



DATA CENTER WATER USE: AN ISSUE BRIEF

How Innovation, Water Stewardship,
and Modern Cooling Technologies
Are Reducing Water Demand

Summary

When data centers are mentioned, there's a great chance that water will also be discussed. Community members are concerned about the "massive" amount of water that data centers demand and whether or not the local water supply can support what they believe are water thirsty facilities. While data centers did once rely heavily on water to cool systems and keep them running efficiently, technology develops and evolves quickly. The amount of water a data center uses today is much less than it was just a few years ago, and the tech companies building data centers are investing heavily in further innovation and local water restoration to ensure those numbers continue to decrease. In fact, these companies, including Google, Microsoft, and Meta, have pledged to reach "water positivity" by 2030, meaning they are promising to restore more water than they consume. When you look at the numbers, how drastically data center water-consumption has decreased in just a few years, and all the new innovations cropping up to continue to conserve water while still operating the data centers we rely on for our personal and professional digital lives, the truth is that data center water-consumption is a concern of the past.

Background

In 2024, only 14% of all water-cooled data centers used more than 16 million gallons each year. That might sound like a lot of water, until you start looking into other industries. One million gallons of water is used by 10 US households in one year, meaning 160 US households would easily use the same amount of water as the most water-thirsty data center in one year. A city of 50,000 people in the US will use about 2.4 billion gallons in one year. The average US city has about 100,000 people uses 5.3 billion gallons of water in a year. In fact, following these numbers, very few, if any, data centers using water for cooling will use the same amount of water as 160 US households let alone the average US city (Solomon). If we're looking at rural areas, you'll find that agriculture, especially that requiring irrigation, can easily use far more water in a year than a data center on the same land. In fact, in Kansas, Tripe Oak Power is looking to develop a data center on 6,000 acres of farmland. That farmland currently uses 3.2 billion gallons of water each year for irrigation, which is more than nearby Garden City with its 30,000 residents uses each year.

Background (Continued)

The largest proposed data center in the US, sited in the Texas panhandle, is proposed to use 2.1 billion gallons of water each year, which is still 1 billion gallons less than irrigating those 6,000 acres of farmland in Kansas. In fact, the data center proposed for those 6,000 acres would only require 20% of the water currently being used to irrigate that farmland (Moore). Several other industries consume just as much, if not more water than data centers, yet you rarely hear concerns about these industries, including the sports and fashion industries. In 2021, before several water-conserving innovations were developed, the average Google data center consumed 450,000 gallons of water each day. Watering just 17 acres of turf lawn grass one time uses the same amount of water. Likewise, the same amount of water is used to grow cotton for manufacturing only 160 pairs of jeans (Hölzle). The production of one single cotton t-shirt, from irrigating the cotton its made of, to dying the fabric, and processing the fabric requires 714 gallons of water before it even reaches stores. That amount of water is enough to provide one person drinking water for more than 2 years. Following the same process, a single pair of jeans requires 2642 gallons of water, which is equivalent to drinking water needs of 4,750 people. In fact, the global fashion industry consumes as much as 93 billion cubic meters of fresh water each year, which is enough to provide the drinking water needs of 5 million people for one year, or enough water to fill 37 million Olympic-sized swimming pools (Athar). In comparison, the 14% of water-cooled data centers that use more than 16 million gallons each year are hardly using any water at all, especially as begin to factor in how constant innovations are leading to rapid decrease in the amount of water data centers require.

In a Short amount of time, Data Centers have Drastically Improved in Water-Conservation:

The first Data Centers relied on cooling that used drinking water, usually billions of gallons each year. Most concerning statistics shared about Data Centers are from these original models. Take a minute and consider how fast technology changes—the phone in your hand is much different than the models that were out just 5 years ago. The first Data Centers were built with the internet in the 1990s and early 2000s. Just as the internet is much more efficient today than when it was first used, Data Centers have greatly evolved from their first prototypes.

New developments and innovations, such as closed-loop systems and using recycled water, are being implemented in newer data centers (Swinhoe). In fact, Microsoft Data Centers now only use water for administrative purposes, like bathroom and kitchen use, no longer using any water for cooling purposes unlike early models. New direct-to-chip cooling saves more than **125 million liters** of water each year **per datacenter** compared to original cooling models. It was reported in 2023 that since the first-generation data centers, Microsoft's Water Usage Effectiveness has improved **80%**. Microsoft's WUE improved drastically in just two years—nearly **40%** since 2021 as of 2023 (Solomon, Walsh).

