

WATER TECHNOLOGIES, TREATMENT INFRASTRUCTURE AND NETWORKS



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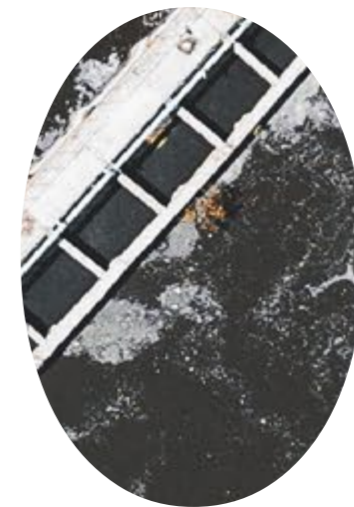
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INTRODUCTION



01

HUMANITY HAS NEVER FACED AS **MANY** **CHALLENGES** AS IT DOES IN THE **21ST CENTURY**

We live on a planet we have not cared for properly.

And now we are paying the price. While the extreme weather events battering every continent are the most visible scars, other seemingly equally fearsome challenges need tackling during the coming two decades. With the clock now running on the climate emergency, water technologies, treatment infrastructure and networks play an essential role in terms of public health, social justice, food supplies, the fight against pollution, regional resilience and the preservation of resources.



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In strictly practical terms, in 20 years' time there will be nine billion people on earth, all of them needing homes and food; the rise of the global middle class and digital technologies will increase energy demand by 30%; rampant urban spread will swallow farmlands that are already heavily degraded; proximity between untamed natural environments and urban spaces will increase the risk of new viruses being transmitted to humans; rising temperatures and pollution will make life ever harder in megacities where population densities will continue to increase; resource scarcity, foremost of all freshwater, "blue gold", will be the cause of major

***In 20 years' time
there will be
nine billion
people on earth.***

conflicts between users, destabilizing entire regions across the planet, and so on. These are just a few of the planetary challenges that Veolia seeks to help resolve.

Tackling these challenges is critical: they have shown us that our lifestyles are under threat and that we need to change them right now, humanity cannot go on living in the same way. There is no turning back. Our world is different now, and we must adapt. Unless we act immediately, circumstances that seem exceptional today will become the norm tomorrow. We have to take stock and act collectively.

***The rise of the global middle-class
and digital technologies
will increase energy demand by 30%.***





01

— Introduction

BECAUSE ALTERNATIVE SOLUTIONS EXIST

Veolia's resolute commitment to ecological transformation means that it can respond to the highly complex equations shaping tomorrow's world.



Veolia has adapted its business activities so it can better support its stakeholders in their own transformations. Veolia believes in joining forces, because nobody can tackle all these challenges alone, while also preserving natural resources and combating the climate emergency.

In these unsettled times, the water technologies, treatment infrastructure and networks business line is central to the vital ecological transformation needed to decarbonize our lifestyles.

The following pages show how it actively contributes to the vital ecological transition needed to build a more sustainable world, and how it leverages innovations to roll out new solutions for tomorrow.



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We work for the benefit of all our stakeholders, offering them effective solutions for combatting new forms of water pollution, for energy recovery, particularly from sewage sludges, and for recycling wastewater.

By developing new technologies in fields such as seawater desalination and treating micropollutants, we tailor our offers to match our customers' needs and emerging environmental problems.

Water is a vital resource we cannot live without. It has to be protected and preserved.

”

GEOFFROY CARLIER

Director, Water Technologies,
Treatment Infrastructure and Networks



VEOLIA SERVING RESIDENTS AND THE PLANET

In terms of water technologies, treatment infrastructure and networks, Veolia trials alternative solutions and rolls out innovative procedures on behalf of its municipal and industrial customers. These solutions and procedures are designed to protect biodiversity and the environment by reducing the impact of human activities, to use regeneration (recycling water and metals) to preserve increasingly rare resources, combat harmful pollution (plastics, micropollutants), and recover the sludge produced so that energy use is minimized and greenhouse gas emissions limited.



COMBATTING NEW FORMS OF WATER POLLUTION

Water pollution is a perfect illustration of the new challenges Veolia can tackle. With treatments for mass pollutants now perfected, today's challenges center on new forms of pollution linked to micropollutants and microplastics.

