manufacturing and maintenance (Mushtaq et al., 2023). Research on cellulose as a material has revealed its manifold applications as a biocomposite (Huber et al., 2014), a finding that has the potential to help close the loop in the transition towards building a more robust CE given its contribution towards the manufacturing of circular building materials (Palmieri et al., 2019). In addition to building materials, cellulose may also be repurposed for production of renewable energy fuels, nano-cellulose, or cellulosic flocculant (Mushtaq et al., 2023) (**Figure 9**), the latter being itself used in wastewater treatment applications. Akyol et al. (2022) urge, however, that biogas produced from recovered cellulose should only be considered if no other alternatives for valorisation exist, given its positioning at the bottom of the biomass value pyramid.

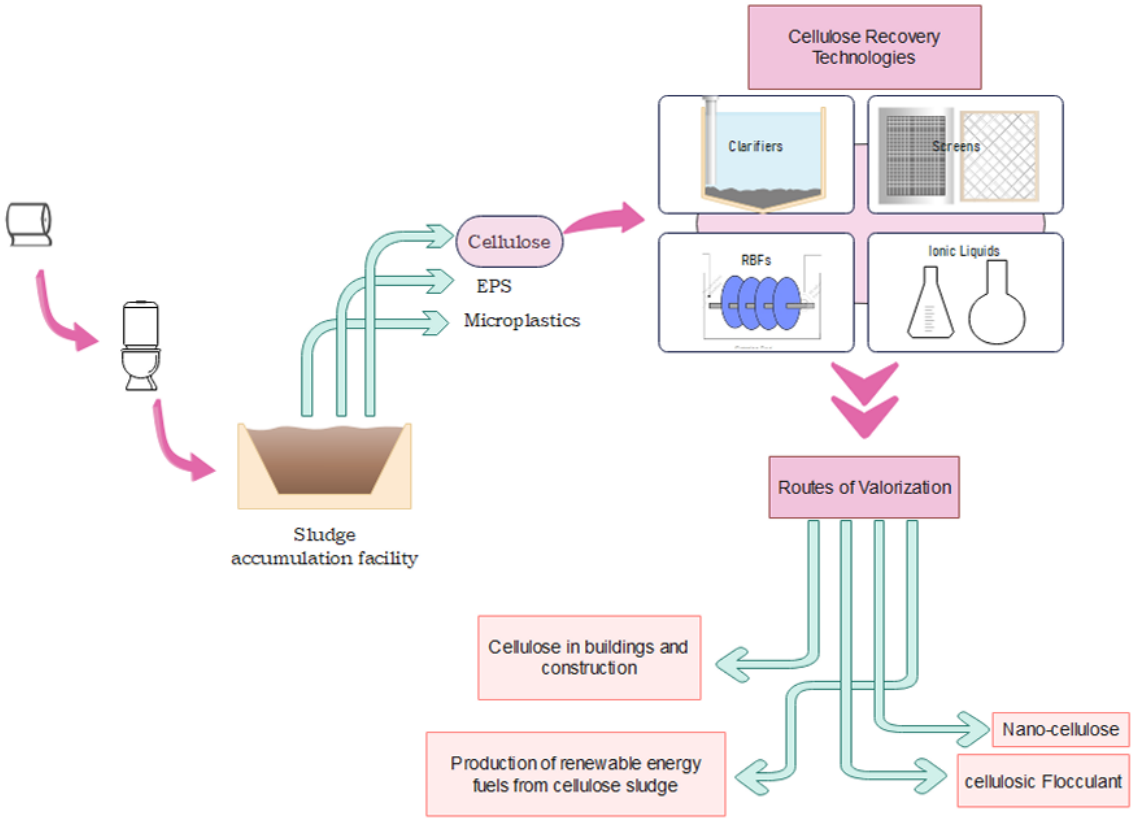

Figure 9. Cycle of cellulose disposal, recovery and revalorization (From: Mushtaq et al., 2023).

1.5.2 High value organics recovery

Primary, secondary and digested sludge are the three types of sludge produced by a typical WWTP, with primary sludge being composed of a combination of valuable organic solids including proteins, lipids, and ashes (Glińska et al., 2020).

By **recovering protein** from wastewater sources, supply chains may be able to derive protein for end uses such as animal feed from local sources, offsetting consumption of plant proteins conventionally used in livestock cultivation (Shahid et al., 2021). **Protein resynthesis** may take place by capturing microalgae, fungi and bacteria found in wastewater streams (Puyol et al., 2017). Microalgae and purple phototrophic bacteria serve as intermediate manufacturers of proteins in various wastewaters, helping to remove wastewater COD, ammonium and phosphate whilst working towards providing feasible pathways towards the establishment of a viable CE (Shahid et al., 2021).

Volatile fatty acids (VFA) are another high value organic product resulting from the **hydrolysation and fermentation of primary sludge** with mixed microbial communities with the maintenance of very specific ambient environmental conditions, ultimately becoming valuable due to their use in electrochemical and thermochemical refinements of chemical products of yet higher value such as fuels and bioplastics (Kehrein et al., 2020). VFA production through processing of wastewater sludge may have adverse impacts on the efficiency of biogas energy recovery, thereby necessitating optimization to take place where the cost of VFA production does not outweigh savings from biomethane generation (Garkoti et al., 2023).

Polyhydroxyalkanoates (PHAs) are similar to VFAs in that they can also be recovered and harnessed to produce bioplastic alternatives to fossil-based plastics. Conventional PHA production processes that incorporate three phases including **acidogenic fermentation**, **culture selection**, and **PHA production**, are typically costly and therefore difficult to scale up (Duque et al., 2021).

