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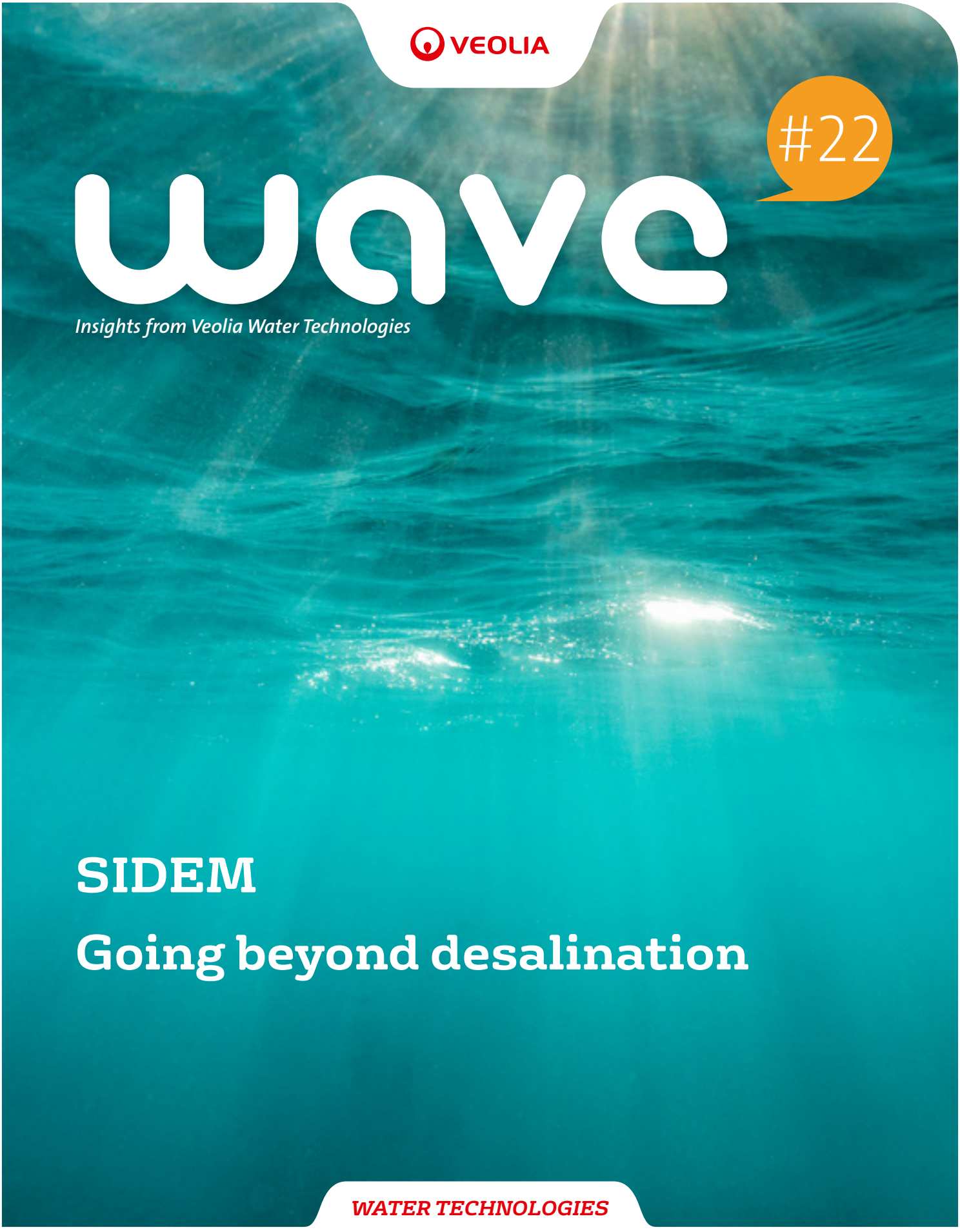
*Insights from Veolia Water Technologies*



# SIDEM

# Going beyond desalination

***WATER TECHNOLOGIES***

**SCARCITY**

Tackling water challenges down under

**INNOVATION**

The Barrel™: from desalination to reuse

**DIGITAL**

Machine learning optimizes maintenance of membranes

**TECHNOLOGY**

Pretreatment improves performance and lowers costs




***WATER TECHNOLOGIES***

# *Sustainable desalination*

In a world facing changing climate and tightening environmental challenges, we need to act now. For SIDEM, acting for ecological transformation means fighting water scarcity by reducing the environmental footprint of our desalination solutions.

From detailed process parameters to materials selection and technology implementation, we leverage our strong know-how and long experience to design and procure for our customers, reliable, cost-effective and energy-efficient desalination plants.

Our latest developments and innovations contribute to meeting such performance and sustainability goals.

**www.sidem-desalination.com**

Resourcing the world

SIDEM VEOLIA

# INSIGHTS

***We are determined to turn the tide***

*Over the past nine months, SIDEM has completed the delivery of three major desalination projects with a combined daily water production capacity of more than 1,500,000 cubic meters.*

*This great achievement is the result of the efforts and endeavors of all of SIDEM's Resourcers. They have shown talent and commitment, solidarity and responsibility to overcome all the challenges they've had to face during this intensive journey.*

*This success also demonstrates SIDEM's determination to turn the tide. Meeting the expectations of the desalination market has meant dividing* ***CAPEX nearly by two and reducing power consumption by 25 percent.*** *And we made it happen.*

***We are optimistic thanks to the Barrel™***

*In the meantime, the roll-out of the Barrel has revealed the huge potential of this safe, compact and simple technology. Not only can it address water needs in traditional desalination applications but it is also proving to be a great solution for the mining and oil and gas markets, as well as for water reuse in the municipal market.*

*SIDEM has a strong team of experts fully dedicated to the Barrel activity and is well connected with sister companies within Veolia Water Technologies, allowing us to deliver and provide local services all around the world.*

