How Does the Location of AI Data Centers Affect Their Water Use, and How Can Wastewater Reuse Help Local Communities?

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ABSTRACT

Artificial intelligence (AI) needs huge amounts of computing power, and most of this computing happens in large buildings called data centers (Mytton, 2022). When people talk about data centers, they usually focus on electricity and carbon emissions, but there is another important issue: water (Bloomberg News, 2025; Mytton, 2021). Data centers use water directly for cooling, and they also use water indirectly through the power plants that produce their electricity (Mytton, 2021). This is a serious problem when many new AI data centers are being built in dry regions that already suffer from water shortages (Bloomberg News, 2025; Siddik et al., 2021).
This paper looks at two main questions.

1. How does the geographic location of AI data centers affect how much water they use?
2. How can data centers reuse wastewater so that they reduce their impact and potentially provide benefits to surrounding communities?

To answer these questions, the paper reviews scientific articles, reports, and news stories about data center water use, government rules, and examples of wastewater reuse projects (Mytton, 2021; Siddik et al., 2021; Shumaker, Loop & Kendrick, LLP, 2026). The findings indicate that geographic location substantially influences total water use, with hot and dry regions powered by water-intensive electricity sources leading to much higher water use per unit of computing than cool and wet regions powered by renewable energy (Mytton, 2021; Lei et al., 2025). At the same time, case studies and pilot projects show that if data centers use treated wastewater instead of freshwater, and if they return some water or heat to cities, they can lower their footprint and even support local water and heating systems (Ebrahimi et al., 2014; U.S. Environmental Protection Agency [EPA], 2026; World Economic Forum, 2024).

1. INTRODUCTION

Modern AI models, such as large language models and image generators, run on special computer chips inside large data centers (Mytton, 2022). As AI becomes more popular, companies are building more and more of these centers around the world, and their electricity demand is expected to grow quickly

(International Energy Agency [IEA], 2024). Most public debates focus on how much electricity they use and how this affects climate change (IEA, 2024). However, data centers also use a lot of water, and this is starting to receive more attention (Bloomberg News, 2025; Mytton, 2021).

Data centers use water in two main ways. First, many centers use evaporative cooling, where water is sprayed or evaporated to remove heat from servers; this can use huge volumes of water, especially in hot and dry climates (Mytton, 2021). Second, data centers use water indirectly through the power plants that generate their electricity, because many power plants also need water for cooling (Mytton, 2021; Macknick et al., 2012). For example, one report estimated that U.S. data centers used about 626 billion liters of water in 2014, and water use has likely increased since then as cloud computing has grown (Shehabi et al., 2016; Mytton, 2022). Some journalists have compared the daily water use of a single large data center to the water use of a small town (Bloomberg News, 2025).

At the same time, many new AI data centers are being built in water-stressed regions, such as parts of California, Arizona, and other dry states in the U.S. (Bloomberg News, 2025; Siddik et al., 2021). In these places, farmers and residents worry that data centers will take water away from agriculture and households (Cowboy State Daily, 2025; Khanna, 2026). This has led to protests, delays, and in some cases, temporary bans on new facilities in certain areas (DutchNews.nl, 2022).

This situation raises two big questions:

- If location and climate matter so much, should water-stressed regions allow new AI data centers at all, or should they set strict conditions?
- Instead of only using freshwater once and then wasting it, can data centers reuse water and even support local water systems?

To explore these questions, in this paper, I will:

- explain how geography and electricity mix affect data center water use;
- summarize policy ideas such as bans, permits, and pricing;
- and describe examples where data centers reuse wastewater or help local communities.

My goal is to understand how we can get the benefits of AI without putting too much pressure on local water resources.

2. METHODOLOGY

My project is a literature review, which means it is based on reading and combining existing sources instead of doing original experiments or fieldwork. To make the review process transparent, this section describes where I searched, which search terms I used, which time period I covered, and how I decided which sources to include.

I searched three main databases and search tools: Google Scholar, ScienceDirect, and the publication libraries of government and research organizations such as the International Energy Agency and

Lawrence Berkeley National Laboratory. The exact search terms were: "data center water consumption," "AI data center cooling," "water usage effectiveness," "water-stressed regions," and "wastewater reuse data centers." The search covered sources published between January 2012 and July 2026; the earlier boundary was chosen so that widely cited foundational studies on power-plant water use and data center energy use (Macknick et al., 2012; Shehabi et al., 2016) could be included.

