European Commission

Business Innovation Observatory

Clean Technologies

Advanced reverse treatment technologies

Case study 31

Enterprise and Industry

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Advanced reverse treatment technologies

Business Innovation Observatory
Contract No 190/PP/ENT/CIP/12/C/N03C01

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European Union, June 2014.

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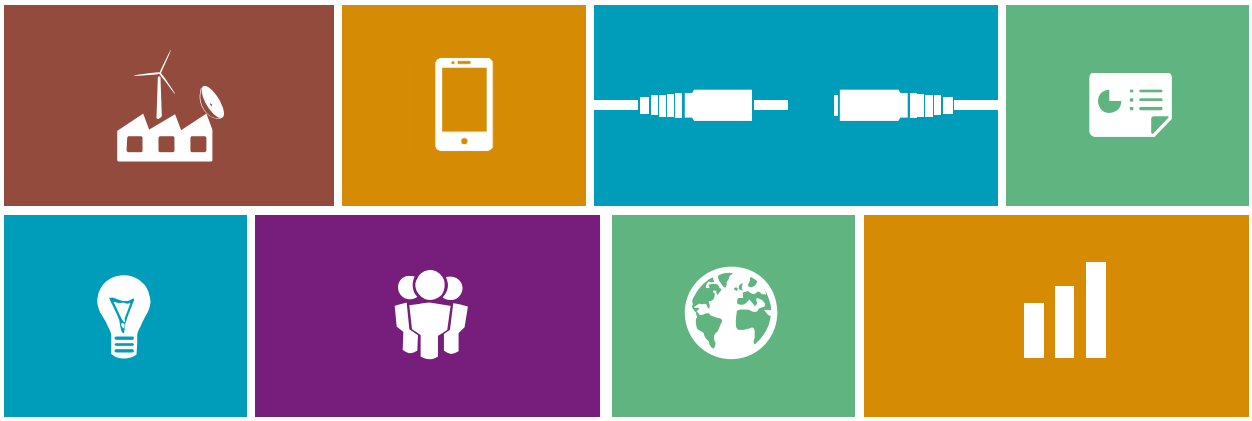


1. Executive summary

Advanced Reverse Treatment Technologies (ARTTs) are used to turn wastewater into a reusable and safe resource; thereby reducing the negative impact wastewater may have on the environment. The need to develop these technologies in a practical and cost-effective manner has been triggered by increased urbanisation and rising populations that place an environmental strain on the water supply.

ARTTs are applied in several sectors, including the desalinisation, oil-water separation, and sewage treatment markets. In all these sectors, the role played by the ARTTs is crucial due to the tightening of regulations. The demand for such solutions is also constantly increasing. Hence, each of these sectors has the potential to prosper to billion euro industries.

Numerous benefits emanate from the use of ARTTs. The first is related to the water. ARTTs provide the possibility to preserve water, which is becoming an increasingly scarce resource. After treatment, the water can be reused indefinitely. Yet, one of the main benefits of ARTTs is the potential to reduce the costs of untreated wastewater, which can take different forms: economic, social or environmental costs. Most economic costs owe to fishing, tourism and investment for securing freshwater sources but social costs are also tied to polluted waters that may be detrimental to the health of people and wildlife.

Plenty of drivers explain the recent emergence of the ARTTs. The skills of the workforce, more specifically the expertise in the engineering, were highlighted by the companies as a driver. The talent of the engineers played an essential role in the development of the technologies. The success of the showcased SMEs is largely explained by their skills. Environmental awareness and regulation are also increasing the demand for ARTTs. The last identified driver is the supporting initiatives from the EU to enhance collaboration.

Several barriers are impeding the rise of ARTTs. One of the main obstacles is securing long-term financing on projects with high work capital needs. The sector requires heavy early investment and long period before having any return on investment. The finance requirements are also high, as the business models based on leasing engender high working capital needs.

Furthermore, the water industry is extremely conservative. The technologies used 50 years ago are still the standards today and the sector is reluctant to change. It is particularly reflected in the portfolio references needed for procurements. The public procurement could play a role to provide such references, but it suffers from the same issues. The lacks of harmonisation between the EU Member States, and the difficulties to access EU funding have also been recognised as major barriers.

