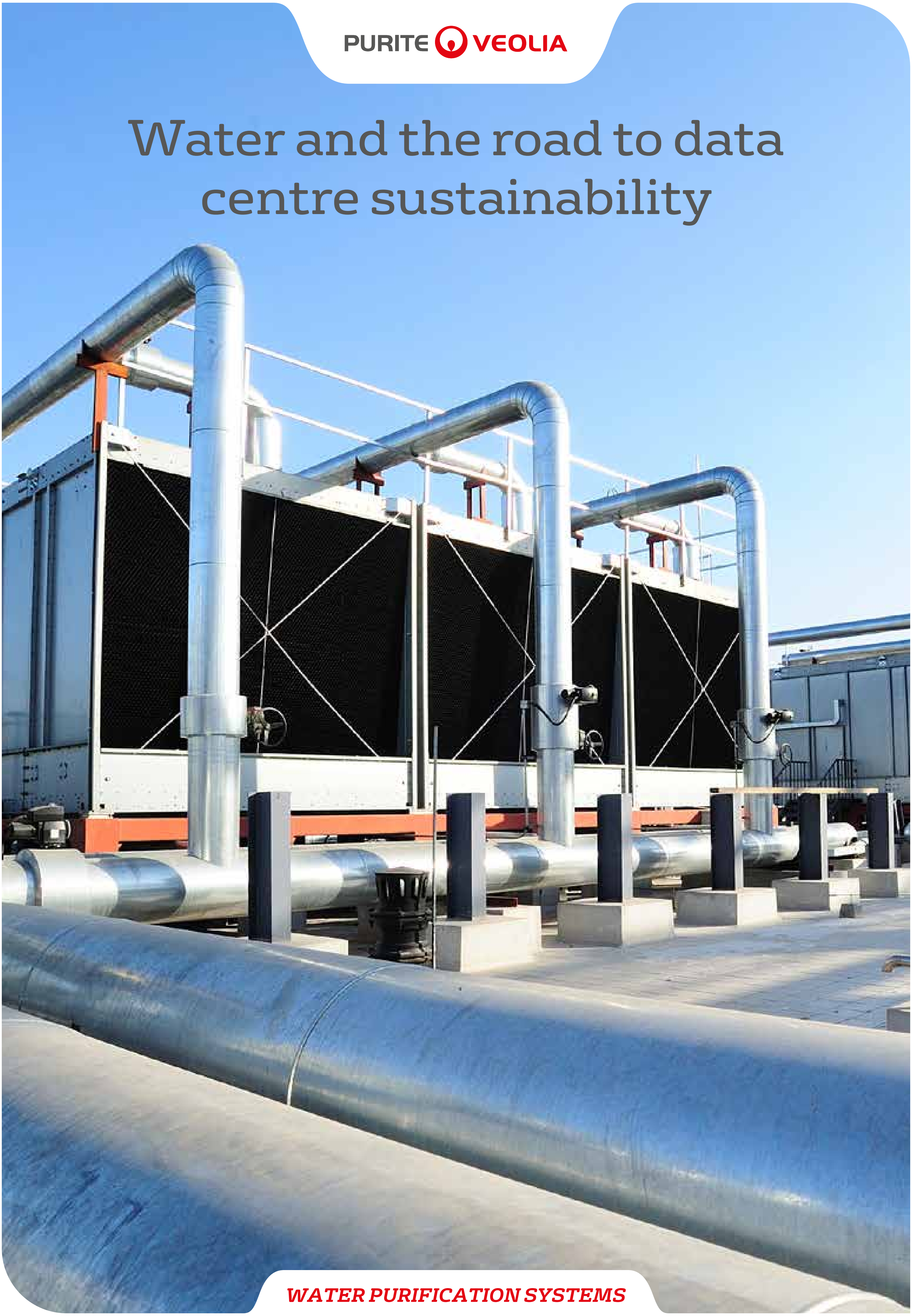
Water and the road to data centre sustainability



WATER PURIFICATION SYSTEMS

Data centres are under pressure to reduce water consumption. How low can they go?

