A FIELD GUIDE TO AI & DATA CENTERS

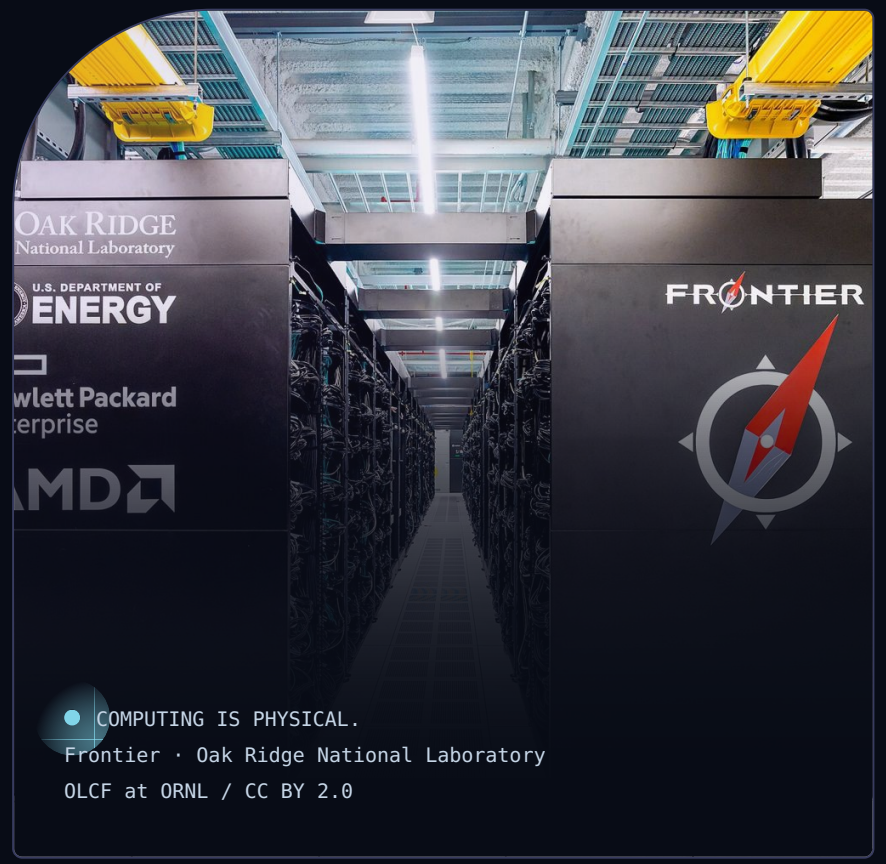
The Physical Cloud.

Power. Water. The places we live.

Behind the digital world is a physical one. Explore the machines, resources, money and decisions shaping the next generation of data centers.

Explore the chapter guide →

U.S. focus · Global context
Research through October 21, 2026



COMPUTING IS PHYSICAL.
Frontier · Oak Ridge National Laboratory
OLCF at ORNL / CC BY 2.0

485 TWh	649 TWh	66 billion L
Global data-center electricity 2025 historical estimate IEA / 2026 REPORT ↗	U.S. data-center electricity in 2030 Reference case · 521–843 TWh range BERKELEY LAB / JUNE 2026 ↗	Direct U.S. water consumption 2023 estimate · all data centers BERKELEY LAB / HISTORICAL BASELINE ↗

Different places, years and measures, deliberately labeled. These figures come from separate models. Select a number to jump to its source record.

OFFLINE READING EDITION / Adapted from approved HTML review 02. Use Contents, Back and Next in the footer or your PDF reader’s bookmarks. Source badges link to the evidence register. External sources and videos require internet access.

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The cloud has an address.

01

Every digital service rests on buildings, machines, people and a place.

CHAPTER SOURCES S04 S02



Ashburn, Virginia. Theodore Christopher / CC0. Full credits in the source library.

A data center is the physical home of computing: servers process information, storage keeps it, networks move it, and electrical and cooling systems keep the equipment running. Email, banking, hospitals, video, scientific computing and artificial intelligence all depend on this infrastructure. The term does not identify a single building size, business model or resource footprint. S04

An AI facility is designed or equipped for AI work. It may be a dedicated campus, a rented hall inside a colocation building, or an upgraded part of an existing cloud region. A single operator can run conventional cloud services and AI in the same broader campus. A national total for all data centers should never silently become a total for AI alone.

Enterprise

A business or institution runs computing for its own operations. This can range from a server room to a substantial dedicated facility.

Colocation

A landlord supplies space, power, cooling and connectivity. Tenants install or operate the computers. The visible developer may not be the final user.

Hyperscale

A large cloud or internet platform operates at enormous scale, across many campuses and regions. A “region” is not necessarily one building.

AI-focused

Accelerator-rich computing for training and serving models. Density and workload differ across generations and applications.

> Read the label on every big number: **which facilities, which place, which year, and which measurement?**

Cryptocurrency mining is another category of computational load. Its hardware, economics and ability to pause are different. A “large-load” queue may include mining, manufacturing and other projects as well as AI; adding all requests together does not reveal AI demand. S02