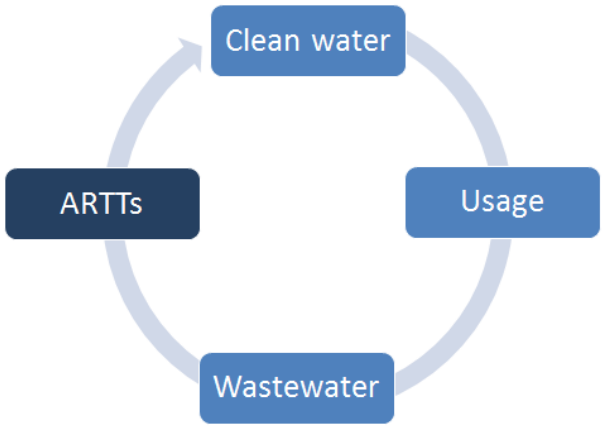
Yet, some solutions could be implemented to further develop the ARTTs. First, the role of utilities can be enhanced by setting energy saving targets, with rewards and penalties to meet them. Utilities would have incentives to promote and support energy efficient solutions, which would help to create a pull from the market on ARTTs. Similarly, a further strengthening of the green regulations would have a similar effect. Public procurement processes could be improved with the introduction of a share reserved to innovative solutions. Finally, focusing the help of EU to a limited number of most promising sectors would increase the impact of the support. The criteria to select the sectors could include the number of jobs created, the added-value or their capabilities to answer societal challenges.

2. Advanced reverse treatment technologies

Advanced Reverse Treatment Technologies (ARTTs) encompasses the processes used to transform wastewater into a reusable and safe resource. As a part of the clean-technologies, they intend to lessen the pollution related to wastewater in the environment. The rising demand to a finite supply of water underlined the necessity to preserve the current freshwater resources, and drove the development of the ARTTs.

The introduction of clean technologies offers the possibility to reusing water indefinitely. The previous linear model would see the disposal of wastewater after its usage. Yet, the loop can now be closed thanks to the ARTTs (Figure 1). In this case study, clean water is not limited to drinking water. It also includes water with lower standards, which is disposable without harming the environment. Clean water is used to supply the needs of human and also in agricultural, commercial and industrial processes. The usage results in wastewater, which holds some pollutants that render water harmful. The traditional wastewater plants use sceptic tanks, which may inconvenience neighbours, require large land area and often consume high quantity of chemicals. Thus, they are located far from the consumption sites. However, ARTT aim to tackle these issues.

Figure 1: The closed-loop value chain of the ARTTs in the water industry



Source: PwC Analysis

The most recent advances in clean technologies for wastewater processing include: reverse osmosis, which uses a membrane for water purification; solid-liquid separation, which uses filtration or flotation systems; anaerobic digestion, which sees micro-organisms break down biodegradable material and create biogas[1]; and waste-eating bacteria cultivation, which draws on microbes that generate electricity by cleaning up nuclear waste and other toxic metals[2].

There are three key benefits emanating from the use of ARTTs. The first is the reuse of water. For example, in the oil industry, large quantity of water is used in the extraction process. On average, one barrel of oil generates 3 to 5 barrels of water. These wastewaters are heavily polluted with hydrocarbons, solids and other contaminants. ARTTs will clean these wastewaters and put them back in the loop, lowering the input of freshwater. Hence, water separated from oil can be reused in the extraction process over and over.

The second benefit relates to advanced reverse water treatment technologies' ability to support water preservation, as increased demand for water, combined with increasing levels of pollution, is contributing to water becoming an increasingly scarce resource. This is reflected in the UN positing that 1.2 billion people are living in water-stressed basin[3] and estimates indicating that one litre of wastewater will pollute almost eight litres of freshwater[4].

Thirdly, clean technologies can be both energy generators and energy efficient. For instance, different types of energy may be harnessed from wastewater, including:

- Thermal energy, which originates from the temperature of the water when it exits the building (at around 27°C)[5];
- Potential energy, which relies on the topography and difference of height; and
- Chemically bound energy, which converts organic matter carbon content into biogas.

Further to generating benefits, and as shown in Table 1 on page 4, ARTTs have the potential to reduce the costs of untreated wastewater. Most economic costs owe to fishing, tourism and investment for securing freshwater sources but social costs are also tied to polluted waters that may be detrimental to the health of people and wildlife.

Table 1: The costs of water pollution

Type of costs	Example of impact
Economic costs	Decrease in the production volume of natural resources (aquaculture, game, timber)
	Less revenues from recreational and commercial fishing activities
	Loss in real estate worth
	Inspection of water quality costs
	Search and access to reliable and uncontaminated sources
Social costs	Expenditure related to heath issues
	Life expectancy decrease
Environmental costs	Losses in biological diversity and sustainability
	Loss of water regeneration / purification by wetland

Source: PwC Analysis

Traditional large players in the water services - like Veolia, Suez-environment or Acciona – have long sort to reduce the costs of wastewater to the economy, society and the environment but are now facing increased competition from innovative SMEs, whose ARTTs are disrupting the market.