Polyphenols are a further high value organic that make their way into process water as waste from industrial activities focusing on food processing and crop cultivation (Franzen Ramos et al., 2023). Their removal and recovery frequently take the form of **advanced oxidation**, **adsorption** and **membrane filtration**, which generally assist in bypassing the negative side effects associated with physicochemical or biological treatment of wastewaters containing polyphenols (Franzen Ramos et al., 2023; Hellwig & Gasser, 2020).

Recovery of high value organics from wastewater offers significant technological, economic and environmental opportunities. However, for many high value organics, namely VFAs and PHAs, valorisation of recovered materials is difficult to estimate given difficulties in calculating accurate figures for recovery potential (Ostermeyer et al., 2022).

1.6 Main outcomes

There are several grand challenges concerned with water resource management that are expected to become exacerbated in coming years and decades in the EU and globally.

CE approaches focussing on **water reuse** and **resource recovery** offer pathways towards improving sustainable practices that will simultaneously assist in stewarding the environment, defending against worsening climate change impacts, and bolstering market robustness for circular water solutions. Through the exploration of various CE solutions, opportunities, and their diverse applications, light is shed on the interconnectedness of technological approaches for bridging the gap between resource

conservation and water use sustainability. In subsequent sections, the methodology for selecting WACES of significance to WP4 will be explained. **Selected WACES** will be subsequently presented and examined to understand their **key business opportunities** and **innovative technical approaches** as applicable to the technological categories observed in the previous sections through a comprehensive analysis of relevant market and competitive landscapes.

2 Funneling process for selection of WACES

This section presents the methodology used to select the WACES that will receive the BOOST-IN market uptake services. This methodology starts with the WACES pre-selection following scouting and characterisation of water sector innovations, as well as initial trends revealed by the pre-selections and second round questionnaire outcomes that allowed for continued funnelling and ultimate selection of the final 11 WACES.

2.1 Background

A total of **149 WACES** applications were submitted as part of the open BOOST-IN call launched in June 2024. The pre-selection of WACES was achieved through a funnelling process, different pre-selection criteria were defined based on the requirements and/or services offered within the project. A schematic of the pre-selection criteria used to identify pre-selected WACES is shown in Error! Reference source not found., with the criteria used to select the WACES that will opt to the market uptake services highlighted in blue. .

Table 1. WACES pre-selection criteria)

Selection criteria	Impact, social and policy assessment / Social perception	Business plans	Marketplace
ROp challenges	5 challenges from ROp	Not needed, but maybe some	Any challenge
TRL	5(6)-8	5-8	9
BRL	Not applicable	5-7	BRL>=7
Case study	Yes	No	No
Type of solution	Tech/Product (No training)	Tech/ Product (No training)	Tech/ Product (No training)
Location	EU – Horizon Europe	EU – Horizon Europe	Anywhere
Other	Motivation	No	No

The pre-selection criteria for the WACES to opt to the market uptake services in the BOOST-IN were limited to **technology readiness level (TRL)** and **business readiness level (BRL).**

- **TRL of 5-8** ensured that innovations were technologically advanced enough to be deemed capable of addressing water circular economy challenges within a reasonable timeframe and with moderate degrees of required advancement
- **BRL of 5-7** was needed to ensure that business plans were already in development for the specified WACES, with further improvement still possible to collaborate on as part of the services provided by BOOST-IN to selected innovations. T

Through this pre-selection criteria, **31 WACES** were pre-selected for further consideration to be part of the market uptake services offered within the BOOST-IN project (WP4). Following the identification of the 31 pre-selected WACES, ISLE designed and disseminated a targeted 2nd questionnaire to determine

gather more detailed information on the pre-selected WACES. Information such as IP ownership was captured to ensure the smooth facilitation of working with WACES candidates upon selection and to avoid misrepresentation of IP ownership among WACES; TRL and BRL were reviewed again to check for consistency in responses between the 1st questionnaire and this 2nd one.

For this 2nd questionnaire, **23 out of the 31 pre-selected WACES responded**. An assessment of whether these 23 pre-selected WACES fit within project scope was then required to ensure that market uptake services could both benefit WACES themselves and that the innovators could assist in fulfilling the obligations of the project. Checking whether WACES candidates possessed a legal entity in Europe was then further required to ensure that innovators were relevant to project objectives. Finally, when an innovator had submitted more than one solution for consideration, only the one with the highest TRL was selected to not give any undo advantages to certain innovators. **Figure 10** details the criteria used to funnel the list of 23 candidates to a pool of 11 that represented the final selected WACES that will access to the market uptake services of the project.

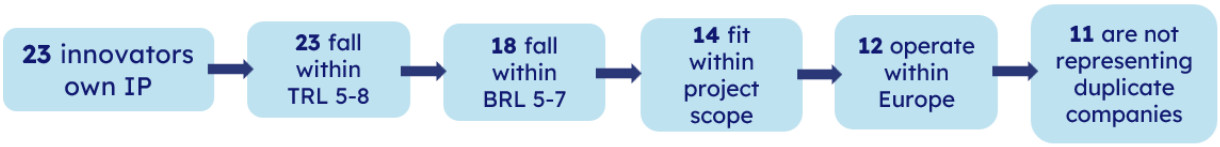

Figure 10. Process for selecting the final WACES for the market uptake services following review of submissions to 2nd questionnaire

3 Analysis of market and competitive landscape of the selected WACES

Understanding **market trends** currently observed and forecasted for each the selected WACES is necessary for **achieving their successful market entry and adoption**.

