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A study proposes using saline and contaminated water to cool the data centers powering AI

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Data centers that support artificial intelligence, cloud computing, and real-time processing consume enormous amounts of energy. All that electricity is converted into waste heat that must be eliminated to prevent overheating, and the most common method for achieving this relies on an increasingly scarce resource: fresh water. In the United States alone, the water demand from these facilities could multiply up to four times by 2028, reaching between 150 billion and 270 billion liters annually, according to estimates gathered in the study.

The pressure on local resources has already raised regulatory alarms. For example, in September, Texas Governor Greg Abbott ordered a halt on permits for new data centers, and the state attorney general launched an investigation into the water consumption of existing facilities.

In light of this situation, a group of engineers and geoscientists posed a straightforward question: can saline or contaminated water, which is currently discarded as industrial waste, be used to cool these facilities and thereby alleviate the competition for potable water? According to their findings, the necessary technology already exists, and even the most energy-demanding options account for only a small fraction of the total electricity consumption of a data center.

These conclusions stem from a study published in the journal Water Research, led by researchers from the University of Texas at Austin. The research evaluated various desalination technologies, which involve processes that separate salts from water to make it suitable for industrial use, and analyzed their technical, economic, and environmental feasibility in data center cooling.

“We are not waiting for a futuristic technology to solve this problem for us,” said Vaibhav Bahadur, a professor in the Department of Mechanical Engineering at the Cockrell School of Engineering, according to the university's press release. “We can solve parts of this problem with the technology we already have; there is simply a cost associated with it,” he added.

Two complementary methods for different salinity levels

The study examined two major technological families. Reverse osmosis filters water under pressure through membranes that retain dissolved salts: it is efficient and cost-effective, but it cannot treat liquids with concentrations higher than those of the ocean. Mechanical vapor compression, on the other hand, evaporates water and condenses it for a clean product, making it suitable for hypersaline fluids, although at the cost of much higher energy consumption.

The researchers tested both methods, along with hybrid configurations, on three types of water: brackish, with a moderate concentration of about 5,000 parts per million of dissolved salts; seawater, with about 35,000; and produced water, a byproduct of hydrocarbon extraction that exceeds 50,000. In all cases, the goal was to obtain water with less than 500 parts per million, the threshold required by cooling systems.

As detailed in the study, a hybrid system applied to seawater with minimum liquid discharge management, a strategy that concentrates the residual brine to minimize the volume discarded, recovered 736 liters of fresh water for every 1,000 kilograms of water fed, at a cost of $3.20 per cubic meter.

For produced water, the recovery was similar, but the energy consumption quadrupled, and the cost tripled. The work concludes that shifting from conventional disposal to minimum or zero discharge schemes increased recovery rates between 4% and 220%, although with energy increases above 12%.

A new indicator measures the impact on local water stress

Beyond the technological evaluation, the team developed an original metric called Saline Water Utilization Intensity, which quantifies how different desalination strategies adopted by a data center affect the availability of water in its surroundings.

The study concludes that “between 2023 and 2030, the values of this indicator increased in representative scenarios, ranging from mild to substantial impacts on water stress.” However, the strategies with the highest recovery reduced this index by 40% in areas with high scarcity.

Of the three scenarios studied, a hypothetical project in Longview, in East Texas, achieved the lowest pressure levels on local water sources. This case involved the use of treated brackish groundwater through two-stage reverse osmosis, allowing for high recovery at low cost and with moderate energy expenditure, according to the press release.

Wastewater from the oil industry, an underutilized resource

In Texas, the oil and gas industry produces enormous volumes of wastewater that are currently transported long distances and injected underground. Bahadur put the figure in perspective: “The Permian Basin generates 1,200 Olympic-sized swimming pools per day, and currently, that liquid is transported long distances and injected underground. This is problematic in many ways, including the risk of seismic activity,” he warned according to the press release.

“We are also running out of space to bury that water, possibly by 2030. We need to find a way to use it, and treating it for data centers is an excellent way to do so,” he added.

This approach is part of the COMPASS consortium, based at the Jackson School of Geosciences at the university. Bahadur and his colleague Ning Lin, Chief Economist at the Bureau of Economic Geology, recently testified before the Texas Senate Committee on Water, Agriculture, and Rural Affairs. “When making important decisions about data centers, local officials often lack objective analysis regarding water, energy, and other relevant factors,” said Lin, according to the press release.

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