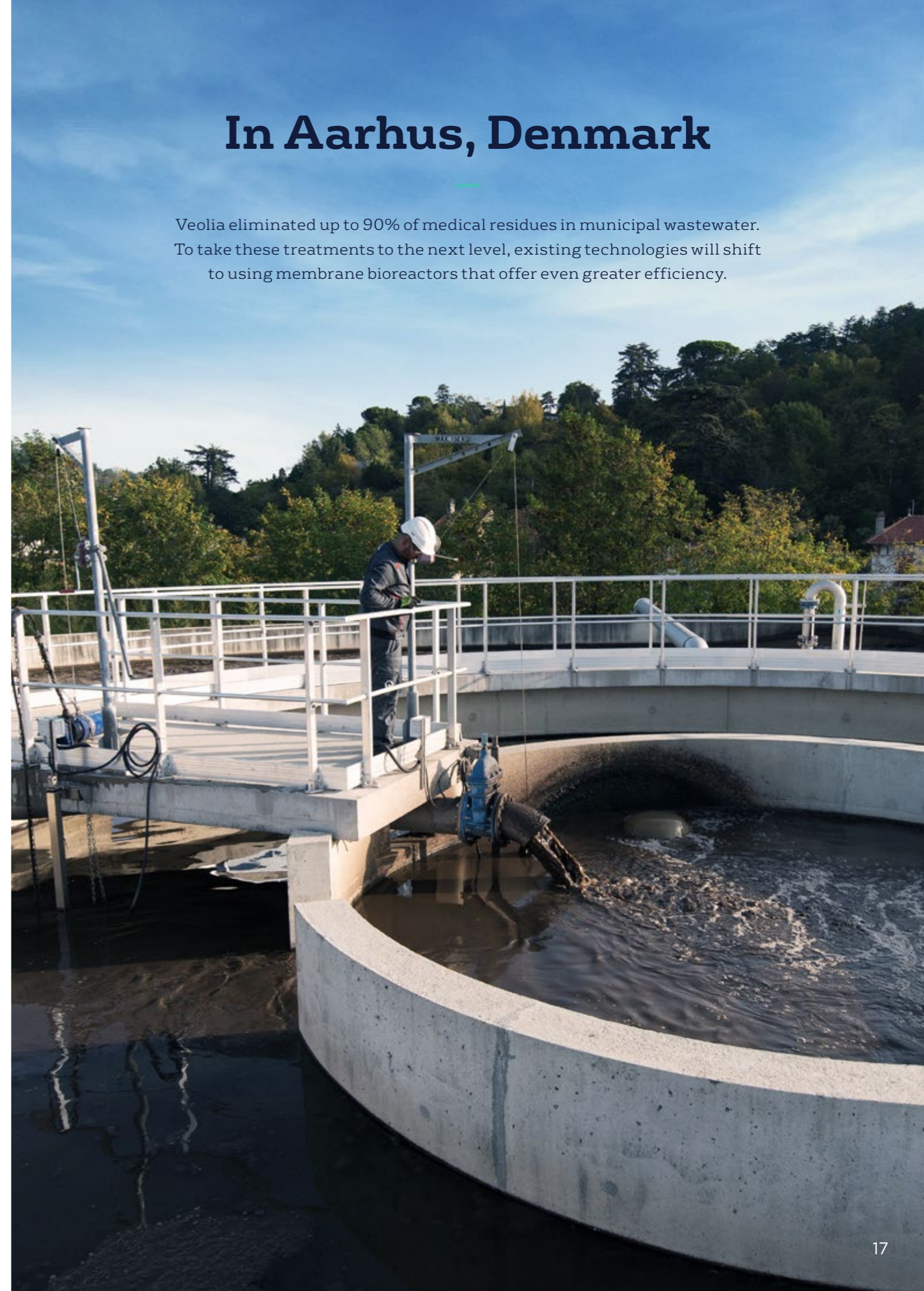
Micropollutants are dispersed toxins present in water in small quantities: pesticides and herbicides from agriculture, toxic products used in daily life (household products, solvents, plasticizers, medicines, etc.).