Microsoft leaders explain, “Legacy facilities... often consume large quantities of water by using open evaporative cooling towers to produce low-temperature chilled water. Conversely, new data centers can use little to no water for cooling by deploying state-of-the-art water-efficient, waterless and hybrid heat rejection systems” (Dietrich). Data Centers today often only rely on water for cooling during the hottest temperatures of the year, which can be as little as 4-12 hours a day for 5-20 days each year. The dependence on water for cooling decreases even more in cooler climates, like the Midwest, as a large 25MW Data Center using a closed-loop system can rely on water-free cooling **90-95%** of the year (Dietrich).

Microsoft is just one of several tech companies that has made great improvements in data-cent water consumption. Google is also dedicated to water conservation, as the continually work on “developing new cooling solutions including a new low-water alternative that can reduce a data center's water use by as much as **50%** while preserving our world-class energy efficiency” (Hölzle). The company has even switched from the first-generation data center practice of using drinking water to using reclaimed water at more than **25%** of its Data Centers (Hölzle).

New Innovations in Cooling have Made Data Centers Less Dependent on Water Consumption:

There's a reason that data center water-consumption has drastically decreased since the first-generation models—continued investment in improvement has led to several innovations in data center operations and these innovations have made Data Centers less dependent on the mass water-consumption of the past.

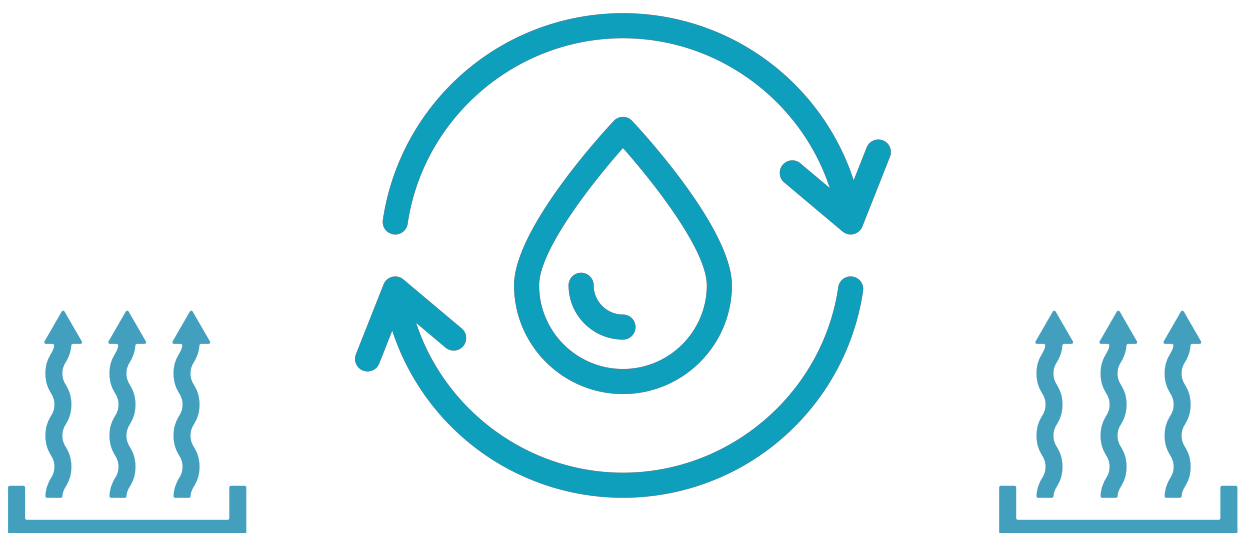
Amazon data centers largely rely on air-cooling, which doesn't require any water at all. In fact, in Amazon data centers, water is only used during the hottest days of the year through evaporative cooling units that are optimized to use minimal water. Unlike first-generation data centers, which used clean drinking water for cooling, when water is required for cooling on the hottest days, Amazon data centers use reclaimed water, or recycled water from wastewater treatment plants that is further treated for other uses like irrigating crops, watering golf courses, or, in this case: cooling data centers. This change will preserve over **530 million gallons**, enough to fill more than **800** Olympic-sized swimming pools, of fresh drinking water each year. To ensure the water used for cooling can be reused as many times as possible, some Amazon data centers are also installing on-site water treatment systems to remove scale-forming minerals, so the reclaimed water can be reused for more cooling cycles (Amazon).

The investment in minimizing water use is important because “We want to be using recycled water whenever possible because that leaves cleaner, higher-quality water available for others”, explained Amazon's water sustainability lead, Will Hewes (Swinhoe).