***We are moving forward together***

*In line with Veolia's multifaceted performance objectives, our mission is to overcome water scarcity by delivering sustainable desalination technologies. Lowering power and chemical consumption, reducing the amount of construction material required (concrete, metals, plastics, etc.), and limiting effluents are the key levers in reducing the carbon footprint and environmental impact of our technologies. And we need to continue working on this.*

*To move forward, we need also to look beyond desalination, as we discovered with the Barrel. By harnessing the wealth of process expertise and technological know-how that exists throughout Veolia Water Technologies, we will be able to develop sustainable reuse solutions to overcome water scarcity on a large scale.*

*We are fully aligned with Veolia's purpose, which is to contribute to human progress by firmly committing to the Sustainable Development Goals set by the UN to achieve a better and more sustainable future for all. Strongly positioned on the desalination market and reinforced by our innovation mindset, we are committed to focusing all of our capabilities on acting for ecological transformation. We hope you will join us on this journey.*

***Adrien de Saint Germain***

*Chief Executive Officer*

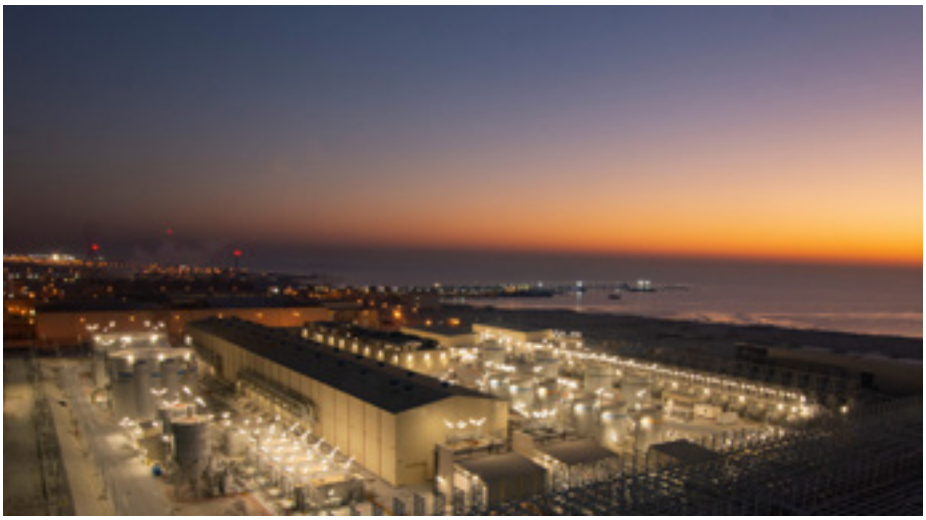
*SIDEM*

# CONTENTS









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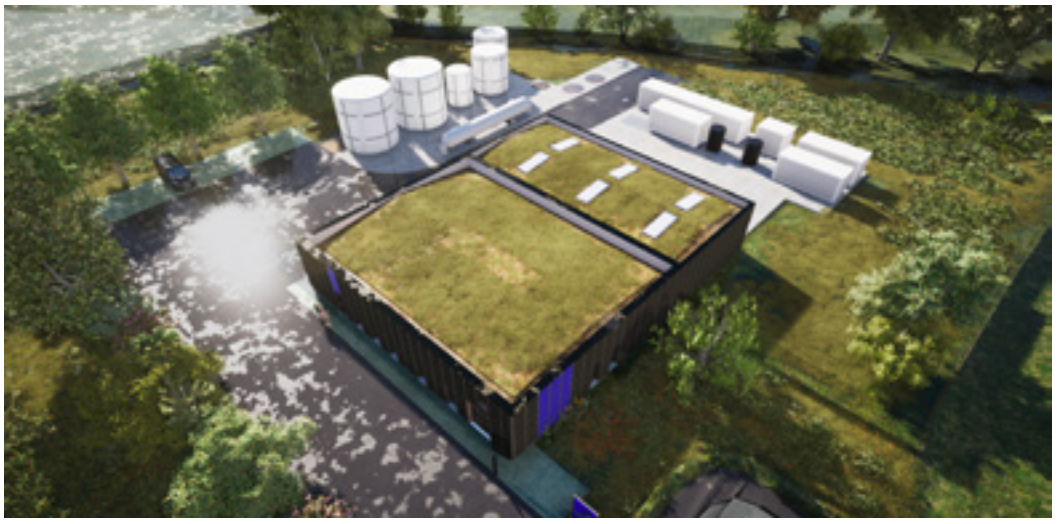


28

# Going beyond desalination

***Desalination technology is more than a means to take salt from seawater. It has the power to solve many of our water resource issues, from securing residential drinking supplies to helping to ensure business resilience as the demand for water sharply rises. With recent innovations greatly improving its energy consumption and environmental footprint, desalination plays a key role in providing access to the resource in water scarce regions. But it remains a complex and costly process which must go hand in hand with water reuse to ensure that we do everything to preserve and valorize the water resource.***

By 2040, it is estimated one in four children worldwide will be living in areas of extremely high water stress; however, water scarcity already has far-reaching consequences today. From Qatar and Saudi Arabia to Spain and Australia, large parts of the world are already feeling the impacts of climate change on their water resources. And this strain will intensify further owing to continued urbanization and surging population growth in many of these areas.

***After treatment desalted seawater becomes too valuable to dispose of.***

Unsurprisingly the desalination market is projected to grow 7.1 percent between 2020 to 2028 largely because it is an effective way of tackling water scarcity issues in arid coastal areas and secondly by facilitating water reuse. The high potential of this solution in coastal regions is supported by the fact that approximately 40 percent of the world's population lives within 100 km of the sea and 25 percent within 25 km of the coast. For those inland, desalination is also viable since it can provide drinking water in areas where natural resources are subject to salinization effects, such as rivers, estuaries, inland or underground brackish water, making it a very versatile solution.