Of all these residues, the presence of traces of medicines in water is certain to increase in the years ahead, driven by longer lifespans and improved access to healthcare. Veolia is testing new technologies that are more efficient and cheaper for treating pharmaceutical residues in wastewater.



In Aarhus, Denmark

Veolia eliminated up to 90% of medical residues in municipal wastewater. To take these treatments to the next level, existing technologies will shift to using membrane bioreactors that offer even greater efficiency.





Perfluorinated alkylated substances (PFAS) are also major dangers if their presence in water is ignored, the most closely monitored being perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Manufactured since the 1940s, these chemicals are used by many industries in textiles, household appliances, vehicles, construction, electronics, etc. The problem is that these forever chemicals are extremely persistent and highly damaging to the environment, contaminating water, soil and foods. They also accumulate in the body and lead to serious health consequences.

In North America

Veolia has trialed the use of powdered activated carbon to adsorb (adhere to the surface) of these substances. 80% of PFOA was successfully eliminated from contaminated well water and Veolia is continuing to research ways to reduce concentrations in drinking water. Sludge produced during these treatment processes is itself contaminated and work is under way to identify the optimum incineration conditions for destroying PFOA.

TRANSFORMING WASTEWATER AND OPTIMIZING ITS TREATMENT

*Veolia sees wastewater not as waste
but as a resource.*

It designs solutions that facilitate the spread of renewable, decarbonized and cleaner energy sources that are decentralized and digitalized and protect resources. It does this through sludge recovery, methanization and water recycling via treating and reusing wastewater.

For example, current technologies can drive down energy use by recovering heat from wastewater and creating a virtuous circular economy loop.



In Marseille, south of France

With Energido, a solution that recovers heat from wastewater, Veolia heats water at the famous Cercle des Nageurs de Marseille swimming pools to 27°C all year round, saving the emission of 230 metric tons of CO₂ every year.





In Ljubljana, Slovenia

The Slovene capital has modernized and extended its existing wastewater treatment plant, increasing capacity by 52% and improving the site's energy efficiency.

By 2022, the treatment plant will be fitted with advanced biological water treatment installations and Exelys, a pre-digestion thermal treatment for sludge. Energy recovery from wastewater will make the plant energy self-sufficient.

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Tools such as Hubgrade — a suite of smart monitoring solutions for combining digital and human expertise — allow wastewater treatment plants to maximize energy recovery by optimizing their use of energy and chemicals, and reducing their operating costs.



In Milan, Italy

In 2019, Italian public service company Metropolitana Milanese SpA turned to Hubgrade for its Nosedo wastewater treatment and reuse plant. With 60 to 70% of final effluent reused in agriculture, Nosedo is the largest wastewater reuse plant in Europe. Hubgrade delivered energy savings that included a 20% saving in biological treatment costs in just six months as well as a 60 to 80% reduction in the use of precipitation chemicals such as ferric chloride, with projected annual operating cost savings of around €500,000 a year.

PROMOTING RESPONSIBLE AGRICULTURE FOR TOMORROW

The demographic challenge facing our planet means we need new and more responsible farming practices if we are to feed nine billion people in the future.



Veolia helps the process of change in farming practices by converting municipal and industrial sludges into composts that are applied to the soil, and by promoting aquaculture.

As worldwide demand for quality fish continues to grow, aquaculture seems an obvious solution, one that also offers an alternative to the problem of overfishing that impacts almost half the fish species we eat. This form of farming faces a range of challenges and Veolia, a major player in the industry via Veolia Water Technologies, offers its technologies and expertise in wastewater recycling to help aquaculture become more sustainable and more respectful of the environment.





VEOLIA SERVING INDUSTRIAL CUSTOMERS

Against a background of globalized competition and accelerating ecological transformation, industrial businesses do not necessarily have the tools and skills needed to reduce both their operating costs and their environmental footprint.

Its innovative solutions mean Veolia can support industrial companies as they seek to optimize their environmental performance, specifically by offering them advanced technologies to improve management and recovery of production by-products, and by optimizing recycling of process water to cut overall water use and protect water resources.



RECOVERING PRODUCTION BY-PRODUCTS

Whether working in oil and gas, pharmaceuticals or chemicals, today's industrial companies have to re-examine their socio-economic growth models, shifting to more sustainable solutions to help combat the climate crisis and optimize their productivity. Given this reality, recovering production waste is an efficient and sustainable solution. Veolia collects these by-products, often as sludge, and recovers them to extend extracted resources' lifetimes and value in use.