These SMEs are typically serving the national, regional and local authorities responsible for managing water resources. However, private companies that must adhere to environmental standards and legislation like the Urban Waste Water Treatment Directive, are also target clients[6].

This case study will look into SMEs that aim to transform the shape of the wastewater industry by introducing innovative technologies. These SMEs have been selected for their potential to create new markets or reshape existing ones. And as they are active in different sectors, they serve a broad range of customers that are leveraging on varied ARTTs.

3. Socio-Economic Relevance

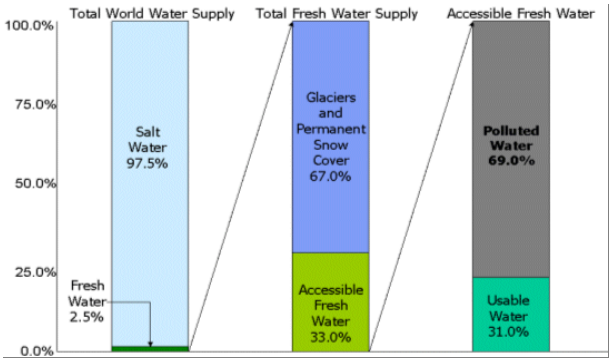
The key necessity of water, the increasing demand for water, the rise of pollution and the environmental standards are driving the market for ARTTs. Further, the ARTTs market is divided in multiple segments coming from different sectors. These sectors, which have been reflected in the selection of showcased companies, include: desalinisation, oil-water separation, and sewage treatment markets.

3.1. The market potential of the trend

The market potential of the trend is significant due to several main drivers. First, there is no denying that without clean water, water is a prerequisite for life. Water is a key component of our health and thus classifies as a basic need in Maslow's pyramid. This is an area where investment in cleaning water cannot be spared.

As the world's supply of freshwater declines and its demand increases, Europe is increasingly viewing ARTTs as both a potential solution for quenching the world's thirst and an economic opportunity. Freshwater resources used to be considered as limitless. However, the increasing need for water and the growing pollution are taking a toll on the fresh water resources. As illustrated in Figure 2, 97.5% of all water on Earth is salt water and of the 2.5% freshwater left, only 1% is accessible. Hence, reverse treatment technologies can help to lessen the strain of pollution on freshwater. ARTTs can also represent a solution to face the rising demand, correlated with the population increase.

Figure 2: Fresh water availability



Source: UNESCO and Frost & Sullivan

Moreover, water knows no borders. For instance, the Danube's river basin is shared by 19 countries and more than 80 million people[7]. Therefore, the treatment of wastewater falling within its catchment area should be considered at an international-level. Hence, the water industry is and will continue to become an ever increasing international market.

ARTTs are applied in a number of areas, including the desalinisation, oil-water separation, and sewage treatment markets, as illustrated by the companies showcased in the case study.

In the case of the desalination market, the global cumulative contracted capacity increased from 46.6 million cubic meters per day (m/day) in 2005 to 67.3 million m/day in 2009. This represents a compound annual growth rate

(CAGR) of 9.6%. Moving forwards, it is expected that the CAGR will hit double digits for the period 2010-2020, as the global cumulative contracted capacity reaches 200 million m/day in 2020. In 2013, the market size for desalinisation is estimated around $ 19.5 billion (EUR 14 billion).[8]

In contrast, the oil-water separation market – now a billion euro industry - is being driven by the strengthening of environmental regulations and the increasing number of wells. More stringent environmental regulations are calling for specific oil-separation standards, forcing companies to invest in clean-technologies. Further, the number of drilled oil and natural gas wells is reaching 950,000 worldwide with half in the United States An additional 50,000 new wells are estimated to be drilled each year in the US alone.[9]. Hence, more wells subjected to more stringent environmental regulations

Similarly, the wastewater treatment industry is also undergoing a period of growth, as it is expected that the market for wastewater treatment products in the top 40 national markets will increase from EUR 35 billion in 2012, to around EUR 70 billion by 2019.[10]