Data processing is thirsty work. The ongoing digitisation of society, and the shift in computing loads to the cloud, is pushing ever more work into larger centralised data centres. These facilities consume a lot of energy, and they use a lot of water too.

A small data centre, with an average power consumption of 1MW, may require around 25.5 million litres of water per year to operate its cooling systems. A medium sized, 15MW data centre may use as much water as three average-sized hospitals.

That water consumption is coming under increasing scrutiny. Data centres are responsible for a relatively small fraction of total water use, but big facilities are often located in densely populated areas where their requirements place additional loads on water supply systems already stressed by climate change and rising demand from other users.

Data centre operators are also paying more attention to water use as they strive to improve their environmental, social and governance (ESG) performance. In Europe, more than 100 data centre companies and trade associations have signed up to the Climate Neutral Data Centre Pact, which includes prioritising water consumption alongside the purchase of carbon-free energy as a key commitment.

And water use is set to become a bigger priority as the IT sector makes progress in its energy transition. Today, the volume of water consumed inside data centres are dwarfed by the vast quantities used in thermal power production. As the sector shifts to wind and solar energy to reduce carbon emissions, it is finding itself directly responsible for a bigger share of its own water footprint.

Water consumption is also playing an increasingly important role in planning decisions. Demonstrating that they will take steps to minimise their impact on local water supplies and resources can be a decisive factor in the approval of new data centre projects.

Reduce, reuse, recycle

Eliminating the need for water in data centres is a long-term challenge. Operators are already using multiple strategies to reduce their water consumption, however. They include:

- **Cooling system optimisation:** Changes to the way cooling systems are set up and operated can reduce water consumption by ensuring that the system operates as efficiently as possible. This may include adjusting set points, optimising airflow, and using advanced control systems to manage cooling system operations.
- **Efficient server and IT equipment design:** Using energy-efficient servers and IT equipment can help reduce heat generation, which in turn reduces the cooling requirements and associated water consumption.
- **High-efficiency cooling equipment:** Using cooling equipment with higher efficiency, such as modern chillers and cooling towers, can help reduce the amount of water needed for cooling. Additionally, installing variable-speed pumps and allows operators to adjust cooling capacity as loads and external temperatures change, further reducing water consumption.
- **Free cooling:** If weather conditions allow, data centres can use outside air to cool their equipment, reducing the load imposed on mechanical cooling systems. Building data centres in regions with lower ambient temperatures can help reduce the need for mechanical cooling all year round.
- **Water reclamation and recycling:** Reusing water within the cooling system or using alternative water sources such as local boreholes, rainwater, greywater, and treated wastewater can help reduce demand for potable water from the public water supply system.
- **Dry cooling systems:** Some data centres may employ dry cooling systems, such as air-cooled condensers, which use air instead of water to cool the equipment. While these systems may not be as energy efficient as water-based cooling systems, they can significantly reduce water usage.

Quality matters
Another way data centres can prevent excessive water consumption - and energy use - is by properly looking after the water they do use. The quality of water can have a significant impact on the efficiency, performance, and maintenance requirements of the cooling infrastructure.

Poor water quality can lead to several issues in data centre cooling systems:

- **Scaling:** High concentrations of minerals, particularly calcium and magnesium, can cause scale deposits to form on heat exchangers, cooling towers, and other components of the cooling system. Scaling reduces the efficiency of heat transfer, which can result in reduced cooling performance and increased energy consumption. It may also lead to clogging of pipes and equipment, necessitating regular maintenance and cleaning.
- **Corrosion:** The presence of certain chemicals, such as chloride and sulphate ions, in the water can lead to corrosion of cooling system components, including pipes, heat exchangers, and cooling towers. Corrosion can cause leaks, reduced efficiency, and equipment failure, leading to higher maintenance costs and potential downtime.
- **Biological growth:** Poor water quality can promote the growth of microorganisms, such as algae, bacteria, and fungi, in the cooling system. These organisms can cause biofouling, which is the accumulation of organic material on surfaces, reducing heat transfer efficiency and potentially leading to blockages. In addition, some microorganisms can produce corrosive by-products, further exacerbating the issue.