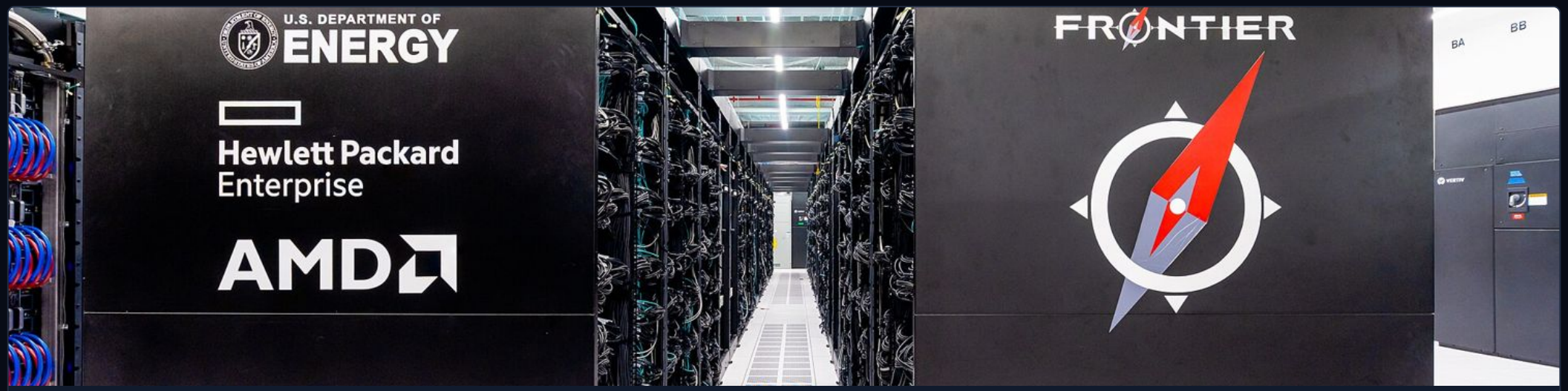
Once the building types are clear, the physical systems inside them are easier to follow.

Inside the machine.

02

Follow the electricity in, the information through, and the heat out.

CHAPTER SOURCES S04 S06 S24



Frontier supercomputer at Oak Ridge. OLCF at ORNL / CC BY 2.0. Scientific-computing illustration, not a commercial AI campus. Full credits in the source library.

A data hall is one part of a much larger operating system. The fence may enclose substations, transformers, power electronics, backup batteries, generators, cooling equipment and water-treatment systems. Fiber routes and new transmission lines can extend far beyond the property. S04 S06

01	02	03	04
POWER	COMPUTE	CONNECTION	HEAT REMOVAL
Grid · transformers · UPS	CPUs · accelerators · memory	Switches · fiber · storage	Air · liquid · outdoor rejection

The rack is changing

NVIDIA’s GB200 NVL72 provides a concrete example: 72 Blackwell GPUs and 36 Grace CPUs connected in a liquid-cooled rack-scale system. Other architectures use different chips, layouts, networking and cooling; this named system makes rack-scale computing concrete. S24

Higher power density concentrates more electricity and heat into a small floor area. A building that has spare square footage may still lack electrical capacity, structural capacity or the right piping. Retrofitting a conventional data hall can therefore be a substantial engineering project.

Installed capacity

The maximum or contracted capability of equipment or a connection. It can include reserves and future phases.

Actual operating draw

What the facility consumes at a particular time. It changes with occupancy, workload, temperature and operating choices.

> A large rack rating is neither a campus electricity bill nor evidence that every rack runs at its nameplate continuously.

The purpose of those machines helps explain their density, location and operating patterns.

What are we building it to do?

03

Training, inference and ordinary cloud computing have different needs.

CHAPTER SOURCES S03 S01 S04

Training

The model’s parameters are adjusted using data. Large training runs coordinate many accelerators. Research, testing, retraining and fine-tuning make this an ongoing development process, not one permanent, once-only event.

Inference

A trained model produces an answer, prediction, image, recommendation or other output. Work ranges from a short text request to long reasoning, video and multi-step agents.

These workloads overlap with ordinary cloud services, enterprise software, advertising, scientific simulation and storage. A campus can support several categories. AI may be the reason for expansion without being the only workload on the premises.

Efficiency and growth can happen together

The IEA’s 2026 assessment finds large improvements in energy per AI task, alongside a shift toward more demanding applications. A single short query cannot stand in for all AI use. S03

A smaller energy cost per task can be offset by more users, more tasks per user, longer outputs or more complicated work. Conversely, improved models and hardware can reduce resource use for a fixed workload. The eventual total depends on all of those moving parts.

WORKLOAD FEATURE	WHY IT MATTERS TO A COMMUNITY
Response time	Some services benefit from proximity to users. Some batch work can run farther away.
Scheduling flexibility	Work that can move in time may respond to power or water constraints. Contracted reliability can limit this.
Communication intensity	Large training jobs need fast links within a cluster; a distant spare computer is not always a substitute.
Utilization	Idle equipment still draws power. Occupancy, computational activity and electrical load factor are different measures.

A practical question for the developer: what work will run here, what flexibility is contractually available, and what public performance reporting will show it?

The investment cycle in context

In its April 2026 outlook, the IEA reports that capital expenditure by five major technology companies exceeded $400 billion in 2025 and was expected to rise by about 75% in 2026. This is company-wide capital expenditure, not a measured total for U.S. AI data-center buildings. It includes equipment and other assets, and expected spending is different from completed investment. S03

The same report estimates global data-center electricity rose 17% in 2025, while electricity at AI-focused facilities grew 50%. These modeled growth rates describe different populations. They help explain the construction interest without establishing that every proposed campus will be needed or financed.

The people behind the buildout.

04

The industry is an ecosystem, not one company and one permit.

CHAPTER SOURCES S25 S26 S27 S28 S07 S23 S24 S33 S34 S35 S20

Chip designers, fabricators, cloud providers, AI labs, colocation landlords, utilities, lenders and contractors perform different jobs. A cloud customer may rent computing rather than own a building. A developer’s announcement can include a tenant’s equipment investment and spending over many phases. Read the ownership and financing structure before adding headline dollar amounts.

A few names in the supply chain

EXAMPLE	ROLE IN THE INFRASTRUCTURE
NVIDIA / AMD	Design processors, accelerators and related computing platforms; suppliers rather than the operator of every building using their chips.
Amazon Web Services	Provides cloud services and its Trainium family of custom AI accelerators. S33
Google Cloud	Provides cloud services and custom Tensor Processing Units (TPUs). S34
Microsoft Azure	Provides cloud infrastructure and AI services to customers. S35
Meta / Entergy Louisiana	The Richland Parish example links a large computing customer to a utility’s planned generation and transmission buildout. S20

The companies are examples of different functions, not a market-share ranking. An organization can occupy several positions in this chain.

JH

Jensen Huang

NVIDIA / FOUNDER, PRESIDENT AND CEO

Founded NVIDIA in 1993. The company’s GPUs, networking and rack-scale systems connect the chip story to the power and cooling equipment in a data hall.