Table 2: Overview of the company cases referred to in this case study

Company	Location	Business innovation	Signals of success
Apateq	Luxembourg	Oil-water separation using membranes that do not clog rapidly	- Technology Innovation Leadership Award 2014 winner from Frost & Sullivan - Red Herring 2014 winner - Visited by the Luxembourg Minister of the Economy (Etienne Schneider) - Extensive media coverage
akvolution	Germany	Energy-efficient "one-stop" process to cleanse very polluted waters.	- Awarded the StarTUp Label as one of the most promising start-ups from Technical University Berlin - EXIST R&D-Grant, a 3 year funding with a total volume of over 550k€ - 2nd place in the largest business plan competition in Germany. - Winner of the GreenTec Award in the start-up category - Financed by a German VC, High-Tech Gründerfonds
Watreco H2oVortex	Sweden Luxembourg	Using biomimetic, the firm developed a vortex generator technology for water treatment	- Cleantech Company of the Year 2009 - REALice product is used in famous hockey league such as NHL (USA), KHL (Russia), SHL(Sweden), FHL (Finland) and at the Ice Hockey World Championship 2012/13 and NHL Winter Classic Games - IVG-CT, 100% chemical free cooling tower solution, used at e.g Vriesoord (Cold store) and Vitelco-Pali Group (Slaughter house) in The Netherlands - End-users include Heineken, Friesland-Campina and Huntsman
Organica Water	Hungary	Build and operate biological wastewater treatment plants, implementing its Fixed-Bed Biofilm Activated Sludge (FBAS) technology	- Named First Cleantech company in Europe and Israel in 2013 - Water and Energy Exchange (WEX) Innovation Award - Worldwide customer base: Europe, Asia, America - Successful Series B financing
Bluetector	Switzerland	Containerized and patented wastewater treatment system for difficult and sludgy waste water	- Patent granted for its BlueBox - Winner of the IMD Startup Competition - Voted into the TOP 100 Swiss Start-ups - Selected as a "Top 20" Water company by industry peers in a survey by Global Water Intelligence - Picked as one of the 20 young promising entrepreneurs by VentureLab

Problem 1 – The production of oil causes a large amount of water to be polluted with oil, due to spillages, oil-contaminated land and oilfield production/flow back wastewaters. An estimated 4 barrels of deposit water are generated for each oil barrel. Hence, polluted water is the largest waste stream associated with oil and gas production.

Innovative solution 1 – Apateq has developed a proprietary oil-water separation system. Deposit water is hard to treat as it contains several elements on top of the dissolved hydrocarbons. Usually, organic and ceramic membranes are clogged within minutes when treating oil. However, Apateq utilizes organic or inorganic membranes in its proprietary processes that can be kept for years.

The benefits offered by Apateq's system are multiple. First, the deposit water is cleaned and can be reused. Second, the recovered oil can be directly processed in a refinery. Complying with environmental laws is often costly, especially in the oil industry, but Apateq's system provides a more efficient solution at lower costs than the current ones.

The application of the technology is mainly directed to separate oil-water. The company delivered its first plant to an undisclosed European market leader to clean water produced from oil production and hydraulic fracturing. However, the company recently diversified by selling a unit to an Italian food industry firm. The treated water is produced in the washing, sorting and packing process of the fruits.

Units in the production line

Operator taking water samples from the plant

Source: Apateq[11]

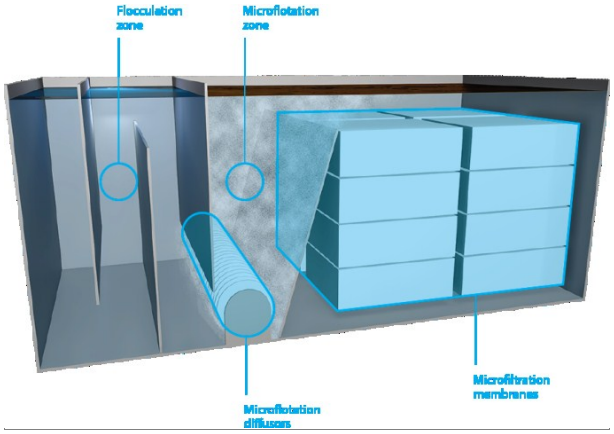
Problem 2 – Seawater represents 98% of the water on Earth. Yet, conventional pretreatment being used in the plants cannot withstand highly polluted waters (e.g. algal blooms). Desalinisation plants have to be shut down many weeks throughout a year. The costs associated with downtime are critical for the economic feasibility of such plants.

Innovative solution 2 – akvolution developed a solution called akvoFloat, which solves the desalinisation issues. The main innovation lies in the integration of flotation and filtration processes into the same tank and in the bubble generation mechanism. Further, the use of ceramic membranes in these two steps is also a new innovation.

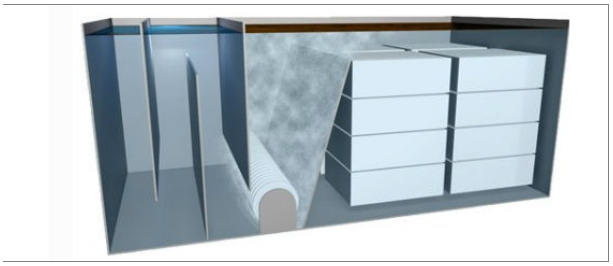
The operating expenses drop due to the low use of chemical, as well as mainly due to the reduced energy need and ease of operation. The energy consumption can be reduced by up to 90%. akvoFloat can be highly automated: it is a one-stop solution for seawater pre-treatment, which is usually done by two or three pieces of equipment. Moreover, 63% of the seawater desalinisation failures are linked to difficulties in the pre-treatment. The akvoFloat remain efficient when faced with high organic loading such as algal blooms.