To ensure optimal performance and longevity of their cooling systems, data centres must monitor and maintain water quality through proper water treatment processes. This may include the use of filtration systems, chemical treatments to control scale and corrosion, and biocides to control biological growth. Regular testing and monitoring of water quality parameters, such as pH, conductivity and Redox are essential to maintain water quality within acceptable limits and to prevent potential issues.

As facilities increasingly turn to unconventional water sources, such as their own boreholes or the use of rainwater and recycled wastewater, the need for effective water purification processes becomes even more acute. Since the type and level of impurities found in these water sources can vary significantly, the best combination of purification technologies is likely to be different for every site.

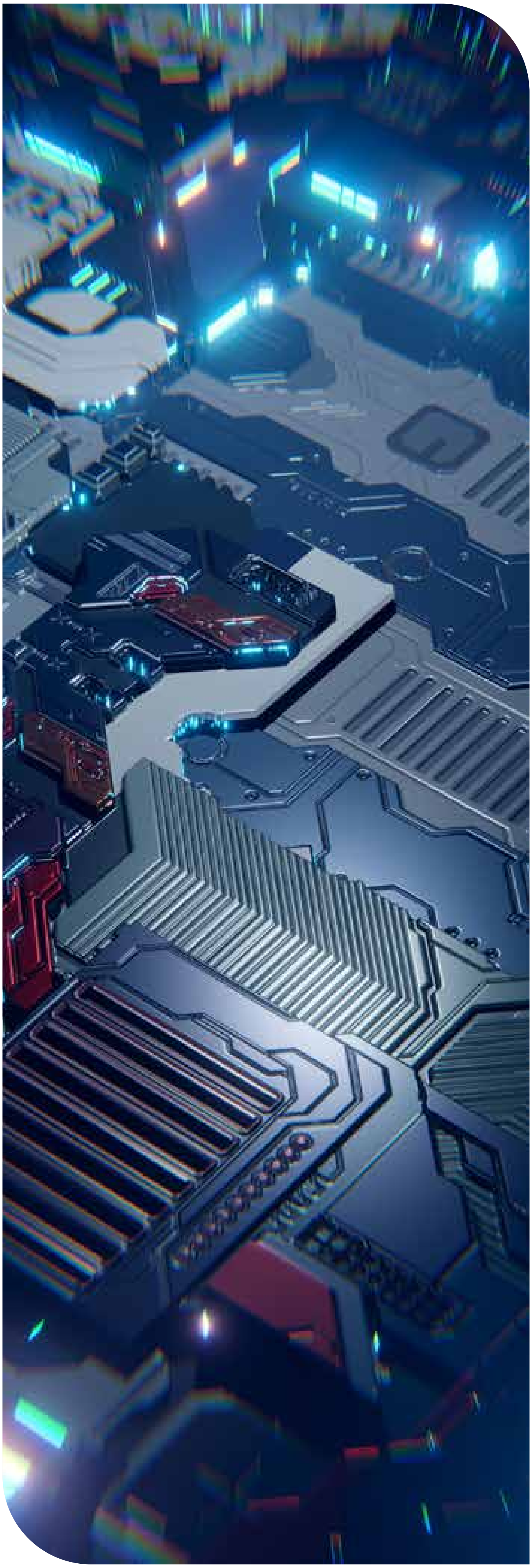
Waterless cooling
There's lots of work underway to develop technologies that can offer efficient cooling for power-intensive, high-density data centre applications without the need for water. One promising approach is immersion cooling, where the electronic equipment is directly submerged in a dielectric liquid coolant. This liquid coolant is designed to have good heat absorption capacity, low viscosity, and excellent electrical insulation properties.

There are two primary types of immersion cooling:

1. Single-phase immersion cooling: In this method, the servers are submerged in a non-conductive liquid coolant that has a high heat capacity and remains in a liquid state throughout the cooling process. The heat generated by the servers is absorbed by the coolant, causing its temperature to rise. The warm coolant is then circulated through a heat exchanger, where it releases the absorbed heat, cools down, and is recirculated back to the immersion tank.
2. Two-phase immersion cooling: In this method, the servers are submerged in a dielectric fluid with a low boiling point. As the components generate heat, the fluid absorbs the heat and undergoes a phase change from liquid to vapour. The vapour rises and meets a condenser, where it releases the heat and condenses back into a liquid. The cooled liquid then returns to the immersion tank, and the process repeats.