After treatment desalted seawater becomes too valuable to dispose of and the same desalination technology can facilitate its reuse. By removing dissolved solids and unwanted minerals from wastewater the same reverse osmosis-based technology means the water can be recycled several

times, reducing the environmental impact of extracting fresh water. A great example of this is the Jourdain program in France as the region has faced increasing water shortages during hotter months, adding additional strain on tourism, wider industry and residents alikewhere. Here the Barrel™, a technology initially developed for desalination, is proving to be a key component in the first initiative to reuse treated wastewater for indirect drinking water production in Europe — read more about this on page 26.

In fact, reuse has such a huge potential in addressing global water scarcity, it is cited as an official means of achieving Sustainable Development Goal six which focuses on ensuring the availability and sustainable management of water and sanitation for all. As a result, reuse is becoming a legal requirement in many countries.

Helping to bridge the gap between water demand and water availability, SIDEM — a Veolia Water Technologies subsidiary — is a desalination specialist that provides expert services in design, engineering, procurement, construction, commissioning, operation and maintenance.

Headquartered in Paris and celebrating its 50th year in operation, it is the oldest desalination company in the world. It has regional offices in Abu Dhabi, Saudi Arabia and India providing local commercial, engineering and field activity support, while simultaneously having access to the full Veolia Group network spanning five continents.

The foundation of SIDEM's success and longevity in this highly competitive and technologically challenging market rests on its agility and capacity to continuously deliver mega projects. For example, in Bahrain on the Al Dur site, the team recently completed a 227,000 cubic meters per day seawater reverse osmosis (SWRO) plant helping to secure drinking water for more than one million residents. Underpinned by innovative best practices, the site does so sustainably via two patented technologies that ensure overall efficiency to lower energy consumption — read more about this on page 12.

Likewise in Saudi Arabia, for the city of Rabigh, SIDEM is providing a new and reliable source of potable water for the region's growing population and expanding industry. Crowned as the "World's largest reverse osmosis desalination facility" by the Guinness World Records you can read more about this 600,000 cubic meters per day capacity site that serves two million people on page 14.

And then there is Umm Al Quwain in the United Arab Emirates. This project, in partnership with China Gezhouba Group Co., is contributing significantly to addressing water scarcity issues in the Northern Emirates which are regarded as extreme. The 682,000 cubic meters per day desalination plant is helping the country end its reliance on groundwater as part of its plans to conserve resources — read more about this on page 18.

While desalination cannot solve the global water crisis alone — the importance of sustainable water management and water strategies to secure alternative water resources remain unmatched — SIDEM and its technologies continue to be a power player in helping to bridge the water gap the world is facing.

This is why innovation is key and why SIDEM experts are focused on bringing its latest technology, the Barrel, to new arenas since its membrane filtration — capable of removing salt, impurities and other unwanted minerals from water — is well suited to reuse and even micropollutant removal. And so, this is where innovation and desalination come into play. ●

***SIDEM and its technologies continue to be a power player in helping to bridge the water gap the world is facing.***

# The Barrel™: from desalination to reuse

*When SIDEM first introduced the Barrel™ in 2019, it was a major innovation for seawater desalination. It soon became obvious, however, that the technology also perfectly addressed the challenges posed by water reuse.*

In becoming the benchmark company for ecological transformation, Veolia is committed to accelerating and expanding the deployment of existing solutions, while simultaneously creating the solutions of tomorrow. The Barrel is a perfect example of this mindset.

The Barrel is a multi reverse osmosis (RO) element vessel that is designed to be a plug-and-play system. The carbon steel pressure vessel is manufactured and tested off-site,


and is delivered as a single unit so installation on-site can be fast-tracked and project schedules shortened. In addition, the modular design of the Barrel makes it highly scalable, offering varying capacities from 400 to 50,000 cubic meters a day per unit. It can also be used in place of existing RO membranes and nanofiltration skids for a more economically viable, sustainable and innovative alternative.

Compact and suitable for outdoor installations, the Barrel offers a footprint reduction of up to 25 percent and does not require a controlled environment. The sustainable solution also provides a reduction in electrical consumption in the range of 0.05 kilowatt-hour per cubic meter of fresh water produced.

Beyond sustainability, the unique design of the Barrel also significantly reduces the number of high-pressure piping connections down to just two — the raw water inlet and the brine outlet. This design feature makes it safer for operators and minimizes risks on-site during the maintenance and operation phases. Corrosion is less likely to occur as seawater leakage sources found on the multiple high-pressure connections of traditional RO skids are reduced.

The Barrel also has a built-in digitalization system with smart connectors providing real-time status updates on each membrane's condition. In fact, their performance can be monitored automatically and accessed remotely — helping operators to make better decisions, whether to shut down, rotate, clean or replace membranes.


## To preserve water resources, the key is to reduce consumption and above all reuse water

With increasing demand for fresh water and rising concerns over water scarcity all around the world, the Barrel meets the challenges and expectations of the desalination market while producing fresh water complying with all water quality standards. It is also suitable for wastewater reuse and low pressure RO applications. The Barrel will empower users with an economically viable and sustainable source of fresh water.

The Barrel was selected as a key technology for the first experiment in Europe in wastewater treatment for the supply of drinking water through the Jourdain Program, in France's Vendee region— see article on page 26. Sydney Water Corporation also chose the Barrel for its water recycling demonstration plant which aims to promote the effectiveness of recycling wastewater for potable use. The technology has also been in use at the Oman Sur desalination plant since 2019.

## Smart Connectors: the must-have feature for water reuse projects

In order to have a permanent vision of the permeate quality production as well as the condition of each membrane, smart connectors are installed within the permeate tube, next to standard interconnectors, while loading the membranes.

These passive devices communicate with antennas molded in the resin structure and provide the monitoring system with local conductivity and temperature of the produced permeate, creating a full mapping of the Barrel's permeate network.

Thanks to these revolutionary devices, the performance of each membrane is monitored and recommendations regarding optimum operation modes can be made, bringing value to clients over the complete lifetime of their plant.

The smart connector is a stand-alone product. It transforms the Barrel from a simple mechanical arrangement of membranes into a digital process device providing transparency, efficiency and security on the performance of each membrane element.