In this section, a **market and competitor analysis** provides WACES innovators with insights into the opportunities facing their water sector solutions in addition to providing a breakdown of the **main players** active in relevant markets, the **market niches** they currently fill, and **opportunities for adoption** that exist for each of the selected WACES given their unique selling points (USPs) and attributes that allow them to stand out against said competitors. The following market and competitor analysis is broken down into the **primary solution categories** represented by each of the respective selected WACES, thereby resulting in the primary categories being **water recovery** and **nutrient recovery**.

3.1 *Water recovery*

3.1.1 The SunAir Fountain®

The SunAir Fountain® technology uses solar-powered atmospheric water generation methods to extract potable water from the surrounding air whilst remaining free of microplastics, PFAS, and other trace contaminants.

The market for such type technologies is currently valued at **USD 4.42 billion**, expected to reach **USD 7.41 billion by 2029** at a **CAGR of 13.8%** (The Business Research Company, 2025). Key players serving as notable direct competitors of **The SunAir Fountain®** are Akvo Atmospheric Water Systems Pvt. Ltd., Drinkable Air, and Hendrx Water (Custom Market Insights (2025) (**Table 2**).

Given the existing saturation of the atmospheric water generation market, **Agua de Sol** may have to accept a comparatively small share when entering the market, or partner with its competitors to ensure successful market uptake. However, by leveraging its unique solar-powered system attributes, the company may be able to assume a presence in niche market segments related to renewable energy-based technologies.

Table 2. Agua de Sol's innovation description, identified market size and main competitors

The SunAir Fountain®	
Company name	Agua de Sol
Country	France
Primary solution category	Water recovery
Supplementary solution category	-
TRL	6
BRL	6
Solution type	Product
Type of organisation	Start-up
Innovation description	Solar-powered solution that autonomously transforms air into high-quality water, free from microplastics, PFAS, and germs. Scalable from a few litres to thousands, it offers water at one-third the cost of bottled water, eliminates plastic waste, and saves one ton of CO_2 per panel.
Market sector	Atmospheric water generation
Market overview	The market is currently valued at USD 4.42 billion, expected to reach USD 7.41 billion by 2029 at a CAGR of 13.8% (The Business Research Company, 2025).

Funded by
the European Union

The SunAir Fountain®	
Main Competitors	
Akvo Atmospheric Water Systems Pvt. Ltd.	**Country:** India **Description:** Designer of atmospheric water generation systems with a mission to broaden access to de-commodified, clean drinking water (Akvo Atmospheric Water Systems Pvt. Ltd., 2025).
Drinkable Air	**Country:** United States **Description:** Atmospheric water generation company operating in the Middle East, North Africa, Asia, and Oceania (Drinkable Air, 2025).
Hendrx Water	**Country:** China **Description:** Water technology provider offering tailored solutions for water filtration and drinking water (Hendrx Water, 2025).

3.1.2 MEMB-RANER

MEMB-RANER, an innovation created by **Aqualia**, is an Anaerobic Membrane Reactor (AnMBR) technological process designed to treat wastewater, recovering water for reuse while also concentrating biomass and disinfecting the effluent, producing biogas and nutrient-rich permeate as byproducts.

The global market for ANMBR was valued at **USD 1.2 billion in 2023** with figures for the year **2032** expected to reach up to **USD 3.8 billion**, exhibiting a **CAGR of 13.5%**, with demand for sustainable wastewater treatment solutions being a primary driver of growth (Sharma, 2025).

A main competitor in the ANMBR market is Veolia Water Technologies and Solutions. With a water revenue of EUR 3.31 billion, it provides engineering, monitoring and chemical solutions with footholds in an array of sectors inclusive of municipal and wastewater sectors (Global Water Intelligence, 2025d). Other main competitors in the ANMBR market include Aquabio, Ross-shire Engineering, Symbiona and Wherle-Werk (GWI Water Data, 2025), further details for which are provided in **Table 3**.

Given the existence of several key players already in the ANMBR market, **Aqualia** may be obliged to either occupy a smaller segment of the market relative to these competitors or form a partnership with them to sell their technology.

Table 3. Aqualia's innovation description, identified market size and main competitors

MEMB-RANER	
Company name	Aqualia
Country	Spain
Primary solution category	Water recovery
Supplementary solution category	Energy recovery, nutrient recovery
TRL	8
BRL	7
Solution type	Technology
Type of organisation	Large enterprise
Innovation description	An AnMBR that treats wastewater for reuse in one step, using micro-/ultra-filtration to concentrate biomass and disinfect effluent. It consumes less energy than aerobic systems, produces biogas for energy, and provides nutrient-rich, high-quality permeate suitable for agriculture or industrial reuse, with low sludge handling costs.
Market sector	Anaerobic Membrane Bioreactors (AnMBR)
Market overview	USD 1.2 billion in 2023, with AnMBR market expected to reach USD 3.8 billion by 2032, representing a CAGR of 13.5% (Sharma, 2025).
Main Competitors	

MEMB-RANER	
Aquabio	**Country:** United Kingdom **Description:** Subsidiary of Freudenberg Filtration Technologies, offering biological treatment, RO and software solutions focusing on the food & beverage industry (GWI Water Data, 2025).
Ross-shire Engineering	**Country:** United Kingdom **Description:** Systems integrator in wastewater recycling sector, offering design, construction and maintenance services on modular treatment units and specialising in process control systems, chemical dosing and fluid dynamics (GWI Water Data, 2025).
Symbiona	**Country:** Poland **Description:** Specialises in biological wastewater treatment, with a technology portfolio incorporating aerobic and anaerobic systems, clarifiers and biogas handling (GWI Water Data, 2025).
Wherle-Werk	**Country:** Germany **Description:** Designs, manufactures and operates treatment plants for water, wastewater, sludge and steam generation, and contains three business divisions across energy technology, environmental technology and manufacturing (GWI Water Data, 2025).
Veolia Water Technologies and Solutions	**Country:** France **Description:** Acquired by Veolia in 2022 as part of the Veolia-Suez merger, offering chemical and monitoring solutions and engineering systems, acting as a systems integrator and equipment and chemicals supplier (GWI Water Data, 2025).