The firm is supplying clients in the US and Europe but mainly in Middle East. It focuses on smaller scale plants to gain market acceptance for larger projects. Algae are a major issue for all plants. The larger the plant, the more expensive the downtime is.

The akvoFloat™ has a hybrid microflotation and microfiltration technology

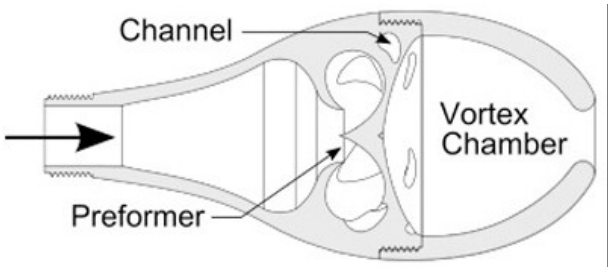


The microflotation process of the akvoFloat™



Source: akvolution[12]

Theoretical drawing of the vortex generator



The generator is produced using 3D manufacturing

Source:Watreco[13]

Problem 3 – There is a need to treat water without the use of chemicals, by using only natural phenomenon.

Innovative solution 3 – Watreco has patented a vortex generator, which has a wide scope of applications. The solutions offered by the generator are based on the transformation induced when a liquid is subjected to a vortex. Gas and particles are attracted by the vortex, which cleans the liquid. Several vortex generators can work together to improve the efficiency.

The benefits are multiple for the end-users. The cleaning done by the vortex allows reducing and even eliminating the use of chemicals. As the vortex removes also the air from the liquid, water flows more easily, reducing the need in energy.

The use of the vortex generator can be applied to diverse sectors. Wastewater treatment is of course one of them, but it has to be considered as only the tip of the iceberg. By influencing the viscosity of water, this technology, has proven its efficiency to create ice of higher quality (for ice rink, food industry or pharmaceuticals), to reduce the needs for water (in cooling towers, watering, irrigation) or to improve the oxygen level in the water (such as in the EU funded Dommelen river project).

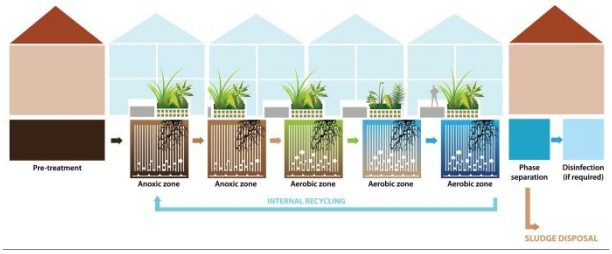
Problem 4 – Plants are known for their cleaning power. However, few solutions leverage on their power, as wastewater treatment plants mainly focus on chemicals.

Innovative solution 4 – Organica Water proposes a Fixed-Bed Biofilm Activated Sludge (FBAS) technology. The FBAS is based on a fixed-film bacterial culture which metabolizes the contaminants to clean wastewater, hence the name Food Chain Reactor (FCR) for the solution. The FCR is a full wastewater treatment solution including solids removal, biological treatment/nutrient removal, phase separation, and final treatment for reuse quality.

The Food Chain Reactor developed by Organica Water offers multiple advantages. The plants grow and thrive in the reactors enhancing the performance of the plant over time. It reduces the operating expenses, as the required maintenance is limited. The energy requirement is also kept at a low level.

The company has a proven track of records in working both with public institutions and private companies. For example, its solution was implemented in the facilities of Foxconn in Shenzen. Indeed, the implementation of this wastewater plant is both limiting the negative impact of the facilities and also improving the surroundings by adding some green between the buildings.

Organica Water's food chain reactor



Foxconn opted for the Organica solution for its facilities in Shenzhen, China

Source: Organica Water[14]

Problem 5 – The cost of ARTTs can be high for private companies, which usually do not own the capital to invest in such solutions. They tend to prefer paying the transport and discharge fees for their sludge.

Innovative solution 5 – Bluetector is tackling this issue with the BlueBox, which combines a patented wastewater treatment and an innovative business model. The patent uses the liquid solid separator to ensure proper removal of solids and faster treatment.