# A tale of two plants: seawater desalination combating water scarcity

Located on the southeast coast of the Kingdom of Bahrain, Al Dur 1 is an independent water and power project — producing 1,234 megawatts (MW) of electricity and 218 000 cubic meters of desalinated water per day — which began commercial operations in February 2012.

Following the success of Al Dur 1, and to help combat the ongoing water stress in the region, a second adjacent project, Al Dur 2, was awarded in 2019. Its mission was to generate an additional 1,500 MW of power and produce 227 000 cubic meters of water utilizing state-of-the-art seawater reverse osmosis (SWRO) technology.

Two years later, the Al Dur 2 SWRO sister plant has been designed and built by SIDEM — a Veolia Water Technologies subsidiary. It consists of two independent production streams that ensure more than one million residents have access to safe, low-risk, potable water necessary for their development and well-being.

Responsible for the assignment, Project Director Jean-Baptiste Schmitt shares with us what makes the plant unique, reveals key milestones and team achievements, and discusses how seawater desalination is an effective means of combating water scarcity in arid coastal regions.

## What makes Al Dur 2 so unique?

*"It's the way the site was designed, built, and is now optimized that makes it incredibly efficient. It has been carefully mapped out from A to Z to help reduce its carbon footprint by combining cutting-edge technologies and ongoing in-house expertise.*

*For example, in pretreatment — where we filter the water extracted from the sea — we've used two patented technologies, our dissolved air flotation (DAF) filter and dual media pressure filters (DMPF) with integrated cartridge filters, to guarantee the removal of high turbidity and suspended solid particles. This holds primary importance since it facilitates smoother operations and supports the overall efficiency of the plant.*

*Another example is when the water enters the heart of the desalination plant: the reverse osmosis system. Here the water is pushed under high pressure through a membrane that retains up to 95 percent of the salt particles and 99 percent of all other impurities. Our in-house experts ensure this high-pressure pump, which is where most energy is consumed, is optimized to significantly improve plant efficiencies and lower energy consumption."*

## What were the main challenges associated with managing such a large-scale project and how did you overcome them?

*"At peak capacity, there were 1,200 people working on site. The large multi-cultural team was required to achieve the completion of the first half of the plant (113,500 cubic meters a day) and put it online after only 22 months. This required precise organization, the knowledge and experience of everyone on the team, and a unified goal of meeting our targets.*

*We set up higher safety objectives than the ones required by our client and achieved 5.2 million working hours without incident with our 'Always-safe' mindset. Considering most of the work took place during the height of the COVID-19 pandemic, safely completing such a huge project in record time is, in my opinion, our greatest achievement."*

***Jean-Baptiste Schmitt***

## The production of desalinated seawater in the Middle East is projected to increase almost fourteen-fold by 2040. What are the major trends shaping this growth?

*"Water consumption in Bahrain has been on the rise for the past ten years and is forecast to continue owing to steady population growth and the impacts of climate change on their natural resources. The country is looking at not only increasing its capacity but doing so sustainably. There is a huge focus on innovation to make vital processes like seawater desalination less energy intensive and we're seeing a greater focus on renewing existing assets and upgrading to smarter, more efficient systems."*

## How important a role does sustainable development play in shaping this growth? And how is Al Dur 2 environmentally related?

*"Today everyone understands that our everyday resources are neither free nor infinite, and the carbon footprint of energy and water production has to be drastically reduced. The government of Bahrain has recognized this and has taken a number of critical steps to shift the country towards more efficient energy consumption and water production as part of its 2030 vision so sustainable development is undoubtedly a major trend.*

*Seawater desalination is an effective way of securing water in arid coastal areas and for countries like Bahrain, which is listed among the top ten countries likely to suffer from a water crisis in the next 25 years, desalination plants are vital. The good news is if we compare the technologies used traditionally in seawater desalination plants 10 years ago to the technologies of today, we are already saving 300,000 tonnes of carbon dioxide ($CO_2$) equivalent annually — equal to flying around the earth 32 times.*

*In that respect, the Al Dur sister sites represent the first in a series of desalination plants that will continue to help Bahrain meet its power and water needs in a more sustainable way, in line with the country's carbon footprint reduction policies."* ●

# Using machine learning to optimize the maintenance of RO membranes

***Anticipating when to clean or change reverse osmosis membranes in desalination plants is complex. Using machine learning techniques, Veolia Water Technologies has developed a solution to optimize the timing of the maintenance. Historical time series data were fed into an algorithm to learn from previous patterns and predict the future evolution of fouling indicators such as differential pressure or conductivity of the water, allowing the operating team to efficiently monitor the state of the system and anticipate possible deviations.***

Membrane filtration is the most advanced technical process for desalinating seawater, purifying fresh water for drinking water and for industrial processes. These membranes, when combined with design and operating expertise, are reliable, efficient and durable. They are vital when it comes to removing salt, micropollutants or any other undesirable dissolved material. But like any technology or component in contact with water, reverse osmosis (RO) membranes used in desalination plants age over time. To slow this aging as much as possible, membranes must be carefully monitored, rigorously maintained and appropriately cleaned.

It is well known that RO systems can be very sensitive to changes in the operating environment, making it difficult for the operator to identify and anticipate the real state of fouling and aging of the membranes. For example, an increase in temperature decreases the rejection of salts, just as fouling does. Similarly, an increase in conductivity of the feed water leads to an increase in the pressure necessary to operate the system, but feed pressure is also used by the operating team to assess when the next cleaning is necessary.

In order to fully assess the state of membranes, it is important to rapidly and accurately normalize the raw data to eliminate the influence of external parameters and to diagnose and deal with problems before they become irreversible. The common practice is to normalize the data using ASTM-based methods based on correction factors mainly applied to correct the temperature, salinity and flow effect on the membrane but this method has limitations, both in terms of quality and practicality. To overcome these challenges, a data-driven modeling approach can take

***To slow aging, membranes must be carefully monitored, rigorously maintained and appropriately cleaned.***

advantage of large datasets generated from modern monitoring systems with sophisticated statistical inference analysis.