I used three inclusion criteria: the source had to (a) be written in English, (b) focus on data center water use, cooling technology, water policy, or water reuse, and (c) contain verifiable data or clearly explained arguments. I excluded marketing materials, sources that only repeated other articles without adding new information, and sources without an identifiable author or organization. Every entry in the reference list was checked against the original publisher or database, and sources that could not be verified were replaced with verifiable ones.

Because the quality of sources on this topic varies a lot, I ranked them in a clear hierarchy. Peer-reviewed journal articles and government or national-laboratory reports (for example, Mytton, 2021; Siddik et al., 2021; Shehabi et al., 2016; IEA, 2024) were treated as the core evidence of this review. Industry and policy analyses (for example, World Economic Forum, 2024; Shumaker, Loop & Kendrick, LLP, 2026) were used to describe recent policy developments. News articles and journalistic investigations (for example, Bloomberg News, 2025; Cowboy State Daily, 2025; Associated Press, 2025; VPM News, 2026) were used only as illustrative examples of real-world conflicts and projects, not as core scientific evidence, because they are not peer reviewed. One frequently used source, Mytton (2022), is a practitioner blog written by the author of the peer-reviewed article Mytton (2021); it was used only for updated numerical estimates. When academic and journalistic sources disagreed, I relied on the academic source.

In addition to the database search, I collected news articles and policy briefs that describe real conflicts and case studies, such as debates in Cheyenne, Wyoming, and legal analysis of new water rules for data centers (Bloomberg News, 2025; Cowboy State Daily, 2025; Khanna, 2026; Shumaker, Loop & Kendrick, LLP, 2026). These illustrative sources helped show how the problem looks from the point of view of local communities and governments.

Finally, I grouped the literature into three themes:

1. **Geography and water use** – how climate, cooling technology, and electricity mix affect water consumption (Mytton, 2021; Siddik et al., 2021; Lei et al., 2025).
2. **Policy frameworks** – how governments try to control data center growth through bans, permits, and pricing (DutchNews.nl, 2022; Monstadt, 2025; Olmstead, 2010; UC Berkeley Center for Law, Energy & the Environment [CLEE], 2026).
3. **Wastewater reuse and community benefits** – how data centers can use recycled water and support local systems (Ebrahimi et al., 2014; EPA, 2026; World Economic Forum, 2024).

This structure helped me answer the two research questions in a clear way.

3. HOW LOCATION AFFECTS DATA CENTER WATER USE

3.1 Direct Water Use and Water Usage Effectiveness

One useful measure for data center water use is Water Usage Effectiveness (WUE), which is the amount of water a data center uses on-site in one year divided by the energy used by the IT equipment in kilowatt-hours (Mytton, 2021). A lower WUE means that the data center uses less water for each unit of computing.

Studies show that WUE depends strongly on climate (Mytton, 2021; Siddik et al., 2021). In cool and humid regions, data centers can often use outside air or "free cooling" for much of the year, so they do not need to evaporate as much water (Mytton, 2022). In hot and dry climates, evaporative cooling is used more often, which sharply increases water use (Siddik et al., 2021).

A recent review of data center workloads found that if you consider climate zone, server efficiency, cooling technology, and the water intensity of the electricity grid together, the water use per unit of computing can vary by more than ten thousand times (Lei et al., 2025). This very large range needs careful explanation, because it is a modeled estimate based on extreme scenarios, not a measured difference between two typical facilities. At the low end of the range is a highly efficient data center in a cool climate that uses free-air cooling, so it consumes almost no water on-site, and that buys electricity from low-water sources such as wind and solar. At the high end is an inefficient facility in a hot, dry climate that relies on evaporative cooling and on electricity from water-intensive thermoelectric power plants. The comparison also uses a wide system boundary that includes both on-site cooling water and off-site water used in electricity generation, and it covers different workload types, from highly optimized cloud servers to older, less efficient equipment. In other words, the "more than ten thousand times" figure describes the gap between a best-case and a worst-case combination of climate, cooling technology, server efficiency, and electricity mix. Even so, it shows that where you put an AI data center and how you cool and power it matters enormously.

3.2 Indirect Water Use from Electricity Generation

Location also matters because of the electricity mix. Many power plants that burn coal, gas, or use nuclear energy need large amounts of water to cool their systems (Macknick et al., 2012; IEA, 2024). If a data center is in a region that heavily depends on these plants, then even if the data center itself uses little water on-site, its electricity indirectly causes high water use (Mytton, 2021; Siddik et al., 2021).

Studies from the United States suggest that, in some cases, the water used by power plants to produce electricity for data centers can be several times larger than the water used directly at the data center (Mytton, 2021). One estimate suggests around 7.6 liters of water used in power generation for every 1 kilowatt-hour of electricity, compared with about 1.8 liters for direct cooling (Mytton, 2022).