The Swiss company is differentiating from the competition with its business model. It aims to solve the problem of the too heavy initial investment for the customers. Instead of selling the solution, Bluetector proposes a renting approach based on the treated quantity. Indeed, the whole solution can be confined in a container, and is thus easily transportable. The clients install it on their own premises, where the sludge is treated and water reused. Remote monitoring also ensures a control on the outcome results, as the fully automated system is controllable at any time from connected devices (smartphone, tablet, and computer).

Most of the clients of Bluetector can be found in the waste collection sector. The solution is also popular among remote workforce camp. The waste collection companies can reduce the fees applied in most EU countries for discharging waste. In remote workforce camp, water is scarce and even more expensive. Hence, reusing water offers to possibility to reduce the operating expenses of the camp.

Input and output of the reverse treatment in the BlueBox

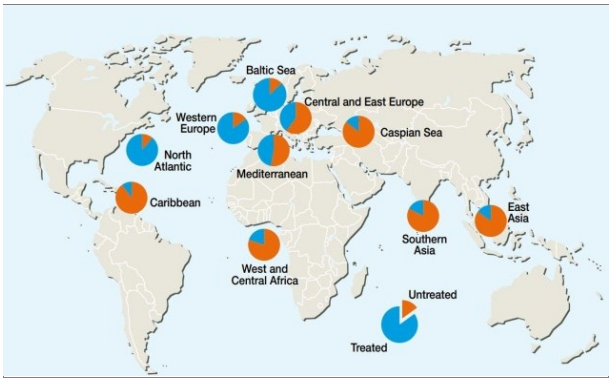
Interior of a BlueBox in a container

Source: Bluetector[15]

3.2. The creation of new markets and jobs

Two geographies exist for ARTTs, namely: mature geographies, like those found in Europe and North America; and high potential geographies, like those found in Africa and Asia (Figure 3 on page 9). ARTTs represent a positive technological step in the wastewater treatment processes of mature markets but present emerging markets with the opportunity to revolutionise their equivalent processes. In 2013, the collection and treatment of wastewater in Europe presented large difference between the leading Member States (Austria, Germany and the Netherlands) and the newer MS. Most of the pollution (91 %) from the EU's big cities is treated. As a result, the Western Europe markets are almost saturated, with a level of equipment. The percentage for North Atlantic and Baltic Sea are similar. Hence, European SMEs are largely targeting the high potential markets, where the need to resolve wastewater issues is more pressing and innovative solutions are better received than in Europe.

Figure 3: Ratio of wastewater treatment



Source: UNEP[16]

3.3. Client perspectives and challenges related to the uptake of the trend

The water industry, and more specifically its wastewater segment, requires heavy investment to set-up a treatment plant. This capital intensity typically slows the uptake of innovation by clients, whether they are private or public firms. The investment in an ARTT plant is often higher than several hundred thousand euro. Such high investments often induce heavy requirements, which SMEs cannot comply with. The decision-making process is hence much complicated than with lower investment.

In addition, larger enterprises are reluctant to test innovative products created by new market entrants. Before any initial investment, they want to minimise the risks by buying a proven technology. As a result, the water industry is extremely conservative and uses techniques that have hardly evolved in the past 50 years.

Another challenge for the uptake lies in the mature markets. The wastewater plants in these markets may be outdated, but many have yet to reach their return on investment. Hence, the decision-makers are reluctant to invest in a new plant, even though the new technologies are more efficient and less energy consuming than the previous one.

4. Drivers and obstacles

The drivers pulling for the success of the ARTTs include: the rise of the public awareness to protect the environment; Europe's talented workforce; and existing supporting initiatives. However, major obstacles are hindering the growth of SMEs active in supplying ARTT products or services. The long-term projects require high working capital and limit the attraction of the sectors to potential investors. Difficulties to access public procurement and to create a reference portfolio are significant to SMEs.

*We have clients waiting, but we need to raise money first" – **Apateq***

4.1. Environmental awareness and regulation

The main driver identified by the showcased companies is the rising awareness of environmental issues, which are encouraging private and public sector entities to minimise their environmental footprint, which entails treating their wastewater before discharging it. On the one hand, a case of pollution can bring disastrous public relation to a company On the other hand, companies can promote their efforts related to the environment, creating a positive image of the brand. Hence, the public awareness puts a pressure on the companies to comply with environmental practice, which drives the sector.

*"We are part of the EU Climate KIC and the Exist program in Germany. Both initiatives are exceptionally good" " – **akvolution***

In addition, policy makers are being encouraged to draft laws that are stricter on environmental issues. For example, major directives such as the Urban Waste Water Treatment Directive or the Water Framework Directive have spurred growth in the reverse treatment industry since their introduction. Moreover, taxation on the wastewater is also widely use among EU Member States. The wastewater taxes are compulsory payments independent of any service received, which are applied to direct dischargers. For example, user charges have been introduced as early as 1970's in France and the Netherlands. Since then, similar schemes were launched in additional countries, such as Germany, Denmark, Italy, Spain or Belgium[17].