Profile source S25



Lisa Su

AMD / CHAIR AND CHIEF EXECUTIVE OFFICER

Leads AMD, a supplier of CPUs and AI accelerators. These processors are part of the broader mix of hardware used in cloud and high-performance computing.

Profile source S26

Portrait: AMD, official biography.

AS

Arman Shehabi

BERKELEY LAB / STAFF SCIENTIST

Coauthor of the U.S. data-center energy reports used here. The Lab’s work explains how equipment, utilization and cooling assumptions become national estimates.

Profile source S27



Fatih Birol

IEA / EXECUTIVE DIRECTOR

Leads the intergovernmental energy agency publishing the global Energy and AI assessments. Global energy scenarios answer a different question from a local permit study.

Profile source S28

Portrait: IEA, official profile.

The decisions are distributed

PARTICIPANT	WHAT TO UNDERSTAND
Operator / tenant	Who consumes the electricity and runs the equipment? Who is contractually responsible if the tenant leaves?
Developer / landlord	Who owns the land and buildings? Are approvals transferable?
Utility / grid operator	Who studies capacity, schedules connections and plans shared infrastructure?
Water supplier	Who controls treatment, storage, pipes, supply rights and drought restrictions?

PARTICIPANT	WHAT TO UNDERSTAND
Local government	Who controls zoning, site plans, setbacks, noise and local fiscal agreements?
State / federal bodies	Which commissions and agencies oversee utility rates, environmental permits and other relevant requirements?

Land-use approval, grid service and water allocation follow separate decision tracks. The governance chapter returns to who controls each one. S07 S23

That chain of participants comes together at a particular parcel of land.

Why here?

05

A proposed site is the intersection of land, power, water, fiber and time.

CHAPTER SOURCES S13 S04 S07



Ashburn exterior. Vahurzpu / CC BY-SA 4.0. Full credits in the source library.

Data centers cluster because existing infrastructure has value: fiber networks, reliable electrical service, suppliers, specialized workers and nearby customers can attract the next project. Virginia’s legislative audit identifies these factors in Northern Virginia’s growth. S13

Time to power

A parcel with a credible connection schedule can be more useful than a cheaper parcel waiting for major transmission.

Network geography

Latency, redundancy and fiber access shape where different workloads can operate.

Land and permissions

Large contiguous parcels, suitable terrain, compatible zoning and predictable approval processes can shorten development.

Climate and water

Outdoor conditions and dependable supplies affect cooling options, cost and operating flexibility.

The footprint does not stop at the fence

A campus can require off-site power lines, substations, generation, pipelines, roads or water infrastructure. Some facilities may share those assets; others may be dedicated. The host municipality and the people affected by new infrastructure are not necessarily the same population.

A realistic map should show the campus, nearby homes, schools and sensitive sites, the source watershed, the utility service area and any planned off-site works. Exact security-sensitive layouts are not needed to understand public impacts.

> “There is plenty of land” and “there is capacity to serve this site” are separate statements.

For a local proposal, compare the selected parcel with feasible alternatives. Ask which constraints genuinely rule alternatives out, which are matters of cost or timing, and which impacts can be reduced through site design.

To understand why a site can become difficult to serve, first put its proposed size into units that can be compared.

How big is big?

06

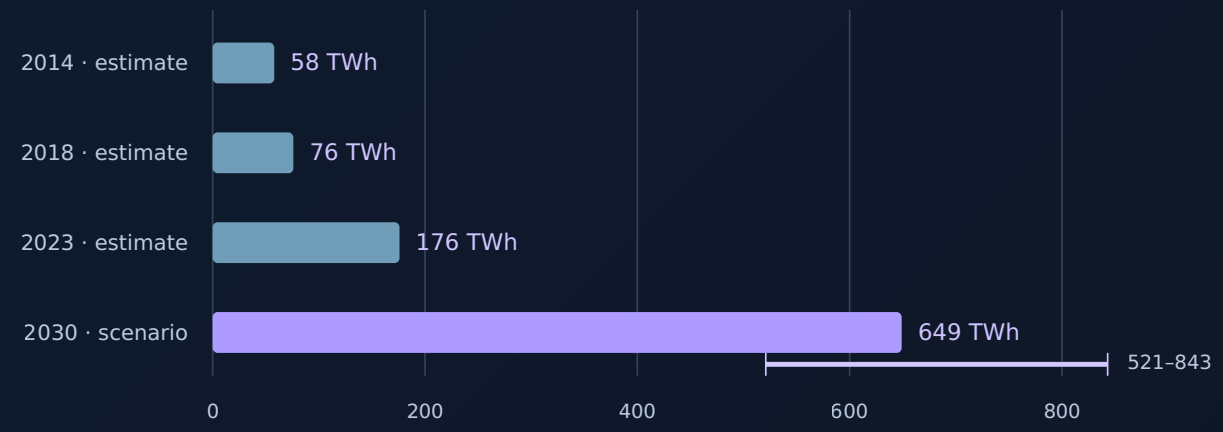
Power is a rate. Energy is what accumulates over time.

CHAPTER SOURCES S01 S03 S32

A megawatt (MW) measures power, like the rate of flow through a pipe. **A megawatt-hour (MWh)** measures energy, like the amount that flowed over an hour. A gigawatt is 1,000 MW; a terawatt-hour is one million MWh. A proposed 1 GW campus does not automatically consume 8.76 TWh a year: that assumes full draw every hour.

U.S. ELECTRICITY / TWO REPORT GENERATIONS

History is estimated. The future is modeled.



Historical values: Berkeley Lab 2024 (S02). 2030: Berkeley Lab June 2026 update (S01). The interval is compounded uncertainty, not a statistical confidence interval. Different report vintages are shown explicitly. All U.S. data centers; not AI alone.

