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Part 3

Data Centers and the Water-Energy Nexus

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The first two columns in this series established a measurement and management foundation for data center water stewardship. Part 1¹ introduced water usage effectiveness (WUE), WUE_{source} and water usage impact (WUI) as metrics for quantifying direct site water consumption, upstream power-generation water use and regional water stress. Part 2² examined water conservation initiatives at leading hyperscalers and introduced Water Use Credits (WUCs), a market-based framework organized around three investment categories: conservation (WUC-C), offset (WUC-O) and technology (WUC-T). This third and final column turns to implementation of a potential market-based framework: How should water be valued? How do water and carbon goals sometimes conflict? How can a market-based structure for data center water use be designed? And finally, how can ASHRAE help advance the field?

Water Valuation: From Cost-of-Service to Scarcity Value

Current water valuations represent a market failure. Water is frequently priced below its full scarcity or ecological value, which can encourage increased consumption relative to what local communities could support.³ To create an effective market-based solution that directly impacts data center water consumption, the public must understand how water is currently priced and what is omitted in its calculation.

WUE_{source} captures the water consumed by the power plants to generate the electricity that data centers require. Many large thermoelectric plants withdraw water directly from rivers, reservoirs or groundwater basins under long-term water rights or permit authorizations. That cost reflects water rights acquisition, pumping, treatment and environmental

compliance. It does not reflect the broader nonconsumptive value of water in the watershed, which can instead be captured using a practice called environmental valuation,⁴ which is not the subject of this article. This upstream water consumption⁵ is captured by the energy water intensity factor (EWIF), which is used to calculate WUE_{source} ($= [EWIF \times PUE] + WUE$) and is not captured in facility-level WUE reporting. This distinction illustrates why WUE_{source} must accompany WUE in every disclosure of water consumption in the data center industry to maintain transparency and accountability.

At the utility level, water rates reflect a cost-of-service framework. Utilities calculate the revenue required to

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TABLE 1 Water utility rates by city and World Resources Institute overall water risk tier.

LOCATION	PRIMARY WATER SOURCE	OVERALL WATER RISK (WRI)	COMMERCIAL/INDUSTRIAL RATE	NOTES
Portland, Ore.	Bull Run Watershed/Columbia South Shore Well Field	Low (0–1)	\$74.14/mo base + \$8.17/CCF ⁸	Small meter; low-stress Pacific Northwest supply
Atlanta	Chattahoochee River	Low-Medium (1–2)	\$6.56/mo base + \$6.16/CCF ⁹	ACF basin subject to multistate water conflicts
Milwaukee	Lake Michigan	Medium-High (2–3)	\$278.87/mo base + \$1.69/CCF ¹⁰	Great Lakes supply; low inherent physical stress;
Tucson, Ariz.	Colorado River via CAP; local groundwater and reclaimed water	High (3–4)	\$790.96/mo base + \$6.62/CCF ¹¹	Rate reflects Colorado River scarcity and imported supply costs
San Diego	Imported (Northern Calif. + Colorado River); local reservoirs	Extremely High (4–5)	\$1,537.58/mo base + \$9.36/CCF ¹²	Reflects import dependency and scarcity premium

Meter sizes vary across cities; rates current as of available public schedules; verify at time of project analysis. OWR tiers are approximations; confirm against WRI Aqueduct Atlas at project initiation. ACF = Apalachicola-Chattahoochee-Flint basin, CAP = Central Arizona Project

operate, maintain and reinvest in the system: pipes, pumps, treatment facilities and staff. Those costs are then distributed across customer classes. Commercial and industrial customers, such as data centers, typically pay a fixed base charge plus a volumetric rate expressed in dollars per hundred cubic feet.⁶ While volumetric rates are intended to reflect use and encourage conservation, they primarily recover infrastructure obligations and do not systematically incorporate the scarcity value or ecological impact of the water resource itself. Also, water is often subsidized by the government to maintain affordability, making water cheaper than either its free-market or environmental cost.

Table 1 illustrates how commercial and industrial water rates vary across five U.S. cities with different overall water risk (OWR) designations.⁷ While the data suggest a general correlation between water stress and volumetric rate, the relationship is not direct. A facility in an extremely high-stress region paying \$9.36/CCF covers the infrastructure cost of delivering scarce imported water and is not directly covering the full ecological opportunity cost of the water consumed. This shows that utility billing alone cannot substitute for rigorous WUE_{source} and WUI reporting used alongside a market-based framework like WUCs.

Water and Carbon: Competing Sustainability Goals

Parts 1 and 2 hinted at the relationship between water priorities and carbon reduction goals. Referencing the example calculation in Part 1, which compared an air-cooled chilled water plant and an indirect adiabatic cooling system for a hypothetical 1 MW data center in Georgia. The air-cooled plant achieves WUE ≈ 0, appearing water-neutral at the site level. However, the

air-cooled plant drives a higher PUE of 1.30, consuming more electricity than the adiabatic alternative (PUE 1.15), meaning its WUE_{source} is also higher. When accounting for water consumed at the power plant (WUE_{source}), annual consumption of the air-cooled chiller plant is approximately 13 million liters (3.4 million gallons). The indirect adiabatic operation has WUE ≈ 0.25, as it runs mostly dry with limited seasonal water use. The total-system water footprint is approximately 12.5 million liters (3.3 million gallons), despite consuming water on-site.