## Digitalizing membranes in Oman

The Sur desalination plant is located in the Sultanate of Oman's eastern region of Sharqiyah. The plant helps fight the depletion of the region's limited groundwater resources by producing over 130,000 cubic meters a day of potable water, supplying more than 600,000 inhabitants across the Sharqiyah region. The plant is operated by Bahwan Veolia, who sought a data-driven decision tool to help maintain the quality and continuity of water production as well as predict when the membranes needed to be replaced or cleaned before they failed or fouled. Doing so would also reduce the downtime and prevent excessive energy and chemical consumptions.

Aditya Akella, Operations Manager at the Sur desalination plant, explained: *"An emergency shutdown cannot always be avoided. But having the ability to better plan the short-term preventative maintenance as well as long-term curative maintenance provides the operator with the ability to optimize water storage capacity to limit the negative impact of unavoidable shutdowns."*

Veolia Water Technologies, who designed and built the Oman Sur plant, collaborated with other Veolia entities to see how data could be harnessed and developed into practical artificial intelligence. Data generated by the sensors on the plant are collected, stored and processed through a cloud-based architecture in order to generate the normalized data and the predictions. From the pre-processed data, operating parameters that are essential for an efficient monitoring of the membranes' state are calculated and stored in the database to be used by the machine learning models for training and inference. Data normalization then makes it possible to remove the influence of certain external parameters in order to visualize only the influence of the membrane fouling on a given operational parameter.

The approach was first tested on a set of historical data from the Oman Sur desalination plant. The aim of this cold data study was to validate the chosen model and select the training period to use for the algorithm. The whole cloud-based architecture was then deployed and tested with real-time data coming from the plant by the Oman Sur operating team.

Marie Gaveriaux, Digital Product Owner at Veolia Water Technologies explained: *"Leveraging on this first approach, we developed and trained during the prototype a complete end-to-end solution for short and long term time series forecast which solved the predictive analytics of membrane aging and fouling and settled the foundations for further prescriptive analytics."*

To predict when is the best time to clean the membranes, the evolution of key operational parameters is predicted for the coming week. The normalized data is used and fed into the short-term algorithm to predict the evolution of the key operational parameter. The long-term algorithm then predicts the aging trend of the RO membranes for the next three months and recommends the date of the next membrane replacement, if needed.

With this information, the maintenance team can optimize the long-term maintenance strategy of the plant.

In order to accurately predict a membrane replacement within any of the trains, several fouling indicators are generated from raw historical data previously collected within the plant. They are curated, enhanced and used as features within the forecasting engine. By accessing real-time normalized data instead of manually extracting and normalizing them once a month, the Oman Sur operating team has been able to better assess the real state of fouling of the membrane. *"As an example, this normalization approach allowed the detection of a gradual degradation of the produced water quality from September, whereas in the raw data this trend was hidden due to a decrease in water temperature,"* added Gaveriaux.

This normalization approach can be applied to any operational parameter that is relevant to the efficient monitoring of the membranes' state. The chosen operational parameters are displayed in real time through the web-based interface to the operating team, and the short-term algorithm can be used to predict the fouling indicators for a week. *"By following the recommendations made by the tool, the Oman Sur team was able to identify the need to perform a partial membrane replacement on the plant, which considerably helped improve its performance,"* concluded Gaveriaux.

## Hubgrade Performance Smart Membranes module

These advanced analytics and machine learning algorithms are integrated into the Smart Membranes module of Hubgrade Performance, which has been in operation at the Oman Sur plant since September 2020. Since then, Hubgrade has provided operators with a holistic visibility of the operations and processes, empowering evidence-based decision making when planning for membrane cleaning or replacement. Benefits have included predictive maintenance which has helped improve maintenance planning and decision making, and access to key normalized fouling indicators to monitor the effectiveness of CIP and production cycles.

Hubgrade allows the Oman Sur team to save valuable time by preventing lengthy manual data extraction. As Maintenance Manager Grégoire Bourguignon summarizes: *"Thanks to Hubgrade, it's possible to identify any membrane issues sooner and be more proactive in planning the corresponding corrective action. Normalizing operational data can now be completed in two-clicks instead of 12 hours of data management and analysis."*

Advanced analytics and artificial intelligence treatments on top of Veolia Water Technologies' process expertise propelled the Oman Sur desalination plant into the future. Hubgrade has created a significant edge in the value that is delivered to customers, particularly in helping them better operate their water plants and reduce the risk of their business. ●

***Hubgrade provides operators with a holistic visibility of the operations and processes, empowering evidence-based decision making.***

# Major desalination references

**Basrah** *(Iraq)*
**199,000** *$m^3$/day (RO)*

**Sur** *(Oman)*
**131,800** *$m^3$/day (RO)*

**Fujairah 2** *(UAE)*
**136,000** *$m^3$/day (RO)*
**454,000** *$m^3$/day (MED)*

**Rabig 3** *(Saudi Arabia)*
**600,000** *$m^3$/day (RO)*

**Umm Al Quwain** *(UAE)*
**682,000** *$m^3$/day (RO)*

**Sadara** *(Saudi Arabia)*
**178,800** *$m^3$/day (RO)*

**Marafiq** *(Saudi Arabia)*
**809,109** *$m^3$/day (MED)*

**Ras Laffan C** *(Qatar)*
**295,490** *m³/day (MED)*

**Az Zour North** *(Kuwait)*
**490,970** *m³/day (MED)*

**Sydney** *(Australia)*
**250,000** *m³/day (RO)*

**Al Dur 2** *(Bahrain)*
**227,000** *m³/day (RO)*

**Gold Coast** *(Australia)*
**133,000** *m³/day (RO)*

# Commissioning the largest desalination plant in the Northern Emirates

***In 2019, the United Arab Emirates (UAE) was named as one of more than a dozen countries facing extreme pressure on its resources with groundwater reserves depleted through overuse. With water resources becoming increasingly scarce, the country is cutting its water consumption, building more efficient desalination plants and ending reliance on groundwater as part of its plans to conserve resources. The Umm Al Quwain independent water project (IWP), started up in 2022, will contribute significantly to addressing water requirements in the UAE's Northern Emirates.***

Located on the Arabian Peninsula, the UAE is famous for its luxurious resorts and attractions, creating the assumption that water scarcity is not a problem for these rich states. In reality, however, the country is confronted with a serious depletion of its available water resources and relies on desalination to supply water for drinking and industrial purposes.