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By-products from the mining industry are a good example. Veolia offers mine operators a unique combination of solutions for managing and treating process water and solid waste. It provides a major competitive advantage thanks to its mastery of all the treatment processes it deploys and operates. For example, Veolia's proprietary crystallization and evaporation technology helps the mining industry recover precious materials from mine tailings, reuse and/or recycle water and reduce overall effluent volumes. This is a technology used with copper, zinc and lithium.

The benefits for mining industry customers are numerous: yield optimization by recovering ores present in tailings; improved management of water and tailings helps secure licenses to operate; minimized risk of disruption to production.

In Ghana

In an environment subject to highly seasonal rainfall, Veolia enables a gold mine in Ghana operated by AngloGold Ashanti to manage its tailings overflow and meet local discharge requirements. Maintaining and improving its operations required modernization and upgrades to the wastewater treatment plant, a review of operating practices and training for a dedicated local team. In this way, Veolia helped the mine retain its license to operate.



REDUCING THE ENVIRONMENTAL FOOTPRINT OF THE AGRI-FOOD INDUSTRY

Certain practices will have to adapt to the climate crisis if the world is to feed a 9-billion population in 2040.

The agri-food industry is the largest industry in the world, characterized by processes that are highly energy- and water-intensive and the production of massive quantities of organic and solid waste (plastic, glass, paper). The industry faces a major two-pronged challenge in dealing with fast-growing population growth and rising living standards: how to meet its customers' demands while simultaneously preserving resources and limiting its environmental impacts.



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To help this process, Veolia provides agri-foods businesses with a wide range of custom solutions. Actors in the fish-farming industry are one example.

Although fish farming has been practiced for thousands of years, the domestication of marine resources — fish, shellfish and aquatic plants — has expanded massively over the past 30 years. This is one way to preserve fish resources that are increasingly threatened by overfishing: according to the Food and Agriculture Organization of the United Nations (FAO), a third of all fish species are overfished. Aquacultural production could reach 109 million metric tons in 2030, a 37% increase on 2016.

Veolia has offered a comprehensive wastewater treatment and recycling

solution for aquaculture in the form of its RAS2020 Recirculating Aquaculture System for more than 20 years. After extensive clean-up processes, wastewater is then fed back into the fish tanks. A biological treatment eliminates carbon and nitrogen pollution from the water. As well as this technology, another technology is used to separate fish excreta and uneaten food.

Aquacultural production could reach 109 million metric tons in 2030, a 37% increase on 2016.

Extremely careful controls of water quality mean that the fish produced are in better health and more disease resistant: they are not given chemical or antibiotic treatments, and all pollutants are eliminated. In this way, Veolia helps to preserve a great variety of fish species, deep-water, fresh-water, tropical and salt-water, while simultaneously ensuring its customers receive high quality support.

In Norway

Veolia provides recirculation systems for salmon farming. Fredrikstad Seafoods, the first land-based salmon farm in Norway, relies on advanced aquaculture technology to guarantee the stability of water quality parameters, essential for ensuring that fish survive and flourish. They are raised in a controlled environment, without the use of antibiotics or pesticides, in total compliance with all health standards. This is a sustainable, resource-efficient and environmentally friendly method for feeding a growing population while also reducing pressures on fish stocks in the wild and, therefore, protecting life in the oceans.

An aerial photograph of several parallel rectangular wastewater treatment tanks. The water in the tanks is dark and turbulent, with white foam and bubbles visible on the surface. A large, white, stylized number '04' is overlaid on the right side of the image, with the '0' being a circle and the '4' being a solid shape. The number '04' is positioned over the right half of the image, partially obscuring the tanks.

INVENTING TOMORROW: CENTRAL TO EVERY VEOLIA INNOVATION

Today, whether in emerging, recent or mature markets, the challenges are changing and the responses needed demand ever greater levels of technology and innovation. Veolia designs custom solutions today so that it can tackle the challenges facing its customers and the planet tomorrow.