Historical estimate Separate 2030 model, purple bar and range

Berkeley Lab’s June 2026 update puts U.S. data-center electricity at **649 TWh in 2030** in its reference case, or 11.8% of forecast national electricity use. Its compounded uncertainty range is 521–843 TWh (9.5–15.3%). These are model scenarios for all data centers, not AI-only demand or a probability interval. S01

The IEA’s April 2026 update estimates **485 TWh globally in 2025** and projects roughly 950 TWh in 2030. These numbers come from a different model and geography. Do not splice the two organizations’ projections into a single harmonized forecast. S03

Three questions before comparing numbers

BOUNDARY	EXAMPLE OF A MISTAKE
IT versus facility power	Comparing a server-only rating with a whole-campus grid connection.
Average versus peak	Calling an annual household grid-purchase equivalent a count of homes that could be served during a peak emergency.
Operating versus proposed	Counting future campus phases, speculative queue requests and live buildings as though all were consuming power now.

Use the Scenario Lab to try the arithmetic with explicit assumptions. The household comparison uses a labeled historical EIA baseline, which you can change.

S32

The national total sets the scale; the connection process determines what can actually arrive at one address.

From announcement to connection.

07

Electricity must arrive at the right place, at the right time, reliably.

CHAPTER SOURCES S23 S03 S18

Enough annual energy somewhere in the region is not the same as enough deliverable capacity at this site. Generation, transmission, substations and distribution must work together. Planning also needs reserves for failures and extreme conditions. Adding a major load changes more than annual sales.

Generation

Can the system supply the added energy and dependable capacity when needed? New plants and fuel arrangements take time.

Transmission

Can power move through the relevant network without overloading lines or violating operating limits?

Connection

Are transformers, substations, switchgear, studies and construction ready for the promised energization date?

Operating behavior

How quickly can load change? What happens during faults, heat waves, equipment failures and emergency curtailment?

In June 2026, FERC issued orders to six regional grid operators under its jurisdiction to justify or reform large-load rules, including cost allocation, flexible service and co-location. That action does not create one uniform tariff for the entire United States. S23

Bringing power is not the same as leaving the grid

A developer may propose an on-site gas plant, batteries, a renewable contract or co-location with an existing generator. Each arrangement has different physical and financial consequences. A site that expects backup from the public grid still needs its dependence studied, even if much of its routine supply comes from elsewhere.

Batteries can bridge interruptions and manage short variations; their duration, usable capacity, control permissions and recharge needs determine what service they can provide. An existing generator’s output committed to a new campus may also change what is available to other customers.

> A queue entry is a request. A study is an analysis. A signed service agreement is a commitment. An energized campus is an operating asset.

A technically feasible connection still leaves a financial question: who funds it, and who carries the risk?

Who pays for the new demand?

08

The electricity bill depends on the system and the contract.

CHAPTER SOURCES S14 S15 S16 S17

New load can spread existing fixed costs over more sales. It can also require expensive new infrastructure or push a tight supply market toward higher prices. The result depends on timing, spare capacity, procurement, tariffs and what happens if promised demand never appears.

Historical evidence

Berkeley Lab’s 2026 price review describes places where load growth accompanied lower inflation-adjusted prices. A separate 2026 working paper estimates modest average rate reductions from data centers during 2015–2024. Neither guarantees the outcome of the next campus. S15 S16

A constrained-market example

PJM’s independent market monitor attributed $29.4 billion of capacity charges across four auctions to data-center load in its July 2026 report. That is a modeled counterfactual involving existing and forecast demand, not a household-bill increase of the same percentage. S14

Three different costs on the power system

COST	WHAT IS BEING PAID FOR
Energy	Electricity actually produced and delivered, usually measured in MWh. Fuel, generation mix and the hour of use matter.
Capacity, where that market exists	A commitment that resources will be available in a future delivery period. PJM’s auction figures concern this account; not all U.S. regions use PJM’s market design.
Networks and service	Transmission, substations, connection facilities and other infrastructure. The tariff and service agreement determine how costs are recovered.

Read the protections, not just the pledge

CONTRACT FEATURE	WHAT IT ADDRESSES
Minimum payment / term	Reserved infrastructure may need payment even if the campus uses less than expected.
Collateral / credit support	A deposit, guarantee or other security may reduce the chance that others inherit an unpaid obligation.

CONTRACT FEATURE	WHAT IT ADDRESSES
Exit and cancellation provisions	Who pays the remaining costs if development stops, shrinks or relocates?
Dedicated cost allocation	Which connection assets and shared upgrades are assigned to the large customer?
Milestones and phased service	Infrastructure spending can follow demonstrated construction and contracted demand.

Ohio offers a concrete example: its consumer advocate describes a July 2025 AEP tariff requiring qualifying new data centers to pay for at least 85% of contracted capacity for up to 12 years, and notes a later industry appeal. The docket, rather than a national headline, governs the legal details. S17

> Tax revenue goes to governments. Utility costs flow through utility systems. A county’s fiscal gain does not automatically offset a resident’s electricity bill.

Power is only one resource account. Cooling connects electricity demand to a second system: water.

Two cooling questions. One crucial distinction.

09

How does heat leave the chip? How does it leave the site?

CHAPTER SOURCES S05 S06 S09



Liquid-cooled Frontier cabinets. OLCF at ORNL / CC BY 2.0. A scientific supercomputer illustrating cooling hardware. Full credits in the source library.

A liquid-cooled chip transfers heat into a circulating fluid. That fluid then transfers heat to another system or to the outdoors. The final stage may use dry coolers, chillers, cooling towers, or a combination. A sealed loop beside the chip can coexist with an evaporative cooling tower outside. S05

CHIP
Heat enters air or coolant

→

BUILDING LOOP
Heat exchangers and pumps

→

OUTDOORS
Dry rejection, evaporation or hybrid

HEAT-REJECTION APPROACH	WATER CONSIDERATIONS	ENERGY / SITE CONSIDERATIONS
Evaporative cooling	Some water evaporates; additional makeup replaces evaporation and blowdown.	Can reduce cooling electricity in suitable conditions. Performance depends on weather and design.
Dry cooling / air-cooled chillers	Can greatly reduce operational cooling-water consumption. Other site water use remains.	May require more electrical power or larger equipment in hot weather.