This example illustrates a clear water-energy trade-off, reinforcing the point that water and energy metrics cannot be considered separately. In this example, the air-cooled system consumes more electricity, increasing Scope 2 (generation) carbon emissions. The adiabatic system reduced Scope 2 emissions, while increasing on-site water consumption. Thus, a large-scale sustainability commitment targeting only energy or only water or only carbon risks optimizing one resource at the expense of the other.

New data center designs must be designed to be flexible and manage resource consumption dynamically and efficiently. Additionally, water accounting must include WUE_{source} alongside WUE for every data center project; a facility reporting WUE = 0 without also reporting WUE_{source} provides an incomplete and potentially misleading picture of its water footprint.

Implementing Water Use Credits: From Framework to Practice

Part 2 introduced WUCs as a flexible framework for creating economic incentives for water stewardship, organized into three categories: WUC-C (conservation:

avoiding or eliminating potable water demand through design), WUC-O (offset: replenishing water to the local watershed or community) and WUC-T (technology: reducing water use through efficiency improvements, controls or metering).

A central challenge is that water is fundamentally regional. One gallon conserved in an extremely high-stress watershed in Arizona is not equivalent to one gallon conserved in a low-risk watershed in the Pacific Northwest. Effective WUC programs must be anchored to specific water basins, aquifers or watersheds, and water use caps should be based on absolute water volume use or on metrics like WUI or WUE_{source} rather than WUE alone, to prevent facilities from claiming credit for reductions in on-site water use that are offset by increases in upstream power-generation water.

Several existing market structures inform WUC design. Water quality trading markets focus on reducing pollutant loads. Voluntary water credit markets emphasize volumetric conservation. Water rights trading involves the transfer of legal entitlements to use water and is active in the western United States. For example, the Deschutes River Conservancy's Water Transactions Program uses instream leasing, permanent water rights transfers and groundwater mitigation banking to move water toward higher-priority ecological and community uses.¹³ This can serve as a model for WUC-O implementation.

For quantification of WUC-O credits, the World Resources Institute's Volumetric Water Benefit Accounting (VWBA) methodology provides a standardized approach for measuring water benefits across different geographic regions and restoration types.¹⁴ VWBA is already being adopted by hyperscalers as a basis for crediting replenishment projects.

Accounting for the Full Water Life Cycle: Metric Boundaries

An important limitation of current WUE accounting is the exclusion of construction-phase water use. WUE (as defined by The Green Grid and ISO) measures operational water consumption normalized to annual IT equipment energy. It does not capture water consumed for dust suppression during site preparation, the initial fill of chilled water and process cooling loops or flush-and-clean operations required before start-up. These are typically large, time-constrained events managed by the general contractor rather than the building owner

who submits operational WUE reports.

A 2026 incident in Fayette County, Georgia, brought this gap into focus. A large data center campus drew approximately 29 million gallons (109.8 million liters) through utility connections that the county had not fully identified or metered, causing residential water pressure drops in surrounding neighborhoods. The operator attributed the elevated consumption to temporary construction activities.¹⁵ The incident illustrated that the temporal boundary of "data center water use" is not yet well-defined in industry standards; construction and start-up activities can impose acute demands on municipal supply systems before a facility ever reports operational WUE value.

The practical implication is to extend water accounting to explicitly cover preoperational phases. A construction-phase water use disclosure or a reported estimate of one-time fill and flushing volume alongside operational WUE and WUE_{source} would improve transparency and reduce the risk of utility supply conflicts during development. This is consistent with the series' overarching position: water impacts must be relevant to the community it impacts and disclosed with enough specificity to support informed conversations with stakeholders. *Table 2* shows all water metrics available from The Green Grid and ISO.

ASHRAE Standards and the Path Forward

ASHRAE Standard 90.4, *Energy Standard for Data Centers*, recently expanded its scope to include a commitment to balancing energy efficiency with a wider set of environmental metrics. Water consumption is explicitly acknowledged within the standard's purpose, and the SSPC 90.4 committee is examining how water metrics could be incorporated into compliance pathways.¹⁶

One promising direction is aligning water performance requirements with regional water stress designations such as the WRI Aqueduct OWR tiers introduced in Part 1 so that facilities in high-stress regions face more stringent WUE_{source} thresholds or mandatory WUC-O requirements. This would make the geographic dimension of water risk explicit in the standard, rather than relying on uniform national benchmarks that cannot reflect local basin conditions. It would also create a direct link between existing metrics (WUE, WUE_{source} , WUI) and regulatory instruments (caps, credits and disclosure requirements).

TABLE 2 Summary of data center water metrics—Parts 1, 2 and 3.