3.1.3 SuMeWa I

SuMeWa I, a technology created by **Solventum**, generates chlorine from NaCl brine on-site to disinfect wastewater for irrigation applications.

Chlorination is the most largely represented market segment for disinfection from 2022-2029 due to its popularity in developing nations, particularly India and China where discharge regulations are intensifying (Nash, 2022). As a general trend across much of Asia, large populations and industrialization are driving further growth in wastewater treatment markets (Precedence Research, 2025). In parallel, the US and Europe are deemed less likely to adopt chlorination in the utility sector given increasing regulatory consideration for by-products created in chlorination processes (Nash, 2022).

The **chlorination market** in the water sector is valued at **USD 4.34 billion in 2025**, expected to grow to **USD 4.85 billion by 2029** (Nash, 2025).

A major competitor in chlorination is Grundfos, a Danish company with a water revenue of USD 4.68 billion, primarily deriving its revenue from Europe and North and South America, respectively (Global Water Intelligence, 2025b). Other key competitors in the chlorination market include Evac, Veolia Water Technologies and Veolia, detailed in **Table 4**.

Table 4. Solventum's innovation description, identified market size and main competitors

SuMeWa I	
Company name	Solventum
Country	Germany
Primary solution category	Water recovery
Supplementary solution category	-
TRL	7
BRL	5
Solution type	Technology
Type of organisation	Small-medium enterprise (SME)
Innovation description	A solar-driven onsite chlorine generation system that disinfects treated wastewater by producing chlorine from NaCl brine. The chlorine stock solution is stored and dosed proportionally into the treated water, ensuring safe conditions for reuse in irrigation and other applications. This automated process enhances safety and efficiency by eliminating manual handling.
Market sector	Chlorination
Market overview	Chlorination market valued at USD 4.34 billion in 2025, expected to grow to USD 4.85 billion by 2029 (Nash, 2025).

SuMeWa I	
Main Competitors	
Evac	**Country:** Finland **Description:** Specialises in integrated water and waste management solutions for marine, off-shore and commercial building sectors (GWI Water Data, 2025).
Veolia Water Technologies	**Country:** France **Description:** A subsidiary of Veolia Environnement with a portfolio of 350 technologies for water and wastewater sector applications (GWI Water Data, 2025).
Veolia	**Country:** France **Description:** Largest water company in the world and the largest private water operator in France, serving 95 million people with drinking water in 2018 (GWI Water Data, 2025).
Grundfos	**Country:** Denmark **Description:** A leading supplier of pumps for industrial and domestic applications, known particularly for vertical multistage pumps for water extraction and circulators for temperature controls (GWI Water Data, 2025).

3.1.4 W4F – Water4future®

Water4future®, an innovation designed by **Kauai**, combines chlorine dioxide and hypochlorous acid (HClO) to create a highly effective biocide.

The chlorine dioxide market was of **USD 1.04 billion in 2023**, expected to experience a **CAGR of 5.9% between 2024 and 2030** largely driven by increased demand for wastewater treatment processes (Grand View Research, n.d.).

Major competitors in the chlorine dioxide biocide market include De Nora, an Italian company specializing in water technology sales. De Nora has a water revenue of EUR 290 million and net income of EUR 231.1 million as of the end of 2023 (Global Water Intelligence, 2025c). Ekopak, ProMinent, and ISIA are other prominent competitors, detailed in **Table 5**.

As such, **Kauai** may be obliged to occupy a smaller share of the market or partner with existing competitors to sell its **Water4future®** technology. However, no competitor currently on the market was found to offer the same chlorine dioxide and HClO combination biocide soloution developed by **Kauai**, therefore signalling a USP that it could exploit when entering and expanding its influence in the market.

Table 5. Kauai's innovation, identified market size and main competitors

W4F - Water4future®	
Company name	Kauai
Country	Germany
Primary solution category	Water recovery
Supplementary solution category	-
TRL	7
BRL	5
Solution type	Technology
Type of organisation	SME
Innovation description	An innovation that combines hypochlorous acid (HClO) and chlorine dioxide biocides. The system manufactures this mixture, offering heightened effectiveness in the biocide market.
Market sector	Chlorination – chlorine dioxide
Market overview	Chlorine dioxide market valued at USD 1.04 billion in 2023, expected to experience a CAGR of 5.9% between 2024 and 2030 largely driven by increased demand for wastewater treatment processes (Grand View Research, 2025).

W4F - Water4future®	
Main Competitors	
Ekopak	**Country:** Belgium **Description:** Provides water treatment equipment, chemicals and disinfection services, largely within the European market, with specialisation in industrial water treatment (GWI Water Data, 2025).
ProMinent	**Country:** Germany **Description:** Manufactures equipment for treating and metering water and wastewater, including disinfection systems and membrane technologies (GWI Water Data, 2025).
ISIA	**Country:** Italy **Description:** Manufactures and engineers solutions in the disinfection market, providing chlorine dioxide generation, storage and control systems largely for industrial wastewater treatment plants (GWI Water Data, 2025).
Industrie De Nora	**Country:** Italy **Description:** Operates two core business lines within electrode manufacturing with industrial electrochemical applications including chlorine production, as well as water technology sales and services (GWI Water Data, 2025).