Amazon is not the only company investing in minimizing water use in data center operations. Google also uses reclaimed water at more than **25%** of their data centers. Apple also uses reclaimed water with an innovative twist—installing plant-based water treatment method that uses less chemicals than previous treatment designs. Leaders at Apple explained, “This system, which uses compostable, natural sphagnum moss to improve water quality, can further improve water savings”. These new systems have already been installed on-site at data centers in Nevada, North Carolina, and Arizona (Swinhoe).

New Innovations in Cooling have Made Data Centers Less Dependent on Water Consumption:

Innovations in water conservation go far beyond using reclaimed water. In 2024, Microsoft developed a new data center design that does not use any water at all. The new design, relying on chip-level cooling providing precise temperature control, and allowing data centers to run efficiently without depending on water consumption for evaporative cooling. Even before this zero-water design was created, Microsoft, like most other companies, had adopted closed-loop cooling systems as standard-design for their data centers. These closed-loop systems, once initially filled with water, circulate the water between servers and chillers to dispel heat without using a new water supply. For now, Microsoft data centers in hotter temperatures, including Texas, and California will still use closed-loop systems only on the hottest days of the year. However, water use for data center cooling, even in the hottest temperatures, **will soon be a practice of the past**, as Microsoft is piloting its new, **zero-water data center** design in Phoenix, Arizona, as the company continues to apply this design in the other data centers under construction, like the one in Mount Pleasant, Wisconsin (Solomon).



Data Centers are Investing in Community Partnerships and Watershed Health:

Beyond investing heavily in innovation that allows data centers to operate independently of water, companies constructing data centers are also investing heavily in water conservation and watershed health for the communities in which they are building.

In fact, most companies, including Amazon, Google, and Microsoft, have pledged to be water positive by 2030, meaning they are promising to restore more water than they use in data center operations (Amazon, Google, Microsoft, Swinhoe). These companies have various approaches for supporting watershed health and restoring water in the communities housing their data centers.

Amazon was already **53%** of the way to achieving the company's water-positivity goal in 2024 (Amazon). Through partnering both with private and public entities, Amazon is working to ensure that when Amazon data centers discard water, that water can be reused again, like in irrigation.

Microsoft is investing heavily in data center and chip innovation to meet the company's water-positive goal. In addition to investment in innovation, Microsoft is also involved in more than **49** water restoration projects worldwide, which, throughout the span of the projects, can restore more than 24,000 Olympic size swimming pools of water. Through these programs, Microsoft has aided in providing more than 1.5 million people with clean water and sanitization services. Microsoft leaders explain their water advocacy projects focus on three different priorities, “: **(1)** serving on a coalition to increase water reuse and recycling across the United States, **(2)** funding projects that support Tribal Nations and state governments in increasing water security, and **(3)** supporting research, analysis, and advocacy on water in the European Commission” (Walsh).

Data Centers are Investing in Community Partnerships and Watershed Health:

Google has included a specific number with its goal of water-positivity, pledging to restore **120%** of the water it uses for data center cooling (Google, Swinhoe). More specifically, Google's goal for water positivity is "to enhance our stewardship of water resources across Google office campuses and data centers and to replenish our water use while improving watershed health and ecosystems in water-stressed communities" (Hölzle). In Douglas County, Georgia, Google has used recycled municipal wastewater that would otherwise be discarded in the Chattahoochee River for cooling its data centers. Any water that is left over after evaporative cooling is treated by Google and then the cleaned water is returned to the river (Hölzle). Google leaders explain they are focusing on three areas for water conservation, "enhancing our stewardship of water resources across Google office campuses and data centers, replenishing our water use and improving watershed health and ecosystems in water-stressed communities; sharing technology and tools that help everyone predict, prevent and recover from water stress" (Brandt).



This dedication includes working directly with communities, as Google did for the San Francisco Bay area, working with ecologists and landscape architects to improve landscape resiliency and watershed health. This resulted in the implementation of drip irrigation, watering systems that adjust to weather, and the adoption of diverse landscapes on Google campuses that can withstand climate change. The company also worked with Los Angeles to remove water-thirsty invasive species from the local ecosystems. (Brandt).

When the research is done and the facts are considered, it is beyond clear that data center water-consumption is a concern of the past. Like all technology, the evolution of data center design has led to rapid innovation and drastic leaps towards data center operation independent of water. Several other industries which have existed far longer than data centers use much more water than modern data centers require, and these industries, including agriculture, sporting, and fashion have not made nearly as much progress in altering their practices to conserve water. These other industries do not receive nearly as much criticism as data centers despite the fact that data center operations are racing toward zero-water design while also investing in further water conservation and watershed health for their communities.

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