METRIC	SOURCE	UNITS	SCOPE	NOTES
WUE	TGG/ISO Cat. 1–2	L/kWh	On-site facility	Annual site water consumption ÷ IT equipment energy. WUE alone is insufficient; always report alongside WUE_{source} .
WUE_{source}	TGG/ISO Cat. 3	L/kWh	On-site + upstream power generation	$(EWIF \times PUE) + WUE$. Captures power-plant water use; essential for full life-cycle reporting. Should accompany every WUE disclosure.
WUI	TGG	L/kWh	On-site × regional scarcity	$WUE \times (WSF + 1)$, where WSF is the WRI Aqueduct Overall Water Risk score (0–5). Incorporates regional water stress.
WUE1	ISO/IEC 30134-9	L/kWh	Basic on-site	Physical water input of DC = water consumed; no reuse subtracted.
WUE2	ISO/IEC 30134-9	L/kWh	Intermediate on-site	Water input less nonindustrial reuse output.
WUE3	ISO/IEC 30134-9	L/kWh	Advanced on-site + upstream	Subtracts nonindustrial and industrial reuse; includes upstream energy-production water and excludes rainwater. Functionally equivalent to TGG WUE_{source} .
iWUE	ISO/IEC 30134-9	L/kWh	Interim	Used when the reporting period is shorter than one year.
WRF	ISO/IEC 30134-9	m³/m³	Water reuse factor	Additional KPI reported alongside WUE2 or WUE3 when on-site water reuse is present.

Notes: All units normalized to L/kWh (1 m³/MWh = 1 L/kWh). TGG = The Green Grid. ISO = ISO/IEC 30134-9:2022. pWUE, dWUE, qWUE, peakWUE derivatives appear in ISO/IEC 30134-9

ASHRAE members are well-positioned to advance this work. Practitioners designing data center cooling systems can share measured WUE and WUE_{source} data to support realistic baseline development. Energy engineers familiar with EWIF values and regional power generation mix can contribute to region-specific standard guidance. Environmental engineers with experience in watershed restoration and water rights markets can help define what constitutes a credible WUC-O offset. Engaging with the SSPC 90.4 public review process is the most direct path to ensure that the standard reflects current engineering practice and the concerns that communities are raising about data center development.

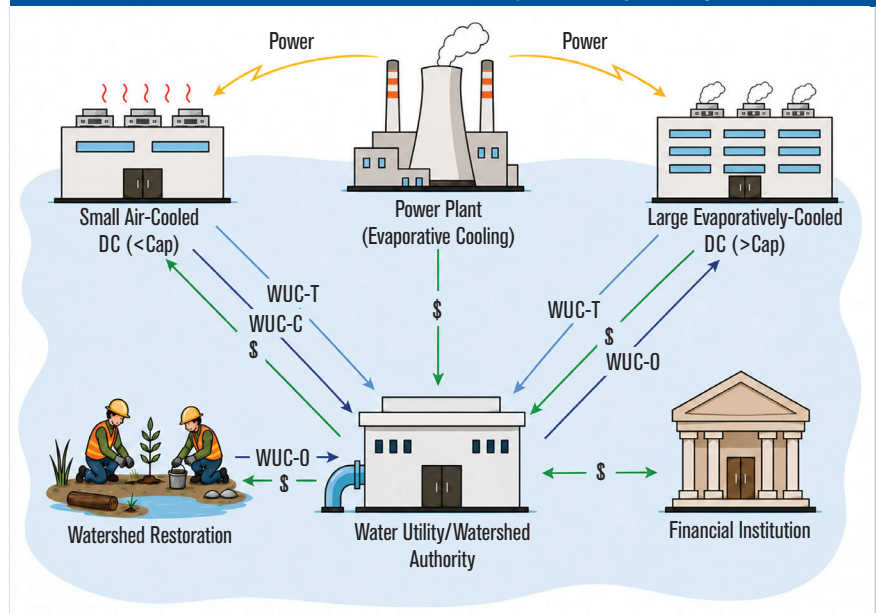
Summary

This three-part series has examined the data center water-energy nexus from measurement through management and toward market-based implementation. The central argument is that water impacts must be reported with specificity to capture upstream power-generation water use and regional water stress. Cooling system selection, power purchase and geographic siting shape total life-cycle water footprints in ways that site-level consumption cannot.

Voluntary corporate initiatives from hyperscalers, while meaningful, are not sufficient to drive industry-wide stewardship. The WUC framework introduced in Part 2 and elaborated here provides a market-based complement: WUC-C credits for water reduction in design, WUC-O credits for basin-level replenishment quantified through VWBA and WUC-T credits for technology-driven efficiency improvements. Caps should be geographically bounded by the watershed or aquifer it impacts rather than national averages.

The data center industry's growth trajectory is not in question. In question is whether the frameworks for

FIGURE 1 The WUC flow network: a localized basin-based cap-and-trade system diagram.



measuring, valuing and managing its water footprint will keep pace. By combining rigorous metric reporting, basin-based WUC programs, transparent life-cycle accounting (including construction-phase disclosure) and active participation in ASHRAE standards development, the industry can support continued growth in digital infrastructure while demonstrating responsible stewardship of freshwater resources.

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