Europe's talented workforce has proven to be a pull factor for entrepreneurs. This is particularly true for European engineers who have proven competency in the field of ARTTs. For example, Apateq, which is located in Luxembourg, has a history of attracting highly skilled German engineers which, in turn, supports the firm's reputation.

Still, Europe's strong engineering workforce is not limited to its western Member States. For instance, the CEO of Organica Water, a Bulgarian firm, shared his pride in having assembled a team of ARTT experts. Today, 95% of the firm's revenues are done abroad and the company keeps opening new offices in its biggest market (China, Indonesia, India and the USA). Yet, all the R&D activities are located in Bulgaria and are expected to remain there in the future.

4.2. Supporting initiatives and collaboration

Many of the showcased companies have benefitted from support programmes. For example, akvolution drew on the Climate-Knowledge and Innovation Communities (KICs) to increase its visibility on the market. The Climate-KIC is Europe's largest public-private innovation partnership. It aims at bringing together education, research and business to tackle climate change mitigation and adaptation. Bluetector was supported by the Venture Lab, the national start-up training program. VentureLab is a Swiss national training program for innovative high-tech startups. The support Bluetector benefited from included training, trip and business development program.

Furthermore, the companies from this case study worked closely with universities and research centres. For example, akvolution, as a spin-off from the Technische Universität Berlin, enjoyed the support from the University's incubator. Apateq is working closely with the University of Luxembourg and the CRP (Public Research centre), also in Luxembourg, on simulation topics.

4.3. Long-term projects with high working capital

Access to finance is regularly identified as a major challenge for SMEs to blossom. In the clean technologies, and more particularly in the water treatment, this issue is even worse. Indeed, the specificities of the sector make it capital intensive. Before achieving any revenue, heavy early investment are required especially in R&D and to create a prototype. In many cases, it drains the initial capital just to achieve the proof of concept. Moreover, the return on investment takes generally more time to achieve than other sector. This is why most investors are not attracted by the sector and prefer ICT, where projects are rewarded with quicker and higher return on investment.

On top the industry requires a high working capital requirement. Some of the interviewed SMEs have chosen a business model that is aggravating the issue. For example, the Swiss company Bluetector chose a renting model for its solution. This approach offers many benefits, but it implies that the company brings the initial capital for producing and setting up the plant. Without the support of reliable investors, who understand the particularities of the sector, these companies would bankrupt before having the chance to break-even.

4.4. A conservative industry requires references portfolio

A recurring complaint that was shared by almost all the companies in this case study is the conservativeness of the water industry. According to respondents, the water treatment techniques currently in use have hardly evolved over the past 50 years. This is largely attributed to large public utility companies being highly risk averse to betting on innovative solutions.

As a result, innovative SMEs find it difficult to build a portfolio of references and are limited to smaller, private clients that on-board the risks associated with ARTTs in the hope of achieving commensurate returns, e.g. in the form of energy savings.

Due to the conservativeness of the sector and the heavy cost of a treatment plant, references play a central role in obtaining clients. A proven portfolio of successful projects is often the toughest requirement to secure early sales and is applicable to both private and public procurement, which typically demonstrate a preference for more established technologies.

The showcased companies have made concerted efforts to overcome their lack of references. For example, Watreco benefited from a positive impact when one of their products was used in major hockey leagues in Canada, USA, Sweden, Finland and Russia. This product called Realice is treating water for ice rinks. It removes the dirt and bubbles to lower the viscosity of the water, which saves energy. Similarly, Organica Water started to implement traditional plants to create trustworthy references in wastewater. It is only after the creation of this references portfolio that the company shifted its approach toward FBAS technology.

"We had to hire a full-time employee for the grant" – ***Organica Water***

4.5. Inefficient public procurement

The need for references could be overcome by revisions to public procurement policy. However, the requirements for public procurement are often too tough for SMEs. Most of the SMEs avoid the procurement due to the time spent, the requirement. For example, during the interviews, public procurement was deemed "not worth the effort" or even worse "a waste of time". Organica Water, who has an extended experience in dealing with municipalities around Europe, insisted that e-procurement would ease the troubles. SMEs also complained that the requirement to participate in the tenders are designed for the big companies and influenced by them. It also prevents any innovative products to win it.

4.6. Lack of EU harmonisation

Some criticisms were also aiming at the lack of harmonisation amongst EU regulations. Reverse treatment technologies do not face the same rules and regulations in all the European countries. For example, the laws concerning sludge differ heavily between Germany and the Netherlands. Thus, most of the sludge from the Netherlands is sent to Germany, where the legislation even differs between Länder. Bluetector further explained that they had difficulties in getting their technologies validated, as validation processes are not fully harmonised across different countries.