HEAT-REJECTION APPROACH	WATER CONSIDERATIONS	ENERGY / SITE CONSIDERATIONS
Hybrid systems	Water use can vary by season and operating mode.	Can shift the energy–water tradeoff; peak operating plans matter.

What “zero water for cooling” actually says

Microsoft announced a new design in December 2024 intended to avoid evaporating water for cooling. This is a specific company design claim, not proof that every existing Microsoft facility uses it or that the entire supply chain consumes no water. S09

Ask for the complete cooling diagram, the heat-rejection method at design-day conditions, the source of makeup water, and any expected changes between phases. “Liquid cooling,” “closed loop” and “water efficient” alone do not answer those questions.

What PUE tells you

PUE divides total facility energy by IT energy over the same period. At PUE 1.25, every 100 units used by IT require 125 units at the facility: 25 for overhead. Overhead is 25% of IT energy but 20% of the whole-facility total. A lower PUE reduces overhead for a fixed IT workload; it does not measure how much useful computing is delivered. S05

> Follow heat from the processor all the way to the outdoors. That complete path explains the water–electricity tradeoff.

Following the heat explains the machinery. Following the water explains which resource is being counted.

Follow the water.

Withdrawal, consumption, discharge and indirect use are different accounts.

CHAPTER SOURCES S02 S07 S10

TERM	WHAT IT MEANS	WHY A READER SHOULD CARE
Withdrawal	Water taken from a source or delivered by a supplier.	Treatment and pipe capacity must accommodate the delivered flow.
Consumption	The portion withdrawn and not returned to the immediate water environment, often because it evaporates.	This is a different measure from the volume entering the site.
Discharge	Water leaving for treatment or another permitted destination.	Temperature, dissolved solids, treatment chemicals and timing affect what the receiving system must manage.
Indirect water	Water associated with electricity generation and other upstream activities.	It may occur in another watershed and cannot be treated as demand on the host town’s water pipe.

Berkeley Lab estimated U.S. data centers consumed about **66 billion liters directly in 2023**, approximately 17.4 billion U.S. gallons. Its estimate of electricity-related indirect consumption was nearly 800 billion liters, about 211 billion gallons. Both are historical estimates for all U.S. data centers, not current AI-only meter readings. S02

U.S. DATA CENTERS / 2023 ESTIMATES

Two accounts. Different places.



Source S02, printed pp. 55–58. Direct ≈17.4 billion U.S. gallons; indirect ≈211 billion gallons (unit conversions). Indirect estimate is based on regional electricity mixes, not facility-specific contracts. These are not current national meter readings.

The indirect estimate uses regional grid mixes and does not incorporate facility-specific power-purchase agreements or behind-the-meter generation. Those boundaries matter. A contract is not automatically a physical change in power-plant water consumption; a grid-average estimate is also not a facility meter reading.

Four details behind a credible water number

Place

Which river, reservoir, aquifer or reclaimed-water system supplies it? Where does wastewater return?

Time

Is this an annual average, a maximum day, a maximum hour, or a future permitted amount?

Quality

Is it drinking-quality water, treated wastewater or another source? What treatment is needed?

Boundary

Does the figure include only the site, electricity generation, manufacturing, or a full life cycle?

CRS’s July 2026 FAQ explains that most operators obtain water from public systems and describes state and local water allocation and federal discharge requirements. It also makes clear why water quantity and water quality must be assessed separately. S07

What location-level disclosure looks like

Google’s 2026 environmental report separates withdrawal, discharge and consumption for 2025. The selected locations below show why the columns should remain separate. These are company-reported annual quantities for data-center locations, not isolated AI workloads, peak delivery requirements or a representative national sample. S10

GOOGLE LOCATION / 2025	WITHDRAWAL, MILLION GAL	DISCHARGE, MILLION GAL	CONSUMPTION, MILLION GAL
Ashburn, Virginia	76.5	23.3	53.2
The Dalles, Oregon	654.3	185.3	469.0
Berkeley County, South Carolina	988.5	86.8	901.7

The arithmetic at The Dalles is 654.3 − 185.3 = 469.0 million gallons. Dividing annual withdrawal by 365 would yield about 1.79 million gallons per day on average; that calculated average is not the maximum-day demand. Facility size, cooling, source and operations differ, so these totals alone do not rank efficiency.

Consumed water is not destroyed: evaporation moves it into the atmosphere, where it remains in the wider water cycle. The local concern is that it is no longer available at the same source, place and time. In Google’s table, withdrawals are potable unless a row states otherwise; the three selected rows do not identify an alternative source. S07 S10

Annual accounting is the starting point. The local system also has to meet its busiest day.

The hottest day is a different question. 11

Annual totals do not reveal a community’s available water capacity.

CHAPTER SOURCES S08 S07 S10

A town can have adequate annual supply and still face a shortfall in treatment, storage or pipe capacity during a hot, dry week. Existing homes and businesses, agriculture, environmental flows and future growth may all depend on the same system. The relevant comparison is not simply the project’s gallons divided by all water in the state.

A March 2026 research preprint by Han and colleagues focuses on this capacity problem. Its projected national need for additional water-system capacity changes substantially with growth and water-efficiency assumptions. Its central practical contribution here is the distinction between annual consumption and peak withdrawal. S08

Drought rules

Which restrictions apply to this customer? Are industrial commitments interruptible, and who has priority during a shortage?

Cumulative demand

What happens if several approved projects reach full operation together, alongside planned housing and industry?

Reclaimed water

Can the treatment plant supply the needed quality and peak flow? What existing downstream uses depend on that water?

Infrastructure finance

Who funds new pipes, treatment and storage, and who pays if the expected customer never arrives?

Water positive is an accounting claim, not a replacement pipe

A replenishment project can have value, but its place, season, additionality and durability need scrutiny. A watershed restoration project elsewhere does not by itself create the extra local flow needed at 4 p.m. during a heat wave. Google’s environmental report is an example of corporate water accounting that should be read alongside location-specific data. S10

> Request annual consumption and peak withdrawals, under normal weather and drought conditions, at each development phase.