3.1.5 Water quality data engine

Liquisens offers its **water quality data engine** to leverage Internet of Things (IoT) and advanced algorithms that bestow users with insights into pathogens and bacterial contaminants to enable effective water quality management. This falls into the asset performance management (APM) software market, a sub-section of the asset management market experiencing rapid growth, and that is implementing AI tools with increasing frequency (Bratt, 2025a).

In terms of data management software in the water sector, the asset management market is valued at **USD 4.75 billion in 2025**, expected to grow to **USD 7.09 billion by 2029**, whereas the **real-time asset optimization market** is valued at **USD 1.34 billion in 2025**, projected to increase to **USD 2.77 in 2029** (Bratt, 2025b).

Liquisens may face strong market competition with its innovation, despite filling different market niches. Relevant competitors already existing in the market facing both **Liquisens** include ABB Water Solutions, Siemens, Endress + Hauser, and Vienna Water Monitoring Solutions (**Table 6**).

Table 6. Liquisens's innovation, identified market size and main competitors

Water quality data engine	
Company name	Liquisens
Country	Belgium
Primary solution category	Water recovery
Supplementary solution category	-
TRL	8
BRL	7
Solution type	Product
Type of organisation	Start-up
Innovation description	A technology leveraging IoT and advanced algorithms for real-time water quality management. It combats bacteria and pathogens, upholds hygiene standards in food production, and boosts yields in aquaculture and agriculture. Indispensable for efficient water management.
Market sector	Asset management – digital solution
Market overview	The asset management market is valued at USD 4.75 billion in 2025, expected to grow to USD 7.09 billion by 2029, whereas the real-time asset optimization market is valued at USD 1.34 billion in 2025, projected to increase to USD 2.77 in 2029 (Bratt, 2025b).

Water quality data engine	
Main Competitors	
ABB Water Solutions	**Country:** Switzerland **Description:** Provides control and automation technology across sectors, provisioning water sector with distributed control systems as well as components needed for automation (GWI Water Data, 2025).
Siemens	**Country: Germany** **Description:** Provides software, automation and measurement technologies with relevance across the water cycle, with operators able to optimize efficiency while avoiding water loss and contamination (GWI Water Data, 2025).
Endress + Hauser	**Country:** Switzerland **Description:** Provides sensors, field equipment and data and energy management solutions, with a range of flow and level metering solutions and pressure management systems available for water networks (GWI Water Data, 2025).
Vienna Water Monitoring Solutions	**Country:** Austria **Description:** Developer of Colminder automated microbiology monitoring system, an online tool for measuring bacterial contamination (GWI Water Data, 2025).

3.1.6 Aqua Alarm

The use of Artifical Intelligence (AI) holds particular relevance to **Aqua Alarm**, one of the selected WACES that offers SaaS in a B2B model that manages water storage, reuse and distribution through AI models to provide incident management capabilities.

As such, **Aqua Alarm** like **Liquisens** may face strong market competition, and it may be important for them to consider forming partnerships to sell their technology or accept smaller market shares. Competitors likely to challenge market entry potential of **Aqua Alarm** meanwhile include Aqua Robur Technologies, Haskoning, Suez and Xylem (**Table 7**).

Table 7. Aqua Alarm's innovation, identified market size and main competitors

Aqua Alarm	
Company name	Aqua Alarm
Country	Norway
Primary solution category	Water recovery
Supplementary solution category	-
TRL	7
BRL	6
Solution type	Product
Type of organisation	Start-up
Innovation description	An innovation that offers business-to-business (B2B) software-as-a-solution (SaaS) tools for managing water storage, reuse, and distribution. Using sensing and AI-supported models, it provides early warnings and incident management. Operational benefits include lower penalties, informed maintenance, and smarter operations.
Market sector	Asset management – digital solutions
Market overview	The asset management market is valued at USD 4.75 billion in 2025, expected to grow to USD 7.09 billion by 2029, whereas the real-time asset optimization market is valued at USD 1.34 billion in 2025, projected to increase to USD 2.77 in 2029 (Bratt, 2025b).
Main Competitors	
Aqua Robur Technologies	**Country:** Sweden **Description:** IoT company providing sensors and software for collection and monitoring of flow data and water and wastewater pipelines for leak detection and other parameters of interest (GWI Water Data, 2025).

Aqua Alarm	
Haskoning	**Country:** Netherlands **Description:** Provides wastewater treatment solutions in industries with high levels of organic loading (GWI Water Data, 2025).
Suez	**Country:** France **Description:** Operator with large global presence, offering an elaborate suite of digital solutions used for water sector applications (GWI Water Data, 2025).
Xylem	**Country:** United States **Description:** One of world's largest water equipment suppliers, focusing on pumps, analytical instruments and wastewater technology with major presence in US and Europe (GWI Water Data, 2025).

3.1.7 Electrochemical sensor

DIAMSENS has created a **diamond-coated electrochemical sensor** to monitor water quality.

The water electrochemical sensors market is experiencing significant growth, driven by increasing focus on automation and remote monitoring needs, and rising of government regulations and initiatives to ensure water quality, as for example the new EU Water Resilience Strategy and it is expected to reach a value of **USD 23.1 billion by 2032** with a **CAGR of 8.7% from 2025 to 2032.**

The water quality monitoring market can be divided into large companies with wide portfolios and smaller companies creating sensors for more specified pollutants, with Veolia, Veralto, Xylem, and Endress + Hauser serving as prominent competitors in the water quality monitoring sensor market (Garland, 2025), illustrated in **Table 8**..

Nevertheless, no direct competitor was identified in the market for **DIAMSENS**. Condias GmbH is a German company creating diamond-coated electrodes that produce oxidants in water for disinfection purposes (Global Water Intelligence, 2025a), but no direct competitor was found to use diamond-coated sensors for water quality monitoring. This highlights a clear entry potential for **DIAMSENS** as it strives to gain a client base seeking innovative water quality monitoring solutions.