On the other hand, if a data center runs mostly on renewable energy such as wind and solar, which use almost no water for operation, then its total water footprint can be much lower (Lei et al., 2025; Macknick et al., 2012). This means that when choosing data center locations, companies and governments need to think about both climate and the type of electricity available. Table 1 summarizes the difference between direct and indirect water use and shows where wastewater reuse fits in as an alternative supply.

Table 1. *The main water pathways of an AI data center (based on Mytton, 2021, 2022; Macknick et al., 2012; Ebrahimi et al., 2014; EPA, 2026).*

Water pathway	Where the water is used	Approximate scale (U.S. averages)	Main ways to reduce it
Direct cooling water (on-site)	Evaporative cooling towers and humidification inside the data center	About 1.8 liters per kilowatt-hour of IT energy (Mytton, 2022)	Free-air cooling, liquid cooling, siting in cool and humid climates
Indirect water from electricity generation (off-site)	Cooling of thermoelectric power plants (coal, gas, nuclear) that supply the grid (Macknick et al., 2012)	About 7.6 liters per kilowatt-hour of electricity (Mytton, 2022)	Buying or generating low-water electricity such as wind and solar
Wastewater reuse (alternative supply)	Reclaimed municipal wastewater used for cooling; recovery of blowdown and condensate	Can replace a large share of freshwater withdrawals (EPA, 2026)	Reclaimed-water cooling, blowdown and condensate recovery, sharing water and heat with the community

Note. The figures are illustrative estimates drawn from different system boundaries and should not be interpreted as a direct facility-to-facility comparison. Water withdrawal and water consumption may also differ depending on the technology evaluated.

3.3 Building Data Centers in Dry Regions

Recently, journalists and NGOs have paid attention to the fact that many new AI data centers are being built in already dry regions (Bloomberg News, 2025). A Bloomberg investigation in 2025 found that more than half of new large AI data centers in the U.S. since 2022 were located in states such as California, Arizona, Texas, Illinois, and Virginia, which already face strong competition for water (Bloomberg News, 2025). It should be noted that this is a journalistic investigation rather than a peer-reviewed study, but it is based on a large dataset of facility locations and public water records, and its overall picture agrees with peer-reviewed findings that a large share of U.S. data center servers rely on watersheds that are already moderately or highly water stressed (Siddik et al., 2021).

In Cheyenne, Wyoming, for example, some farmers fear that AI data centers will use irrigation water, while local officials argue that advanced cooling will keep water use similar to a large office building (Cowboy State Daily, 2025; Associated Press, 2025). In other places, projects have been delayed or cancelled because of water-rights disputes and community opposition (Khanna, 2026).

These cases show that data center siting is no longer just a technical or financial decision; it is also a political question about who gets access to limited water resources and who carries the risk when supplies run low (Hogan, 2015; Monserrate, 2022).

4. GOVERNMENT RESPONSES: BANS, PRICING, AND JUSTICE

4.1 Moratoriums and Permitting

Because of these conflicts, some local and national governments have considered or introduced moratoriums (temporary bans) on new data centers in certain regions. One well-known case is the Netherlands, where in 2022 the national government paused approvals for new hyperscale data centers across most of the country while new siting rules were developed (DutchNews.nl, 2022). Research on the Amsterdam region, which markets itself as the "Digital Gateway to Europe," shows how local governments have struggled to govern the spatial and environmental footprint of fast-growing data center clusters (Monstadt, 2025).

In the western United States, water rights were mostly designed for agriculture and cities, not for fast-growing industries like data centers (Khanna, 2026). Legal researchers argue that current permitting systems often look at each new project on its own, without considering the combined effect of many centers on long-term water availability (UC Berkeley CLEE, 2026).

4.2 Using Prices to Signal Scarcity

Some economists think that instead of bans, changing water prices could guide data center locations more effectively (Olmstead, 2010). In this view, utilities should charge higher prices per unit of water in dry regions and lower prices where water is more abundant (Olmstead, 2010). This would encourage companies to build water-intensive facilities in wetter regions or to invest in more efficient cooling where water is scarce.

In practice, however, changing water prices is politically difficult, because many water markets are incomplete or heavily influenced by powerful groups, and households often worry about higher bills (Olmstead, 2010). For this reason, bans or strict permit conditions may sometimes be easier to implement in the short term, even if they are not perfect from an economic point of view (Khanna, 2026).