The Scenario Lab includes a simple peak-capacity balance. It is an arithmetic illustration; it does not model hydrology, water rights, emergency reserves or the reliability of a real supply.

Water supply is one part of the environmental picture; air, materials and discharges have their own records.

Beyond the water meter.

12

Air, carbon, materials and waste follow different pathways.

CHAPTER SOURCES S21 S31 S06 S07

Electricity-related emissions depend on the power system and time of use. Backup engines and on-site generation can create local air emissions. Chip fabrication, concrete, steel and equipment manufacturing add other impacts. Counting one boundary does not describe the entire life cycle.

IMPACT	USEFUL EVIDENCE
Local air quality	Engine type and count, fuel, hours of use, permit limits, controls and cumulative dispersion modeling where relevant.
Electricity emissions	Location-based grid emissions and market-based procurement accounting, with each method identified.
Construction and materials	Embodied emissions, land clearing, concrete and steel, equipment production and transport.
Water quality and drainage	Wastewater acceptance conditions, blowdown management, stormwater plans and construction controls.
Equipment turnover	Reuse, resale, secure data destruction, repair and documented end-of-life handling.

EPA explains that state and local agencies issue most air permits for data centers under approved Clean Air Act programs. Emergency use, routine testing and regular generation have distinct regulatory implications. A permitted worst-case amount is not the same as actual annual emissions. S21

What a renewable purchase does and does not show

A long-term power contract can support new supply. Annual renewable matching does not establish carbon-free electricity in every hour or prove that a site can operate off-grid. IEA’s supply analysis explicitly separates the physical generation mix from corporate contractual procurement. S31

Waste-heat recovery is another site-specific option. Its value depends on useful temperatures, a nearby heat customer, matching demand, pipes and economics. A cooling system can reject substantial heat while having no practical customer for it. S06

> Compare like with like: annual with annual, measured with measured, and the same physical or accounting boundary.

A snapshot of physical electricity supply

For 2024, IEA’s 2025 assessment estimated the global physical data-center electricity mix at roughly 30% coal, 27% renewables, 26% natural gas and 15% nuclear, with rounding and other sources accounting for the remainder. The shares vary by region. These historical estimates are not the contractual energy claims of individual companies. S31

The same assessment projected renewables would meet nearly half of the additional electricity demand through 2030, with gas and coal together supplying more than 40% of the increase. This is the published 2025 scenario, not an inventory of new plants that are certain to be built. A low-carbon supply agreement can coexist with a grid that still needs fossil generation in some hours.

A large investment is not a local balance sheet. 13

Separate private spending, tax collections, incentives and public obligations.

CHAPTER SOURCES S13 S20

A campus announcement may include buildings, servers, utility works, financing and years of planned expansion. Much of the equipment may be manufactured elsewhere. That investment can generate local business and tax revenue, but the headline amount does not tell a town what remains after exemptions, public costs and contractual commitments.

ACCOUNT	KEEP IT SEPARATE
Private capital spending	Buildings, machines and other assets purchased by companies; timing and geographic scope matter.
Local revenue	Real-estate tax, equipment tax, fees and negotiated payments actually retained locally.
State incentives	Sales-tax exemptions, credits or other forgone revenue; these may affect a different government budget.
Public spending and risk	Roads, utilities, emergency services, debt, administration and potential stranded assets.
Community benefits	Grants or negotiated commitments; distinguish binding terms from voluntary programs.

The same equipment, different local receipts

JLARC compared a facility with $150 million in taxable computer equipment under different Virginia local tax rates and depreciation schedules. Five-year equipment-tax collections ranged from about $0.4 million to $10.8 million. Real-estate taxes were excluded from that comparison. This is a controlled fiscal illustration using the report’s tax rules, not a forecast for an arbitrary new campus. S13

Local officials in the audit described uses of the revenue: lower real-estate tax rates in Loudoun and Prince William, an affordable-housing trust fund in Henrico, reserve funds, and new schools in Mecklenburg. These are specific examples of public benefits; their size and availability depend on the local tax base and budget choices. S13

The tax base can be powerful and concentrated

Virginia’s 2024 audit found substantial variation in local receipts and in the treatment of computer equipment. Its examples show why identical equipment investment can produce very different revenue under different tax rates and depreciation schedules. That is a lesson about fiscal structure, not a universal estimate of profit per campus. S13

Equipment value changes over time. Replacements can renew the base, while abatements, depreciation or slower investment can reduce it. A community relying heavily on a few large taxpayers may want reserves and a downside forecast. The project’s promised growth is not the same as a diversified local economy.

> Request a year-by-year fiscal table: revenue collected, incentives granted, public costs, debt exposure and the result if later phases do not happen.

The useful comparison is with realistic alternatives for that land and infrastructure, including leaving them available for future uses. A national total of “economic impact” cannot replace this local accounting.

Public revenue and private investment are different from employment. The next chapter follows the workers.

The jobs arrive in different waves.

14

Construction employment, permanent staffing and wider economic effects are not interchangeable.

CHAPTER SOURCES S13 S20

Construction can employ many trades: electricians, pipefitters, equipment operators, concrete crews, engineers and commissioning teams. A multi-phase campus can sustain activity for years. Once operating, the staffing mix changes to facility technicians, network and hardware workers, security, management and contracted services.

BUILDING PHASE

Crews, trades, suppliers

Count workers over time, local hiring and job-years.

OPERATING PHASE

Technical teams and services

Count ongoing positions, contract roles and local wages.

Virginia’s audit reports a representative 250,000-square-foot facility with approximately 50 full-time workers, roughly half contracted, and around 1,500 workers at peak construction. These are contextual examples from interviews, not staffing rules for every AI campus. S13

A better employment description

ASK FOR	BECAUSE
Peak headcount and job-years	1,500 people at the busiest point is different from 1,500 jobs maintained for ten years.
Local residence and hiring	A worker lodging nearby during construction is not necessarily a permanent addition to the local labor force.
Wages, benefits and contractor roles	An average across engineers, guards and contractors can hide substantial differences.
Training and access	Apprenticeships, community-college programs and clear qualifications determine who can realistically benefit.
Direct versus supported employment	Supplier and induced jobs are model estimates across an economy, not all people employed on the campus.