THE PROMISE OF AQUAPONICS

As well as working with aquaculture, Veolia continues to experiment with aquaponics as part of its research into the agriculture of tomorrow. Aquaponics is a symbiotic method for growing plants and rearing fish by recreating an ecosystem in fish tanks.

In Belgium, working with BIGH, a startup that leads the field, Veolia hopes to roll out a solution centering on a network of aquaponic urban farms and to emerge as a key player in this new sector.

More generally, aquaculture would benefit from adopting the principles that underpin agroecology, starting by using natural mechanisms to prevent certain diseases and parasites such as sea lice, which can be a problem for fish farms.

The activities of the fish help plants (or rice) to grow in a natural manner without added chemicals: biological filtration provided by micro-organisms transforms the ammonia in fish urine into nitrates, fertilizing plants even as the urine is eliminated from the water.

MOBILE TREATMENT UNITS: A BOOMING MARKET

*Modular mobile water treatment units
are another promising lever for change.*

To safely deal with emergency situations or temporary needs for treating or producing water, Veolia has designed and manufactured a fleet of mobile multi-treatment units able to meet any needs its customers may have. Veolia's fleet of Mobile Water Services trucks and trailers can deploy rapidly to industrial sites in the event of a need during preventive or corrective maintenance operations. The main customer benefits are flexibility and speed of intervention. And because Veolia can intervene on demand, customers do not have to invest in fixed installations, meaning that they enjoy significant cost savings.

Mobile units also provide a second function: as emergency back-up. Electricity company EDF has contracted Veolia to supply this service so that it can be certain to have a treatment installation in place within 24 hours, if needed.



In Bassens, near Bordeaux, France

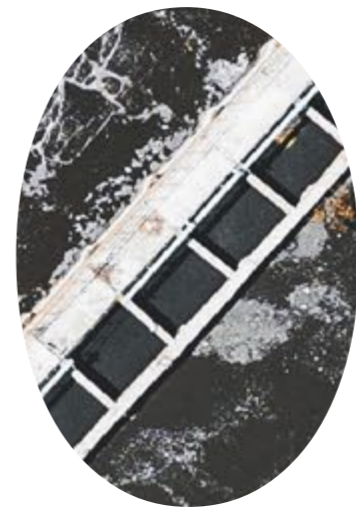
The Michelin factory is one of three in the world to produce synthetic rubber for tires. Two on-site demineralization units provide the constant supply of demineralized water needed by the production process. In September 2020, Michelin needed to carry out maintenance on one of the units, so instead of compromising production it called in Veolia. With a capacity of 100 cubic meters of demineralized water every hour, the on-site fleet of trucks quickly delivered the 600 cubic meters needed daily at the plant.





IMPACTFUL SOLUTION

MUNICIPAL SEWAGE SLUDGE



BACKGROUND

Rapid population growth around the world, and the urban growth this leads to, have major impacts on the colossal quantities of wastewater and sewage sludge that municipalities have to deal with. According to ADEME, France's environment and energy management, 9 million metric tons of sludge were produced in France in 2020.

Maximizing the use of by-products created during wastewater treatment has become a major issue for operators and officials in charge of managing wastewater treatment plants.





SOLUTION



The world now needs a change of model. To meet this challenge, Veolia has created and designed innovative services for local authorities and municipalities, supporting them in their energy transition and helping to maximize extraction of raw materials for recovery from sewage sludges. Carbon sources found in these residues are transformed into energy via methanization, while phosphate and nitrogen become fertilizers that are in high demand for agriculture.



TURNING SLUDGE INTO A GREEN ENERGY SOURCE

Veolia has perfected a wide range of technological solutions for processing and recovering energy from sewage sludges.

For wastewater treatment plants operators, transforming sewage sludge into biogas is a powerful lever for ensuring compliance with environmental regulations. This limits emission of greenhouse gases, dramatically reduces environmental footprints and the volume of residual sludge, and helps combat the increasing scarcity of resources. In this way, sewage sludges can offer an alternative to fossil fuels and a new source of income, whether through on-site use of the energy produced or the sale of energy to the local energy network.

Optimizing wastewater treatment technologies is boosting the quantity of energy produced by sewage treatment plants. What is more, these solutions created by Veolia mean that today's plants can ultimately become carbon neutral, or very low carbon.