Table 8. DIAMSENS' innovation, identified market size and closest main competitors

Electrochemical sensor	
Company name	DIAMSENS
Country	France
Primary solution category	Water recovery
Supplementary solution category	Nutrient recovery, inorganic materials recovery
TRL	5
BRL	5
Solution type	Product
Type of organisation	Start-up
Innovation description	Electrochemical sensors for in-situ water quality monitoring that use diamond-coated electrodes. These provide analytical performance, stability, and durability, reducing maintenance costs. Competitive fabrication processes are envisioned to make diamond electrodes mainstream.
Market sector	Electrochemical sensing

Electrochemical sensor	
Market overview	The global electrochemical sensors market is estimated to be valued at USD 12.90 billion in 2025 and is expected to reach USD 23.1 billion by 2032, with a CAGR of 8.7% from 2025 to 2032.
Main Competitors	
Veolia	**Country:** France **Description:** Largest water company in the world and the largest private water operator in France, serving 95 million people with drinking water in 2018 (GWI Water Data, 2025).
Veralto	**Country:** United States **Description:** A spin-off of the environment business of Danaher. Listed on the New York Stock Exchange and owns 13 brands oriented around water and related sectors (GWI Water Data, 2025).
Endress + Hauser	**Country:** Switzerland **Description:** Provides sensors, field equipment and data and energy management solutions, with a range of flow and level metering solutions and pressure management systems available for water networks (GWI Water Data, 2025).
Xylem	**Country:** United States **Description:** One of world's largest water equipment suppliers, focusing on pumps, analytical instruments and wastewater technology with major presence in US and Europe (GWI Water Data, 2025).

3.1.8 Turbevap

Turbevap, created by **Leviathan Dynamics**, uses Mechanical Vapor Compression (MVC) to treat and reuse industrial wastewater with strong distillation and energy efficiency capabilities.

Growth in the MVC market, distinct from that of mechanical vapor recompression (MVR), is primarily driven by population growth and increasing demand for potable water given the ability of vapor compression technologies to separate contaminants from water (Technavio, 2024). Falling under the larger thermocompression market which currently is estimated to be worth a total of U**SD 11 billion as of 2024** (Markets and Markets, 2024), the vapor compression distiller market size is expected to increase by **USD 543.7 million from 2023-2028** (Technavio, 2024).

Several competitors in the wider vapor compression distiller market include Alfa Laval AB, Aqua Chem Inc., and Chart Industries Inc. (**Table 9**) although traditionally high costs to this family of technologies could serve as a hurdle towards achieving higher levels of market growth (Technavio, 2024).

Given a promising level of growth anticipated to take place by 2028, **Leviathan Dynamics** may be able to leverage the USP of its **Turbevap** technology to attract a new range of clients and successfully compete with existing key players of the market. Otherwise, it may have to form partnerships with these competitors or accept a comparatively smaller market segment as it continues to innovate

Table 9. Leviathan Dynamics' innovation description, identified market size and main competitors

Turbevap	
Company name	Leviathan Dynamics
Country	France
Primary solution category	Water recovery
Supplementary solution category	Inorganic materials recovery, organic materials recovery
TRL	8
BRL	7
Solution type	Product
Type of organisation	Start-up
Innovation description	Evapo-concentrator, ranging from 160 to 5120 m^3 per year, that treats and recovers industrial wastewater using mechanical vapor compression (MVC). Operating under vacuum at 35°C, it reduces aqueous waste and produces high-quality water for reuse, with greater energy efficiency and improved distillation quality compared to traditional MVC evaporators.
Market sector	Thermocompression

Turbevap	
Market overview	Falling under the larger thermocompression market which currently is estimated to be worth a total of USD 11 billion as of 2024 (Markets and Markets, 2024), the vapor compression distiller market size is expected to increase by USD 543.7 million from 2023-2028 (Technavio, 2024).
Main Competitors	
Alfa Laval AB	**Country:** Sweden **Description:** Provides technologies to an array of sectors including the water sector, where particular attention is paid to wastewater and sludge treatment for industrial and municipal end users (GWI Water Data, 2025).
Aqua Chem Inc.	**Country:** United States **Description:** Designs, builds, and performs maintenance activities to provide clean water solutions, with a range of technologies on offer including RO, filtration, sterilizers and vapor compression (Aqua-Chem, 2025).
Chart Industries Inc.	**Country:** United States **Description:** Chart Water, the company's water subdivision, provides gas transfer systems for water treatment purposes such as disinfection and corrosion control (GWI Water Data, 2025).

3.1.9 Wasser 3.0 PE-X®

Wasser 3.0 PE-X® is a filter-free technology using silica gels to agglomerate microplastics in wastewater to enable reuse of water free of microplastics and recovery of plastics for applications in construction. While mature technologies capable of managing microplastics in wastewater have traditionally focused on RO and nanofiltration techniques, municipal applications for microplastic removal using agglomeration techniques are envisioned to become increasingly prominent in the market due to nanoplastics become more targeted by regulations, with **Wasser 3.0** offering unique technological routes for realising this (Oakes, 2025).

With an estimated market size of **USD 277.1 million in 2025**, the global microplastic recycling market is projected to reach a value of **USD 444.8 million by 2032** with a **CAGR of 7%** (Coherent Market Insights, 2025).

As it currently stands, no direct competitor for microplastic removal from wastewater using similar agglomeration techniques has been identified, with Ecofario (**Table 10**)**,** a German company offering hydrocyclone-based technology to employ microplastic concentration techniques in WWTPs at the polishing stage, representing the most comparable alternative (Oakes, 2025).