A project can have meaningful value with limited permanent staffing if its revenue, training and supplier opportunities suit local priorities. It can also disappoint expectations if temporary work is marketed as long-term employment. The presentation supplies the distinctions rather than ranking which outcome a community should prefer.

Employment describes one relationship with a campus. Living next to it creates another.

Life on the other side of the fence.

15

Daily experience is measured in sound, light, traffic, views and trust.

CHAPTER SOURCES S13 S21 S06

Sound

Fans, chillers, pumps and generator testing can have different noise patterns. Nighttime sound, tones and low-frequency components deserve attention alongside average levels.

Construction

Truck routes, dust, road wear, work hours and temporary housing demand may matter for years during phased development.

Appearance and land

Building height, screens, vegetation, setbacks and new power lines affect views and nearby land uses.

Emergency readiness

Fire access, high-voltage systems, fuels and battery equipment require a site-specific response plan and coordination.

Virginia’s audit distinguishes noise that violates existing ordinances from persistent sound that some neighbors still find disruptive. Compliance and lived experience do not always align. The evidence does not support treating every facility as equally noisy, or assuming that one neighbor’s experience predicts every site. S13

What makes a commitment useful?

An understandable condition identifies the metric, measurement location, operating conditions, reporting schedule, responsible authority and remedy. A promise to be a “good neighbor” leaves those details open. A plan should address the combined sound of all campus phases and relevant nearby facilities, including simultaneous testing where allowed.

For residents, useful records include preconstruction sound measurements, predicted worst-case operating sound, lighting plans, public complaint channels and the process for verifying a complaint. Health concerns should be heard without turning anecdotes into a diagnosis or assuming a medical outcome from a facility label.

> The host jurisdiction, nearby households and people along new utility corridors can experience different benefits and costs.

Public trust also depends on what can be learned before approval. Commercial confidentiality may protect specific business details, but communities can still seek meaningful disclosure about resource demand, public obligations and enforceable operating conditions.

Clear operating conditions matter most when someone has authority to enforce them.

One project. Several decision rooms.

16

A zoning hearing, a utility tariff and an environmental permit answer different questions.

CHAPTER SOURCES S07 S23 S22 S18

DECISION TRACK	TYPICAL QUESTIONS
Land-use planning	Is this use allowed? What setbacks, height, landscaping, noise and phase conditions apply?
Electric service and system planning	What load can connect, when, under what studies, service conditions and upgrade requirements?
Utility rates and contracts	Who pays, for how long, with what guarantees and exit provisions?
Water availability and supply agreement	What source, peak delivery, drought priority, infrastructure and payment terms are available?
Environmental permits	What air emissions, withdrawals, discharges, stormwater or wetland impacts require approval?
Fiscal and development agreements	Which incentives and obligations are binding, transferable and enforceable?

Authorities vary across states and between municipal, cooperative and investor-owned utilities. Some towns control zoning but not the electric tariff. Some water arrangements depend on state law or regional suppliers. Neither “the federal government approved it” nor “the county approved it” describes the entire process. S07 S23

Public information with usable boundaries

Readers need enough detail to understand the proposal without needing operational security diagrams or private customer data. A public fact sheet can identify owner and operator, phases, maximum and expected power, normal and peak water, sources, discharge plans, fiscal obligations and complaint contacts.

NIST’s July 2026 initial public draft on AI data-center security examines threats and architectural differences from high-performance computing. Its draft status matters; a draft is not a final mandatory standard. Security does not settle whether a particular local development agreement is well structured. S22

> Ask who can enforce each promise. A statement in a presentation may have no legal force unless it appears in the applicable permit, tariff or agreement.

The following examples show how those decisions differ across real places.

Four places. Four different questions.

17

Case studies illuminate mechanisms; they do not settle every community’s decision.

CHAPTER SOURCES S13 S17 S18 S19 S20

VIRGINIA

A mature cluster

The legislative audit documents a large established industry, major local tax receipts in some jurisdictions and substantial projected power needs. The lesson is to examine fiscal success and infrastructure pressure together; maturity does not remove tradeoffs.

S13

OHIO

A contract for reserved capacity

AEP’s tariff example addresses the risk of building for demand that does not arrive. The consumer advocate reports minimum capacity payments and a multi-year term, and notes an industry appeal. The transferable idea is financial commitment; the exact legal terms are local.

S17

TEXAS

Growth meets a water-and-power audit

Texas SB 6 addresses large-load interconnection and reliability. Separately, the governor’s September 21, 2026 directive announced a permit halt tied to audits. These are dated policy developments, not proof that every proposed facility is harmful or that all permitting steps stopped.

S18 S19

LOUISIANA

A campus and a new energy system

Entergy’s March 2026 Meta agreement describes seven planned gas plants totaling more than 5,200 MW, transmission and batteries, plus projected customer savings. These are utility projections and proposed investments, not completed assets or verified future savings.

S20

A common comparison frame

For each case, keep the same columns: project stage; capacity boundary; water source and peak demand; public investment; revenue retained; ongoing jobs; operating conditions; and the entity that carries downside risk. A proposed campus and a mature county-wide industry should not occupy the same row without clear labels.

A nearby example may be informative but still differ in weather, generation mix, water rights, tax law or utility ownership. That is why a local record is more useful than assuming a national average applies.

> The case-study question is “what explains this outcome?” The decision about what matters most remains with the reader.

A global buildout, with local constraints. 18

Computing crosses borders. Electricity, water and permits stay rooted in places.

CHAPTER SOURCES S04 S03 S31

The IEA’s 2025 regional analysis places the United States and China at the center of projected demand growth, with additional growth in Europe and other markets. National totals conceal regional clusters and different power systems. The updated 2026 global outlook should be used for the current aggregate trajectory. S04 S03

United States

Large cloud markets and AI investment meet a patchwork of utilities, state commissions, local land-use rules and water systems.

China

A major computing market with a different generation mix and infrastructure-planning system. U.S. tax and tariff examples should not be transferred directly.