The Umm Al Quwain IWP is one of the largest desalination projects in the UAE. Located at a coastal site in the Emirate of Umm Al Quwain along the border with the Emirate of Ras Al Khaimah, the project is part of the UAE's effort to optimize water production and meet the increasing demand for water in the country. As part of a consortium, SIDEM — a Veolia Water Technologies subsidiary — took charge of engineering and procurement for the 682,000 cubic meters a day reverse osmosis plant while Chinese partner Gezhouba Group International Engineering undertook construction. The plant started commercial production in August 2022. ●


## A Resourcer's journey

At Veolia, wherever we work, whatever our role, our mission is to resource the world. We are a community of over 220,000 Resourcers determined to deliver solutions that make a positive impact.

Fabien Vergnolle is a process commissioning engineer at SIDEM and was part of the team in charge of carrying out the Umm Al Quwain IWP project. Engineering and procuring the largest desalination project in the Northern Emirates was no small feat, especially during a global pandemic.

He shares with us his journey as a Resourcer.

**What were your main responsibilities as a process commissioning engineer?**
*My main task was to work on the design details of the Umm Al Quwain plant, and I was lucky enough to join the team onsite to help commission the plant.*

**What do you like most about your work?**
*What I like most about working for Veolia Water Technologies is working on very concrete and high-impact issues, both societal and environmental.*

**What is the most important skill to succeed in your work?**
*Among the key skills needed to be a good process commissioning engineer are, of course, technical skills. We are dealing with very technological subjects. But I would add listening to our customers, and making sure to understand their needs and the purpose of the projects we carry out.*

**Veolia's mission is Resourcing the World. What does that mean to you?**
*For me, resourcing the world means transforming what used to be considered as waste, or rubbish, or things with no added value, giving them back the status of a resource, and being able to reuse them in an economic circuit.*

# Innovative pretreatment improves RO performance and lowers costs

***Providing new sources of potable water for Saudi Arabia's growing population and expanding industry has been a key preoccupation of the desert country for many years. The Kingdom has relied on desalinated water since the 1950s and is now the largest producer of desalinated water in the world with 60 percent of its water coming from desalination in 2019.***

Turning seawater into drinking water was once seen as an expensive last resort for rich countries. After years of significant investment in technological development to make the process more efficient, costs have fallen and the price of desalinated water is lower than ever, making it a potential option for more arid countries to address water shortages.

Located in the Kingdom of Saudi Arabia on the coast of the Red Sea, the Rabigh 3 independent water plant (IWP) has been recognized as the "World's largest reverse osmosis desalination facility" by the Guinness World Records although it has since been surpassed. With a production capacity of 600,000 cubic meters per day, the plant supplies potable water to around two million inhabitants of the Jeddah and Mecca areas, procuring water availability and reliability even during high demand periods such as the Holy Month of Ramadan and Hajj seasons.

Veolia Water Technologies subsidiary SIDEM was in charge of engineering and procurement for the pre- and post-treatment facilities, supplying advanced technologies for these two key steps of the desalination process. No less than 44 giant filters were designed, delivered and installed, playing a crucial role in optimizing the treatment steps necessary to produce drinking water from seawater and improving the durability and the performance of the reverse osmosis membranes.

The innovative design supplied by SIDEM contributes to Rabigh 3 benefiting from the highest level of plant availability and one of the lowest power consumption during day-to-day operations of any reverse osmosis desalination plant.

## A compact pretreatment solution for SWRO plants

**Efficient pretreatment ahead of membrane filtration is key to minimize fouling, scaling and overall degradation of the membranes, increasing their efficiency and life expectancy.**

The M&C filter consists of an innovative combination of dual media pressure filter (DMPF) and cartridge filters (CF) which reduces the footprint required for pretreatment.

This unique two-in-one pretreatment solution allows removal of high turbidity and suspended solid particles from the feedwater. Reverse osmosis membranes are therefore protected and the risk of biofouling is highly reduced.

- **CAPEX savings** thanks to reduced piping, civil and installation costs.
- **OPEX savings** generated by high water recovery and low chemical requirements, CF replacement rate and energy consumption.
- **Robustness** to deal with any water quality and low sensitivity to variations in parameters.
- **High removal efficiency** of suspended solids, turbidity and SDI 15.
- **Reduced footprint** with CF installed directly in the DMPF vessel for treatment plants of medium sizes.
- **Full planning control** through concerted design and procurement on metallic manufacturing.
- **Easy access for maintenance** and replacement of CF.

SIDEM has also capitalized on its long-established expertise in the manufacturing of large evaporators to develop giant DMPF. These filters are essential to ensure that the membranes installed within huge desalination plants such as Rabigh 3 can function properly over time.

# Reuse

*Water is too precious to be used only once*

# State of play

***It is 2022 and it is clear that the world is not on track to meet Sustainable Development Goal six: securing sustainable water and sanitation for all by 2030. With little more than seven years to go, a global water crisis is looming meaning business-as-usual is no longer viable.***

Never before has humanity's future been so closely entwined with environmental concerns — a critical one being our limited water resources. At the same time, even though water play a key role in issues such as food security, energy production, economic development and poverty reduction, the word "water" rarely appears in international climate agreements.

We must change this as the 2020 World Water Development Report on water and climate change shows how water, its use and its management, play a large part in both limiting the impact of climate change and achieving goal six.