If immersion cooling systems are designed to use "dry" condensers and heat exchangers, which transfer their waste heat to the air, they can operate without any requirement for cooling water. While its use is not yet widespread, immersion cooling offers potential benefits beyond the reduction in water use.

They include space savings, since immersion technology can provide efficient cooling even when components are packed close together. Immersion cooling systems are quieter than conventional mechanical systems too, and fewer moving parts mean that they should operate reliably with lower maintenance requirements and associated costs.



Future challenges: gas turbines and hydrogen

Advanced technologies might take water out of the data centre cooling loop, but digital infrastructure is likely to have significant needs for clean, high quality water even then. One big area where water is set to be vital over the longer term is in the provision of high-efficiency, low carbon backup power generation.

As the industry seeks find an alternative to large diesel engines to provide power in the event of problems with the grid, it is exploring several alternative technologies. One promising option in the short and medium terms is the use of gas turbine generators.

Gas turbines have many characteristics that make them a good fit for backup generation applications. They are reliable and fast to start. They can operate on a wide range of fuels, including both fossil fuels such as oil and natural gas, and lower-carbon alternatives such as bio-based fuels or hydrogen. And they generally produce fewer emissions than conventional diesel generators.

To maximise the efficiency of turbine installations, however, operators need to find a way to utilise the exhaust heat from the turbine. In combined cycle turbine installations, that heat is used to run a secondary steam turbine for electricity generation. And Combined Heat and Power (CHP) or Combined Cooling and Power (CCP) installations make further use of the low-grade waste heat to serve heating or cooling applications in the data centre or other nearby buildings. Combined cycle and CHP/CCP installations require lots of water, which is used both for stream production and the transport of heat to the point of use.

Fuel cells are another promising source of low-carbon backup power. These devices generate electricity from the oxidisation of a fuel such as hydrogen, with no need first convert the energy in mechanical work. That offers the promise of a quiet, clean and highly controllable energy source.

Fuel cells don't completely address the water problem, however. Many fuel cell technologies operate at relatively high temperatures of 200 to 1000. That means they need to be kept cool, just like generators or gas turbines. And the pursuit of maximum efficiency calls for utilisation of that heat in a CHP or CCP process.

The production of hydrogen for fuel cells, meanwhile, is a water-intensive process itself. The most water-efficient hydrogen manufacturing process, electrolysis, requires at least 9kg of clean water for every kilogram of hydrogen produced. Depending on the quality of the source water, commercial electrolysis equipment needs anything from 10kg to 50kg of input water to generate enough pure, deionised water for each kilogram of hydrogen. Other methods, such as steam methane reforming, require even more water, with most used for steam production or system cooling. Switching data centres to hydrogen power at scale, therefore, may simply shift water demand to other points in the energy supply chain.

With four decades of experience in water purification for the most demanding industrial and scientific applications, Purite can help you navigate the challenges involved in sustainable, reliable, and cost-effective water management for data centres. Our engineering teams can design and develop site-specific solutions for facilities of any scale, and we offer complete build, installation, and commissioning services. Purite is continually developing its products to meet the evolving needs of today's data centres, and customers across the country rely on our network of specialist service engineers to keep their critical assets operating.

PURITE VEOLIA

Get in touch

Veolia Water Purification Systems Ltd trading as Purite
Bandet Way, Thame, Oxon, OX9 3SJ, United Kingdom

T +44 (0)1844 217141
E vtc.vwts.puritemail.all@veolia.com
W purite.com

Design **Build** **Install** **Maintain**

Founded over 40 years ago, the Purite brand has a long and proud heritage leading the way in water pre- treatment and process. We are now part of Veolia, one of the world's largest manufacturers and suppliers of specialist water treatment technologies, products and services.

WATER PURIFICATION SYSTEMS