4.3 Environmental Justice

Another important topic is environmental justice. Researchers who study the material footprint of computing argue that the costs and benefits of data centers are not shared equally (Hogan, 2015;

Monserrate, 2022). For example, a recent state study in Virginia found that groundwater levels in a critical aquifer are likely to decline partly because of industrial users such as data centers, which raises concerns for the rural communities that depend on that water (VPM News, 2026). At the same time, the main economic benefits, such as jobs, tax revenue, and digital services, often go to technology companies and urban consumers (Monserrate, 2022).

Experts argue that future rules for data centers should include justice checks, community-benefit agreements, and better participation of local residents in decision-making (Khanna, 2026). Without this, even efficient data centers may face strong local resistance.

4.4 Tiered and Conditional Approvals

Given these tensions, several researchers and legal analysts suggest tiered approval frameworks. In such systems, new data centers would be fully restricted in basins that are already beyond safe levels of water stress, allowed only with strict efficiency and reuse conditions in moderately stressed areas, and encouraged in water-abundant regions with low-water electricity (Siddik et al., 2021; UC Berkeley CLEE, 2026).

International organizations and some industry groups have begun to discuss linking data center permits to water-risk indicators and to detailed water-management plans (IEA, 2024; Shumaker, Loop & Kendrick, LLP, 2026). This approach tries to balance global demand for AI with local water realities and fairness.

5. WASTEWATER REUSE AND BENEFITS FOR COMMUNITIES

5.1 From One-Time Use to Circular Systems

The second research question asks how data centers can move from a linear water model — take freshwater, use it once for cooling, and then evaporate or discharge it — to a circular model (World Economic Forum, 2024). In a circular system, data centers might use treated wastewater from city treatment plants instead of drinking-quality water, recover some of the cooling-tower blowdown for non-drinking purposes, and share recovered heat or water with nearby buildings or farms (Ebrahimi et al., 2014; World Economic Forum, 2024).

Engineering reviews show that data centers produce large streams of low-grade waste heat that can be recovered for uses such as district heating, and that internal water streams, including condensate from air-conditioning units and blowdown water from cooling towers, can be treated and reused for non-potable purposes (Ebrahimi et al., 2014; World Economic Forum, 2024).

5.2 Real-World Examples

There are already some real-world projects that show what is possible. In Quincy, Washington, the city built a water-reuse system so that large data centers can be cooled with reclaimed water instead of drinking water; the U.S. Environmental Protection Agency documents this project as a case study of

successful industrial water reuse (EPA, 2026). Policy briefs from the United States also discuss the idea of using "produced water" from oil and gas operations after proper treatment as a cooling resource for data centers (Shumaker, Loop & Kendrick, LLP, 2026).

In Europe, several data centers already send their waste heat into district-heating networks, which turns a waste stream into a benefit for nearby residents (Ebrahimi et al., 2014; Monstadt, 2025). This suggests that data centers could play a small but meaningful role in circular water and energy systems rather than just being large consumers.

5.3 Barriers to Reuse

Even though the technology is promising, adoption of circular-water strategies has been slow. Industry analyses highlight three main barriers: weak business cases, insufficient monitoring of water flows, and the difficulty of integrating new water systems into existing infrastructure (World Economic Forum, 2024). In addition, different government agencies handle drinking water, industrial wastewater, and reclaimed water, so there is often no clear process for approving integrated systems (UC Berkeley CLEE, 2026; Shumaker, Loop & Kendrick, LLP, 2026).

5.4 Partnerships with Local Communities

Some authors propose viewing data centers as partners in local water systems rather than just users (Monstadt, 2025; World Economic Forum, 2024). One idea is to place hyperscale data centers next to municipal wastewater plants, using reclaimed water for cooling and then returning part of that water and heat to support district heating or industrial processes (Ebrahimi et al., 2014; World Economic Forum, 2024).

For countries in the Global South, where both digital infrastructure and water scarcity are growing challenges, commentators argue that water reuse should be designed into new data centers from the start, rather than added later (World Economic Forum, 2024). This could help ensure that new AI capacity does not worsen local water stress and instead contributes to resilience.

6. DISCUSSION

6.1 Location and Restrictions (RQ1)

The reviewed literature makes it clear that geographic location has a big impact on the water footprint of AI data centers (Mytton, 2021; Lei et al., 2025). Hot and dry climates, combined with water-intensive electricity grids, lead to much higher direct and indirect water use than cool and wet climates with plenty of renewable energy (Siddik et al., 2021; Macknick et al., 2012).

Because of this, it is risky for water-stressed regions to simply approve new AI data centers without strict conditions (UC Berkeley CLEE, 2026). At the same time, complete bans or long moratoriums might push

development to other regions and could reduce local economic opportunities (DutchNews.nl, 2022; Bloomberg News, 2025).