And here is why. From biomass production as a source of renewable energy to recycling water to reduce water stress and droughts, better water management can support efforts to both mitigate and adapt to climate change while providing access to water for those in need.

The proven potential of water must be utilized because, as well as causing humanitarian crises, the growing scarcity of water — due to rising water demands and a changing climate — presents a major risk to industry, since water is an essential ingredient to many industrial processes.

The World Bank predicts that global GDP growth rates will fall six percent by the middle of the century as a result of increased competition for water. This would result in costs of $2.5 billion for companies at the mercy of increased water scarcity and associated business continuity risks.

As a result, the reuse of treated wastewater and the view that it is not to be thrown away is becoming a way of the future. From industries to fields to taps, wastewater is being recycled and reused more and more. For example, why take water from the natural environment to irrigate a field or cool

***Better water management can support efforts to both mitigate and adapt to climate change while providing access to water for those in need.***

# Reuse

*Water is too precious to be used only once*

industrial facilities when treated wastewater is available nearby? In the case of agriculture — which, according to the Organisation for Economic Co-operation and Development (OECD) accounts for 70 percent of the world's freshwater consumption — certain elements found in wastewater such as phosphorus and nitrogen can be widely used as fertilizers.

*The techniques that enable wide water reuse are ready and waiting.*

Additionally, in industries as varied as microelectronics, pulp and paper, power, and food and beverage, the amount of water consumed during manufacturing processes represents a significant expense. With what are now considered standard solutions we can recycle and reuse water into high-quality process water, reducing costs and preserving water resources for municipal populations. In some regions of the world affected by water stress, investing in this type of solution has even become a prerequisite for manufacturers.

One thing for certain is that the techniques that enable wide water reuse are ready and waiting. Today, we can produce drinking water from a wastewater treatment plant and we have all the tools to control and monitor its quality to protect human health. We can even make ultrapure water for microelectronics or pharmaceuticals, with only $H_20$ molecules.

For municipalities, it is also a matter of acceptance by local populations as they see their water resources being drained. With the emergence of more water stress zones, some municipalities are concerned about the resilience of their infrastructure and water supply and realize that they have a resource in wastewater that is currently under-exploited. This holds especially true in regions where desalinated water is relied upon as the main source of potable water.

With the rapid increase in the world's population and the acceleration of urbanization and climate change, the depletion of "blue gold" is now a global issue. The United Nations' Sustainable Development Goal six recognizes the importance of solving water-related issues in continued sustainable development and the vital role that improved drinking water, sanitation and hygiene play in bringing progress in other areas such as unlocking economic growth and productivity.

This situation has placed us at a pivotal point where, if we make the correct decisions, we can fight climate change while better safeguarding our water resources, in turn preventing disruption to our water-dependent industrial operations and even our way of life. Or not. ●

# Water reuse secures drinking water supplies in France

***Known for its long coastline and sandy beaches, Vendée is now putting surface water augmentation on the map too. A first for France and Europe, the Jourdain Program will reuse treated wastewater for indirect drinking water production.***

Located on the western coast of France, Vendée is one of France's most popular holiday destinations owing to its beautiful coastline, historic towns and picturesque villages nestled in idyllic countryside. However, for over 20 years, the region has faced increasing water shortages during hotter months, adding additional strain on tourism, wider industry and residents alike.

For the past 20 years, Vendée has been confronted with severe water droughts. In fact, several conventional investments had been already instated by Vendée Eau — the non-profit public body in charge of water supply — including a very effective water-saving program. Nevertheless, the region was still struggling to make the 50 million cubic meters of drinking water produced per year meet its needs as demand continues to rise.

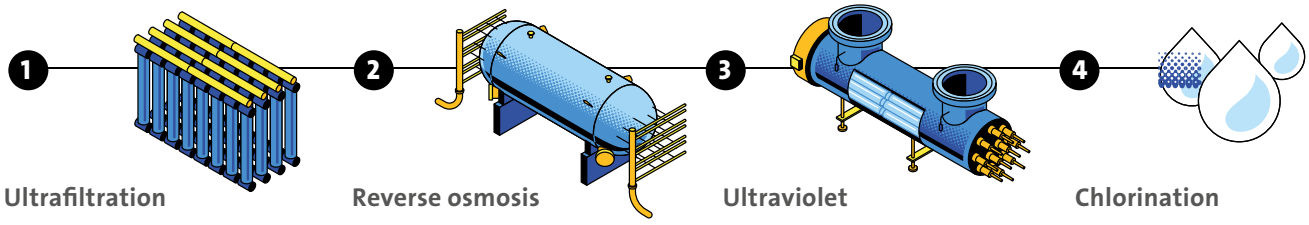
Additionally, the authorities knew they also needed to counteract the impacts of climate change since the water supply of Vendée was highly dependent on surface water which is more at risk of increased evaporation and convection. Indeed, as a direct result of climate change, projections showed this put an additional 100,000 inhabitants at risk of drinking water shortages during very dry years.

And so, Vendée Eau needed to act... and this is exactly what they did.

Taking inspiration from neighboring countries Belgium, Spain and Germany who were reusing water for aquifer recharge, Vendée Eau wanted to take this a step further and started investigating indirect potable reuse (IPR) for surface water augmentation.

# Reuse

## *Water is too precious to be used only once*




*"Considering the large volume of treated wastewater available but then discharged directly in the ocean from a nearby non-coastal touristic zone, indirect potable reuse was deemed very interesting to explore,"* explains Jérôme Bortoli, Head of Vendée Eau.

The intended reuse scheme in Vendée aims to partly refill the Jaunay reservoir with reclaimed water from the wastewater treatment plant of Les Sables d'Olonne, located 20 km away. *"This solution could provide an additional volume of up to two million cubic meters of drinking water; this is half of the storage capacity of the Jaunay reservoir,"* explains Bortoli.

The main challenge Vendée Eau faced was that while other countries in Europe have used reclaimed water for aquifer recharge, there is no such reference in France and currently no regulatory framework for surface water augmentation nor for IPR.