Sewage sludges can also be recovered as compost that is applied to the soil. An inexpensive and efficient way of improving and structuring soils, farmers spread compost made from sewage sludges across their fields. This type of compost also contributes massively to storing carbon in the soil.

These comprehensive solutions operate continuously or on demand, combining thermal hydrolysis with anaerobic digestion. These solutions perform better than conventional digestion and make it possible to optimize sludge treatment by providing:



25 to 35%
less dry material



No
odor nuisance



30 to 50%
more biogas



A hygienic and stabilized digestate
with controlled health risks that ensure suitability for recovery by agriculture

IMPACTFUL EXAMPLE

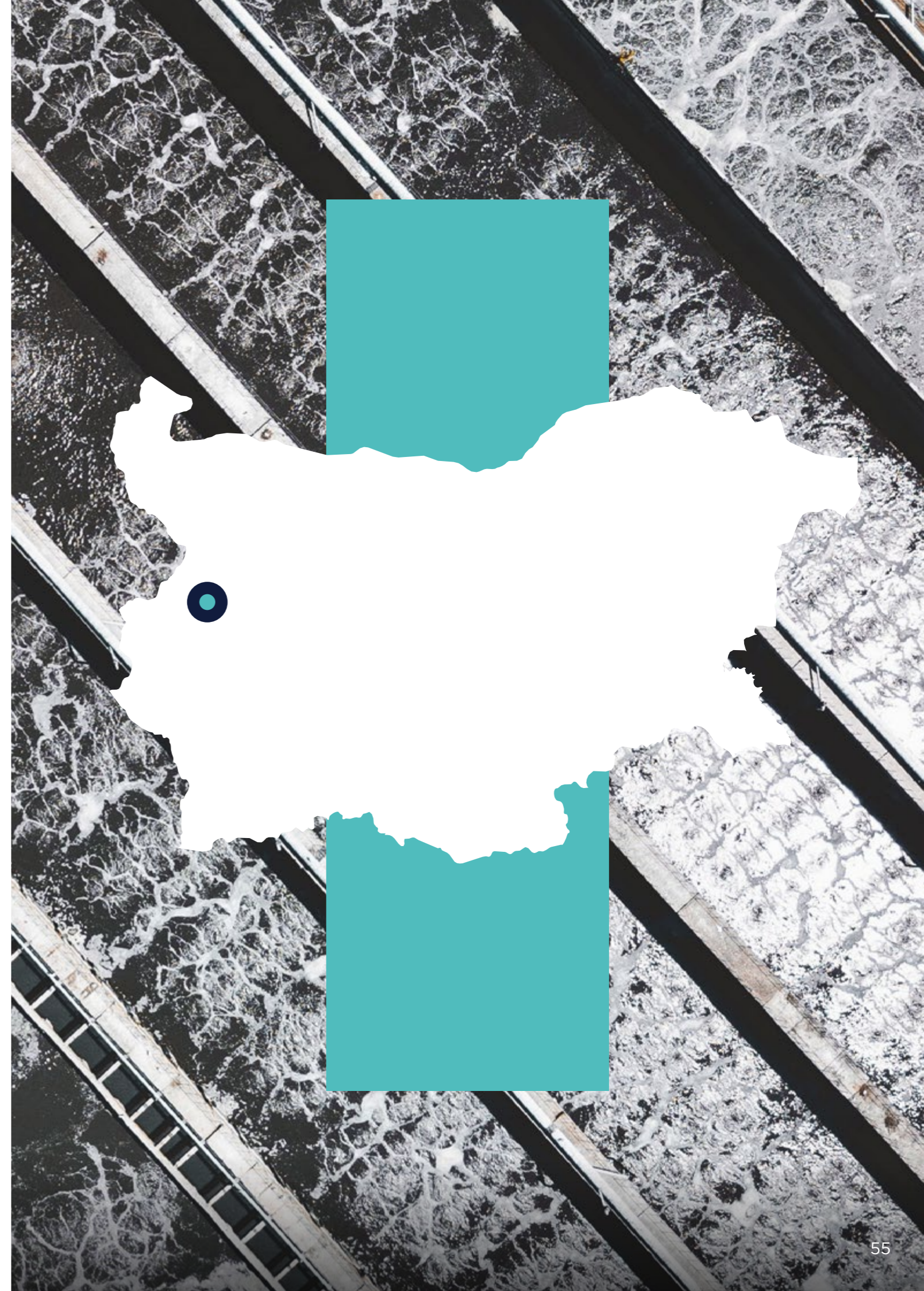
To the north of Sofia, in Bulgaria, the Kubratovo wastewater treatment plant occupies a 60-hectare site and is one of the largest and most innovative treatment plants in the Balkans. Built 35 years ago, it has constantly been updated and currently treats 500,000 cubic meters of wastewater a day from homes and industry as well as rainwater. Better still, the site is now almost self-sufficient in energy after a lengthy process of continuous improvement.