This overall indicates a strong market entry potential for **Wasser 3.0**.

Table 10. Wasser 3.0's innovation description, identified market size and adjacent main competitors

Wasser 3.0 PE-X	
Company name	Wasser 3.0
Country	Germany
Primary solution category	Water recovery
Supplementary solution category	Inorganic materials recovery
TRL	8
BRL	7
Solution type	Technology
Type of organisation	Non-profit green tech start-up
Innovation description	A filter-free technology for removing and reusing up to 95% of microplastics from water that includes microplastic detection, chemical recovery, and water reuse. Using non-toxic hybrid silica gels, larger agglomerates float to the surface within 5 minutes, enabling reuse in construction and industrial processes.
Market sector	Microplastic removal and recycle
Market overview	With a market size of USD 277.1 million in 2025, the global microplastic recycling market is projected to reach a value of USD 444.8 million by 2032 with a CAGR of 7% (Coherent Market Insights, 2025).

Wasser 3.0 PE-X	
Main Competitors	
Ecofario	**Country:** Germany **Description:** Offers hydrocyclone-based technology to employ microplastic concentration techniques in WWTPs at the polishing stage (Oakes, 2025).

3.1.10 Water biosense®

Water biosense® is an **early warning monitoring system** enabling public health decision-making following continuous detection of waterborne pathogens including bacteria, parasites, fungi, viruses and protozoa, employing its technology in both drinking and non-drinking water applications.

Technologies for pathogen testing are experiencing strong degrees of market uptake currently due to increased concern of waterborne disease risks, with demand expected to continue growing as results can become integrated with digital systems, with especially strong growth anticipated in the US with particular emphasis on legionella detection (Smith, 2024). The overall market for pathogen detection is valued at **USD 4.9 billion in 2022**, projected to climb to **USD 9.07 billion by 2030** (Data Bridge Market Research, 2022).

Large companies including B&V Chemicals and Suez conduct waterborne pathogen testing through the formation of partnerships with companies focusing specifically on rapid testing device development such as Nephros, with device accuracy being a chief driver in ensuring further market development (Global Water Intelligence, 2024) (**Table 11**).

Given the significant degree of growth expected to take place in coming years, **Water biosense®** may be able to find a foothold considering existing competitors or forge partnerships with them to springboard market entry.

Table 11. Sensactive Technology's innovation description, identified market size and main competitors

Water biosense®	
Company name	Sensactive Technology
Country	Spain
Primary solution category	Water recovery
Supplementary solution category	-
TRL	7
BRL	6
Solution type	Product
Type of organisation	Start-up
Innovation description	Technology for monitoring biological agents of interest in any kind of water in real time.
Market sector	Pathogen detection

Water biosense®	
Market overview	Market for pathogen detection is valued at USD 4.9 billion in 2022, projected to climb to USD 9.07 billion by 2030 (Data Bridge Market Research, 2022).
Main Competitors	
B&V Chemicals	**Country:** United Kingdom **Description:** Manufactures and supplies chemicals for water treatment purposes and develops customised water treatment solutions throughout the water lifecycle (B&V Chemicals, 2025).
Suez	**Country:** France **Description:** Operator with large global presence, offering an elaborate suite of digital solutions used for water sector applications (GWI Water Data, 2025).
Nephros	**Country:** United States **Description:** Seeks to enhance understandings of water safety and provide accessible technology for improving water quality through offering a combination of educational services and water filtration solutions (Nephros, 2025).

3.2 Nutrient recovery

3.2.1 Flow-electrode capacitive deionization (FCDI) technology

FCDI systems are an established technology, falling under the larger umbrella of electrodeionization processes (Vyas, 2025). **Amovion's FCDI technology** specifically uses a patented FCDI module employing an electric field to remove salt ions from water.

Small and mid-scale drinking water production is expected to be a major driver of growth in this market in coming years, with the North American markets in particular expected to see high levels of growth for deionization systems within electronics and pharmaceutical industries, contributing toward a **CAGR of 6.3% from 2024-2030** that is expected to drive the market size for deionization technologies to **USD 2.66 billion by 2030** (Industry Arc, n.d.).

Key players in the market are currently Veolia, possessing a large portfolio of water treatment technologies relevant to electrodeionization with applications in both industrial and municipal sectors, and Thermo Fisher Scientific, offering customized solutions to a large client base with varied technological applications including electrodeionization (Vyas, 2025) (**Table 12**).

As electrodeionization is already a market occupied by direct competitors and given the forecast of substantial growth to occur by 2030, **Amovion** may therefore benefit most from establishing partnerships with Veolia or Thermo Fisher Scientific, selling their technology to become part of one of these companies' portfolios. Otherwise, **Amovion** may be obliged to accept a smaller market share to begin with.

Table 12. Main attributes of Amovion's innovation and its identified competitors

FCDI module	
Company name	Amovion
Country	Germany
Primary solution category	Nutrient recovery
Supplementary solution category	Inorganic materials recovery, organic materials recovery
TRL	6
BRL	5
Solution type	Technology
Type of organisation	Start-up
Innovation description	Patented FCDI module that uses an electric field to remove salt ions from water. Activated carbon particles adsorb cations, which are then transported away. In the lower channel, particles discharge, releasing cations into the concentrate flow. Anions are transported via the ion exchange membrane, generating desalinated water and concentrate.