4.7. EU funding and grants: a problem rather than a solution

The current funding and grants support schemes in Europe have also been criticised for their administrative burden and strategic constraints. In the case of the former, burdensome paperwork means that SMEs can either hire a full-time employee or outsource the task to external consultants. No matter the decision, both choices represent the inefficient allocation of financial and human resources to administration. This additional workload and misallocation of resources does not only relate to applications for funding and support but is also tied to interim and ex-post reporting that must ensure the traceability of financial support.

*"European harmonisation would be a dream" – **Bluetector***

Further to this, most grants received by SMEs are linked to the specific application of a business plan of some sort. Yet showcased companies believed these plans constrain their strategic flexibility and prevent them from adapting to changes in market demand.

5. Policy recommendations

5.1. Enhance the role of utilities

The role of utilities in the ARTTs could be improved. Utilities have the potential to support innovative technologies. However, they are not currently challenged to take risks. A first recommendation would be to implement regulations that present incentives for utilities to pursue energy efficiency, and compensate utilities for the revenues loss from these energy saving targets.

*"In the US, utilities have energy savings objectives, driving them toward our solution" – **Watreco***

For example, the Swedish Watreco shared its experience in North-America, where most of its clients are based. Each state has defined compulsory energy savings targets and requirements for the utilities. The current results show that the states meet their targets, thanks to the involvement of the utilities. Meeting the targets is rewarded and failing to meet can cost penalties to utilities. Hence, they are incentive to take risks. Watreco even had some instances, where a utility (FortisBC) will give incentives/rebates to REALice buyers, as part of a pilot program to show its efficiency. Since then, based on the results of the pilot program, additional utilities in Canada decided to incentivise the products as well. So, the targets act as a driver to achieve significant energy efficiency savings. This is also a very successful practice to make sure innovative products stand a chance.

5.2. Further the push for green regulations

Regulations are considered in the ARTT sector as one of the main driver for the uptake of the trend. Since the introduction of the 1991 Urban Waste Water Directive, Europe has played a leading role in ensuring the proper treatment of wastewater from municipalities and industry. The Urban Waste Water Treatment Regulations in 2001 further reinforced this role.

However, even though they are highly relevant, these regulations are getting old. The reverse treatment technologies implemented at that time cannot compare in terms of efficiency with the ARTT. ARTT are more energy efficient and with improved results. Tightening the standards to lower the energy consumption of treatment facilities, lessen the use of chemicals could be incentives by new regulations.

5.3. Improve public procurement processes

One of the main obstacles for the innovative companies in this case study was to create a portfolio of references. ARTTs, as a conservative industry, put a high focus on reputation. Public procurement should represent an opportunity to obtain theses references. Yet, this is not the case today. The requirements are too tough and limit the SMEs from taking part to it.

Two possible improvements could be done to change the situation. First, a share of public procurement could be specifically dedicated to invest in innovative solutions. By forcing the hand of decisions-makers in a conservative sector, the uptake of innovative solutions would be supported. Along the years, the mentality of the sector will soon evolve, as some pioneering solutions will prove their efficiency. Secondly, the process should be eased by developing the use of e-procurement. Some countries are still lagging on the issue, creating big disparities depending on the country.

5.4. Better focus for grants and support on specific sectors

To improve the efficiency of the grants and support, the idea of focusing on a limited number of sectors was popular among ARTT firms. In the ARTT industry, the companies struggle a lot to find financing. Private entities tend to fear investing in the capital intensive sector, and favour other sectors such as ICT. Hence, projects with high potential are overlooked and disappear without having a chance to prove their value.

Public sector could play a key role in filling these gaps left by the private sector. By defining sectors with high growth potential and low private investment, the public sector could provide more support to struggling entrepreneurs. It would ensure an improved coverage for financing opportunities. Additional criteria to select the sectors could include the number of jobs created, the potential added-value or their capabilities to answer societal challenges such as sustainability.

6. Appendix

6.1. Interviews

Company	Interviewee	Position
Apateq	Bogdan Serban	CEO
akvolution	Matan Beery	CEO
Watreco	Hakan Grölund	Head of International Business
Organica Water	Ari Raivetz Rachel Segal	CEO Global Marketing Manager
Bluetector	David Din	CEO

6.2. Websites

Apateq	http://www.apateq.com
akvolution	http://www.akvolution.de
Watreco	http://www.watreco.com
Organica Water	http://www.organicawater.com
Bluetector	http://www.bluetector.com

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