Bortoli continues: *"The practice of indirect potable reuse is not yet covered by the current French — or European — regulation that only authorizes uses for irrigation purposes. This means Jourdain will be the first of its kind in Europe for surface water augmentation and, as such, is carried out by the collective as an open demonstrator for experimentation."*

***Jérôme Bortoli***

The Jourdain Program is made up of several infrastructures including a tertiary treatment unit, a 25 km recycled water pipeline, engineered landscaped and wetland area, and Vendée Eau has set up a regional governance system.

*"The objective is to build the installations and then to acutely monitor the system in operation for three to five years, before deciding whether or not to go for the full-scale program,"* adds Bortoli.

The Jourdain Program now has to demonstrate and guarantee that IPR will lead to limited impacts and be compliant with all water use: recreational activities and drinking water production.

Furthermore and beyond technical aspects, governance and social issues are prominent. And so, Vendée Eau has launched coordinated actions to raise enforcement, confidence and mobilization at a large scale of stakeholders who need to be involved, from local communities and direct consumers of drinkable water to national institutions and health services.

This innovative and ambitious program will make it possible to recreate the water cycle in a planned and controlled manner, in order to guarantee the security of the drinking water supply for the people of Vendée. ●


## TECHNOLOGY AT THE HEART: THE BARREL™

Vendée Eau is running trials on water reuse as part of its Jourdain Program. This process — reusing treated wastewater by pumping it into waterways upstream of dams in areas that suffer from water shortages — is a first for Europe. Currently under construction, testing will start in 2023 with full production scheduled for 2026.

The technology at the heart of this is the Barrel™, an ultrafiltration and low-pressure reverse osmosis vessel designed by Veolia Water Technologies that contains 200 membrane elements, ultraviolet disinfection and chlorination.

**Pascal Pluyaud, Director OTV West Central Caribbean - Veolia Water Technologies:**
*"The tertiary treatment unit being used as part of the Jourdain Program addresses a critical need: the reuse of wastewater through one of our latest innovations, the Barrel. This project, through its refining unit, aims not only to provide a reliable source of drinking water for the future but also to reduce the environmental footprint of our customers."*

# Reuse

*Water is too precious to be used only once*

# CaptuRO™
# Resilient high recovery reverse osmosis

***Veolia Water Technologies' latest innovation is a game changer for multiple industrial markets. CaptuRO™ is a high recovery reverse osmosis (RO) technology that has been designed specifically to extract purified water from industrial, brackish and wastewater sources. For clients, this means a guaranteed supply of the highest permeate water recovery — up to 98 percent — across numerous applications.***

Over the past few decades, fresh water sources have become increasingly scarce throughout the world. At the same time, brine disposal options have become less available and increasingly more expensive due to environmental regulations and sustainability requirements. These ongoing trends have been drivers for municipalities and industries to utilize high recovery RO processes.

Robert Koch, Manager of Industrial Applications at Veolia Water Technologies, is part of the team that developed CaptuRO. He explains: *"This technology is truly versatile. From food and beverage to chemical, petrochemical and healthcare, it is a perfect fit for all general manufacturing. From pretreatment to wastewater reuse across all applications — we can recover water at an extremely high rate.*

*For our customers, this means they get a sustainable solution that can lessen their reliance on the municipal water network to help ensure business continuity while also reducing overall water stress."*

***Robert Koch***

CaptuRO is a semi-batch process which enables a higher water recovery rate. Separate system volume containers are systematically employed upstream of the membranes to ensure that concentration turn times are optimum. Koch adds: *"This enables concentrated salts such as silica and calcium sulfate to be purged from the system before they have time to precipitate. It allows CaptuRO to run at higher water recovery rates while minimizing the potential for membrane scaling and fouling."*

The technology also minimizes the volume of brine generated, resulting in savings in liquid waste disposal costs. Along with this come energy savings and the potential to further optimize the use of antiscalants. Last but not least, the semi-batch process automatically adapts to changes in salt concentration in

effluent reclaim applications, allowing it to run continuously at an optimum recovery rate.

When asked what drove this innovation, Koch points out: *"The customer pain point was really about saving water. Many of our customers were relying on municipal water which comes with a high price tag and there can be a lot of risk in terms of supply. Our customers needed to ensure the resilience of their business and maintain operations, with the same amount of water resources but from alternative sources and at a lower cost. CapturO is our solution."*

Thanks to its huge potential for water reuse, CapturO helps protect local water resources and reduce water pollution discharges. It is also a great tool for industrials who need to vastly reduce their water consumption, often driven by a corporate environmental initiative or by a regulatory requirement. •

## A water reuse solution for Limelco in Belgium

Limelco is a dairy producer located in Zonhoven, Belgium. Its production capacity is expected to expand further in the coming years, notably to accommodate a new butter production line. The existing sewage treatment plant, which is obsolete and already heavily loaded, will not be able to handle the estimated 30 percent increase in effluent.

Veolia Water Technologies will work with Limelco to build a new wastewater treatment plant with a daily flow rate of 2,880 cubic meters. The treatment chain will include a CapturO system, allowing for a hydraulic recovery of more than 90 percent (compared to 70 percent with a conventional RO system).

- Meeting discharge standards.
- Lowering water footprint and environmental impact.
- Reducing concentrate disposal costs.
- Saving chemicals.
- Saving energy.


***WATER TECHNOLOGIES***

# *Innovation is our belief, water is our expertise.*

## In nine podcasts
## discover real people
## working every day to protect our global water resources

Blue Gold is the story of our employees, our partners and our customers who are working together to contribute to the United Nations' Sustainable Development Goals (SDGs). Listen as they share their efforts and inspirational stories in their own words.

**In this episode, focused on SDG 6:** ensure access to water and sanitation for all, meet the team that helped more than 40,000 people regain access to safe drinking water in the aftermath of Hurricane Irma.

***Podcast producer*** *tootakpro.fr / Pierre Denis*
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Resourcing the world

VEOLIA

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