In 2009, a new combined heat and power system was installed that uses biogas to produce renewable energy. The aim was to optimize the plant's operation

and energy efficiency to reduce its CO₂ emissions. And to boost performance even more, the CHP system with its three cogeneration units, each capable of producing 1,063 kW of electricity and 1,088 kW of heat energy, was modernized in 2019. The updates mean all the plant's installations will reach 100% energy self-sufficiency in the coming years, making it one of the few sites in the world to operate entirely using renewable energy produced on-site.

Since 2009, the plant has produced 198 million kWh of renewable energy from wastewater sludge, 92 million cubic meters of biogas and avoided the emission of 1,080 metric tons of CO₂ into the atmosphere.

*Since 2009,
the plant has produced*
198 million kWh
of renewable energy.





IMPACTFUL SOLUTION

THE BARREL, A PLUG & PLAY
APPROACH TO REVERSE OSMOSIS
WATER TREATMENT

06

BACKGROUND



The scale and number of seawater desalination and wastewater treatment and reuse plants is directly proportional to the demand for drinking water. These plants need to adapt to rising population numbers and, often, the lack of available land, without resorting to large-scale investment. A clear trend is emerging, with increasing numbers of actors seeking treatment installations that are more flexible, less complex and cheaper. The time for agility has come.





SOLUTION

To support its municipal and industrial customers, Veolia has created a unique plug and play concept for reverse osmosis water treatment: The Barrel. The pressure vessel, manufactured off-site and then delivered as a plant's sole component, can house up to 200 membrane elements depending on the water treatment required, each fitted with a sensor.

The units have a small footprint, can be installed indoors or outside and scaled as needed. This means that no building is needed to house a seawater desalination or wastewater reuse process.

And The Barrel is fully digital. Fitted with a system that provides remote surveillance of the membranes, it delivers the reliability and operational cost-effectiveness that operators require. The system lowers the investment required by 3 to 5%, and energy use by 1.5%.

IMPACTFUL EXAMPLE

Vendée Eau, a public service water authority in western France, chose The Barrel for its wastewater reuse demonstrator at Sables-d'Olonne on the Atlantic coast, an area where 9 in every 10 liters of drinking water are produced from surface water, making it highly susceptible to the impact of the climate crisis.

With its Jourdain program, Vendée Eau is trialing a solution unlike anything other in Europe: replenishing surface water resources with treated wastewater discharged from the Sables-d'Olonne treatment plant. The water is treated in a refining plant then channeled to a planted transition zone before being released behind the Jaunay dam. It then mixes with river water prior to a final treatment stage at the drinking water production plant.

The Barrel is a key component of the refining plant: its modularity and technical sophistication meet Vendée Eau's requirements for the production of very high quality water. Once built and tested, the refining plant should reach full capacity in 2026.



KEY ACTIVITY DATA



VEOLIA CAN CALL ON
A PORTFOLIO OF

**OVER
350
SEPARATE PROPRIETARY
TECHNOLOGIES**

(physicochemical, biological, membrane
and bio-membrane treatments, thermal
and hybrid desalination, etc.)



**TO PROVIDE SOLUTIONS
FOR THE MANAGEMENT OF ALL FORMS
OF WATER**

(drinking water, industrial water, ultra-pure water,
wastewater, seawater)



3,362
DRINKING WATER
PLANTS MANAGED



2,737
WASTEWATER TREATMENT
PLANTS MANAGED

Veolia Communications Department
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