FCDI module	
Market overview	CAGR of 6.3% from 2024-2030 that is expected to drive the market size for deionization technologies to USD 2.66 billion by 2030 (Industry Arc, 2025).
Main Competitors	
Veolia	**Country:** France **Description:** Largest water company in the world and the largest private water operator in France, serving 95 million people with drinking water in 2018 (GWI Water Data, 2025).
Thermo Fisher Scientific	**Country:** United States **Description:** Leads as a supplier of kits, digital solutions and instrumentation in industry, academia and government. Provides solutions for elemental and organic content analysis for wastewater and water processes (GWI Water Data, 2025).

4 Conclusions

Following the analysis of market segments filled by the selected WACES, a depiction of market segments and their projected growth over the next several years is depicted in **Figure 11**. Aqua Alarm and Liquisens have been grouped into the same market segment, and no data was available to analyse the value or growth prospects of DIAMSENS's target market.

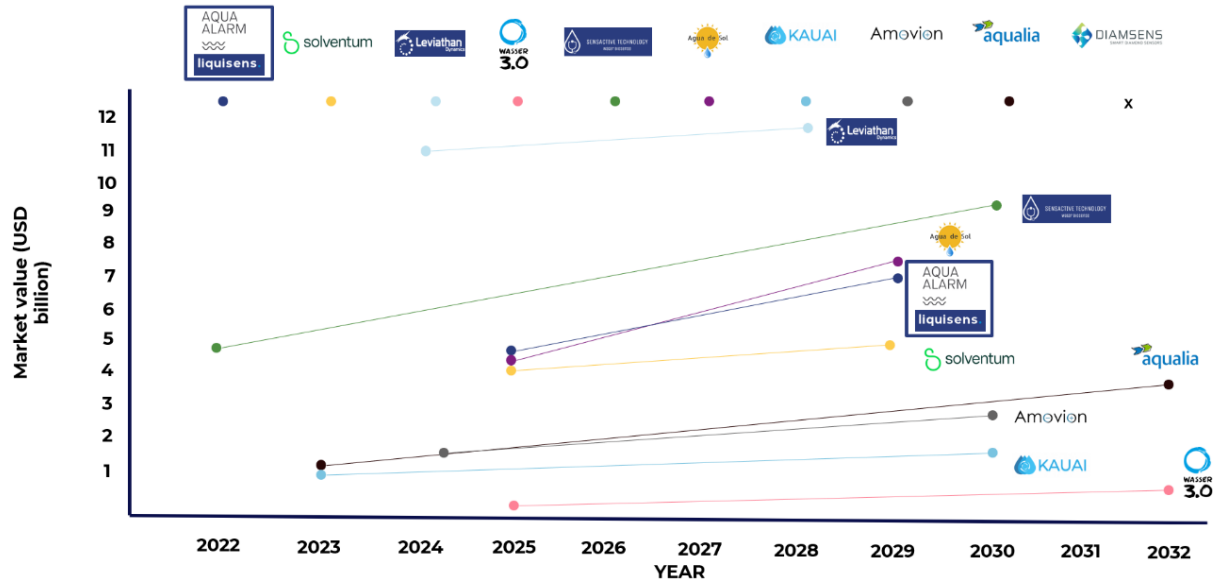

Figure 11. Size and expected growth of WACES market segments

The majority of selected WACES innovations face competition stemming from existing key players serving as competitors across a range of sectors and markets relevant to their water sector applications. However, the WACES **deemed to face the least competition** either **fill the smallest relative market segments** examined in the market analysis, as is in the case of **Kauai** and **Wasser 3.0**, or have **no direct competitors** such is the case of DIAMSENS, indicating challenges in accessing readily exploitable market entryways, but also an opportunity to access to the market through its differential USP.

Meanwhile, an analysis of the **WACES occupying the largest relative market segments**, being L**eviathan Dynamics**, **Sensactive Technologies** and **Agua de Sol**, shows strong **growth potential** in water recovery technologies, with further relevance towards inorganic and organic materials recovery as well.

Overall, uncertainties remain regarding emerging markets and technologies, the relative risks posed towards nutrient and energy recovery technologies compared with other solution categories of technologies in this review, and the influence of political and social barriers to implementation on water technology development. This ultimately highlights knowledge gaps and the need for further research throughout the BOOST-IN project alongside collaborative efforts to springboard selected WACES into their target markets. Cumulatively, the background research and analysis conducted in this report suggest that the robust pre-existing TRL, innovative attributes and USP of each WACES innovation can be leveraged to rival competitors and take advantage of the varying degrees of growth anticipated to take place across each market segment in question.

Further project activities of BOOST-IN will assist in ensuring widespread adoption of the WACES selected for the market uptake acceleration services within WP4, including undertaking targeted engagement with end-users and investors, developing a diversity of traditional and business models, and developing standardized quality criteria for CE products from water. Furthermore, developing a booster compendium for CE innovators will aid in facilitating access of start-ups and selected innovators to support programs and opportunities to ensure successful market uptake.

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The quantity and quality of water resources are serious problems in many European areas, mostly being a joined result of climate change and anthropic influences. The BOOST-IN project aims to develop a successful strategy that promotes technological changes, governance schemes, shifts in mind-set and organizational structures to solve these problems through a better management of the water sector and application of the circular economy principles, enabling water reuse and recovery of different materials (e.g. energy, nutrients). However, implementation of these changes still faces several barriers (e.g. technology, economy, knowledge, social perception) that need to be overcome. BOOST-IN will achieve these goals by an effective identification, selection (through a specifically designed dynamic funnel method) and transfer of innovative Water Circular Economy Solutions (WACES) to further close and improve the water cycle.

The project will develop and apply its approach in six Regions of Opportunity evenly distributed across Europe (Spain, Greece, Germany, France, Italy and Bulgaria) by organization of co-creation workshops to increase public awareness and support for WACES implementation, barriers overcoming as well as by the specific risk management plans design.

BOOST-IN

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