A more balanced strategy is to use tiered, conditional permitting that restricts new data centers in already over-stressed basins, allows them only with strong efficiency and reuse measures in moderately stressed regions, and encourages them in water-abundant areas with low-water electricity sources (Siddik et al., 2021; UC Berkeley CLEE, 2026). This approach requires better data about local water resources and closer coordination between energy, water, and digital-infrastructure planning, which many governments are still developing (Khanna, 2026; Monstadt, 2025).

6.2 Wastewater Reuse and Community Benefits (RQ2)

For the second question, the literature shows that data centers can greatly reduce their freshwater withdrawals when they rely on reclaimed water and share some of it with the community (Ebrahimi et al., 2014; EPA, 2026). Some companies describe such projects as "water-neutral" or even "water-positive," but these labels should be used with caution. Replacing drinking water with treated wastewater reduces pressure on potable supplies, but the facility may still evaporate large volumes of water, and the reclaimed water it consumes might otherwise have been returned to rivers or aquifers. A data center can therefore still have a net impact on the local watershed even when it withdraws no freshwater directly (Mytton, 2021; Siddik et al., 2021). Real projects in the United States and Europe show that cooling with reclaimed water and recovering heat are technically possible and can be cost-effective in the long term (EPA, 2026; Ebrahimi et al., 2014).

To make these practices standard instead of exceptional, three changes seem important: better regulation, new types of contracts, and a more positive public narrative (World Economic Forum, 2024; Shumaker, Loop & Kendrick, LLP, 2026). If these conditions are met, it might be reasonable to allow AI data centers in some water-stressed regions, but only when they commit to strong reuse systems and clear community benefits (Siddik et al., 2021; Khanna, 2026).

6.3 Limitations

This review has several limitations. First, it does not conduct original calculations or measurements; all numbers come from published sources that use different methods and assumptions. Second, it does not quantitatively compare specific data center designs, so the conclusions describe general patterns rather than precise engineering results. Third, most of the case studies come from the United States and Europe, where data availability, climate, and regulation differ from other regions; the findings may therefore not apply equally to Asia, Africa, or Latin America. Finally, because journalistic sources were used to illustrate recent conflicts, some details of those examples may change as more academic research becomes available.

7. CONCLUSION

AI data centers are now essential for many digital services, but they also have important environmental impacts, including water use (Mytton, 2022). This review has shown that where a data center is built and how it is cooled strongly influence its total water footprint (Mytton, 2021; Lei et al., 2025). Hot, dry regions with water-intensive power plants create much higher water use per unit of computing than cooler, wetter regions with renewable energy (Bloomberg News, 2025; Siddik et al., 2021).

Government responses are still evolving. Some places have tried bans or moratoriums, while others have started to design more detailed approval systems that take water risk into account (DutchNews.nl, 2022; UC Berkeley CLEE, 2026). Economic ideas like water-scarcity pricing are interesting but often slow to implement (Olmstead, 2010). Questions of fairness and environmental justice remind us that the costs and benefits of data centers are not shared equally, especially between wealthy tech companies and local communities (Hogan, 2015; Monserrate, 2022).

On the positive side, engineering research and real-world projects show that data centers can significantly reduce their freshwater use by relying on treated wastewater and by recovering water and heat for local uses (Ebrahimi et al., 2014; EPA, 2026; World Economic Forum, 2024). Turning these pilots into normal practice will require better regulation, creative business models, and trust between companies, governments, and citizens (World Economic Forum, 2024; Shumaker, Loop & Kendrick, LLP, 2026).

Based on this review, I propose four specific policy recommendations. First, regulators should require a water-risk assessment before granting permits for new data centers, so that the cumulative impact on the local basin is evaluated, not just each project on its own (UC Berkeley CLEE, 2026). Second, in water-stressed areas, permits should mandate the use of reclaimed or other non-potable water for cooling wherever a suitable supply exists (EPA, 2026; Shumaker, Loop & Kendrick, LLP, 2026). Third, operators should be required to publicly report their annual WUE and total water withdrawals, so that communities and researchers can compare facilities and track progress over time (Mytton, 2021). Fourth, large projects should be linked to community-benefit agreements that return part of the water, heat, or revenue to local residents (VPM News, 2026; Khanna, 2026).

In the next decade, as AI continues to grow, decisions about data center locations, cooling technologies, and water-reuse systems will directly affect many people living in water-stressed regions (Bloomberg News, 2025; Siddik et al., 2021). For this reason, AI policy and water policy should not be treated separately; instead, they need to be planned together, with careful attention to climate, local water availability, and the needs of surrounding communities.

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