Europe

Power availability, grid access, carbon accounting and potential heat-reuse customers can influence site choices.

Other growing markets

New capacity may be driven by domestic services, data residency, connectivity and access to energy. Each region requires its own evidence.

Strategic value is a separate layer

Governments and businesses can value domestic computing for research, industry, defense, resilience and control over sensitive data. Those possible national benefits do not tell a host town how much water a particular facility will use or what the local tax agreement delivers.

There are also dependencies outside the fence: semiconductor manufacturing, advanced packaging, memory, power equipment, fuel and financing. A building can be domestic while essential components come from a global supply chain. IEA’s 2026 report discusses the bottlenecks connecting computing growth to these physical systems. S03

> Compare jurisdictions by the same measures, while keeping differences in climate, laws, accounting and infrastructure visible.

These different settings also help explain why one forecast cannot describe every future project.

What changes the outlook?

Demand, technology, finance and infrastructure can move in different directions.

CHAPTER SOURCES S01 S03 S20

Forecasts are conditional stories built from assumptions. The number of accelerators shipped, their useful life, idle power, workloads, occupancy, cooling and electricity constraints all affect demand. Berkeley Lab’s update makes several of these sensitivities explicit instead of presenting one number as inevitable. S01

IF THIS CHANGES…	POSSIBLE CONSEQUENCE, ALL ELSE EQUAL
More efficient software and chips	Less energy for the same task; lower costs can also encourage additional use.
More reasoning, video and agents	A different task mix can raise energy requirements even as simple text becomes more efficient.
Slower connection or equipment delivery	A proposed campus may enter service later or at a smaller first phase.
Tighter financing or weaker revenue	Projects can be delayed, reduced, sold or cancelled; contract protections become important.
More flexible operation	Some work may move in time or place, potentially reducing stress during constrained periods.
Different cooling / electricity supply	Direct water, indirect water and emissions can change in different directions.

Watch milestones, not just announcements

A useful project timeline distinguishes land control, approval, service agreement, financing, construction, first energization, occupied capacity and later expansions. Announced megawatts or investment are not equivalent to committed demand or operating capacity.

On-site gas, batteries, geothermal, nuclear and other supply arrangements each have development schedules and constraints. A memorandum or purchase agreement is evidence of intent, not proof that a technology will be online by the campus’s required date. S03 S20

> The most useful forecast is one whose assumptions you can inspect and whose actual milestones you can revisit.

Questions behind the headline.

20

Replace a sweeping claim with the measurement that would make it meaningful.

CHAPTER SOURCES S05 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S31 S32

“Does every AI question use a bottle of water?”

There is no universal per-question quantity. Model, task, answer length, location, time and accounting boundary change the result. Google’s 2025 Gemini study reports a median text prompt of 0.26 mL of direct water; academic modeling includes other boundaries. Neither is a measurement of every chatbot interaction.

S11 S12

“If it is closed-loop, does it use no water?”

Ask which loop. A sealed chip loop can transfer heat to an evaporative outdoor system. A dry heat-rejection design can avoid most operational cooling consumption, while bathrooms, commissioning, electricity generation and manufacturing remain outside that narrow claim.

S05 S09

“Is it using as much electricity as a city?”

Specify capacity, average annual draw and the comparison city. A household-energy equivalent excludes shops, schools and industry. A rated connection is also not the same as actual consumption. Use the calculator to see the assumptions.

S32 S01

“Will it lower or raise my utility bill?”

Both mechanisms exist: spreading fixed costs over more sales, or adding expensive infrastructure and tightening supply. Historical averages and a constrained regional market can point in different directions. The service agreement and local supply conditions are essential.

S14 S15 S16

“Does a renewable contract mean clean power every hour?”

Annual contractual matching differs from hourly physical supply. Ask about the project’s location-based footprint, the contract, whether new generation is added and what supplies the site when contracted resources are unavailable.

S31

“Are thousands of jobs permanent?”

Separate peak construction workers, job-years, ongoing employees, contractors and modeled supplier jobs. Ask for local hiring and wages rather than a single combined headline.

S13

“Does replenishing water cancel local consumption?”

Replenishment can support water stewardship, but timing, watershed, additionality and delivery capacity matter. It does not by itself guarantee available municipal supply during a local peak.

S10 S08

“If other industries use more water, does this project not matter?”

A national comparison can show scale but cannot establish local capacity or priority. Use equivalent metrics, the same year and watershed, and distinguish withdrawal from consumption. Both existing uses and new demands belong in the local balance.

S07 S08

“Will efficient AI make all this construction unnecessary?”

Efficiency reduces resource use for a given task. Overall demand also depends on adoption, task complexity and pricing. Forecasts should show several assumptions rather than choosing one direction as certain.

S03 S01

“Does a giant investment guarantee prosperity?”

Local benefit depends on retained revenue, costs, jobs, supplier access and the alternatives available. Private spending, state tax incentives and local receipts are different accounts.

S13

Put a proposal in perspective.

21

Inspect illustrative assumptions and their calculated results. Keep the boundaries visible.

PDF EDITION / The examples below preserve the HTML tool’s default assumptions. Values are illustrative, not forecasts for a proposed site.

CHAPTER SOURCES S32 S05 S08

01 / ANNUAL ENERGY & DIRECT WATER

What does the proposed capacity mean?

Illustrative assumptions, not a typical-facility forecast. Change them to match a documented proposal.

Proposed capacity · MW

100

Capacity boundary

IT equipment power

Do not apply PUE twice to total facility MW.

Average electrical load · % of capacity

85

Electrical load factor, not GPU utilization.

PUE · facility energy / IT energy

1.25

Illustrative annual ratio, held constant.

Direct consumption · liters per IT kWh

0.5

User-entered WUE; excludes power-plant and manufacturing water.

Household comparison · kWh/year

10791

EIA 2022 utility purchases; excludes self-generated electricity.

930.8

GWh/year · whole facility

98.4

million U.S. gallons/year · direct consumption

86,252

homes’ annual grid-purchase equivalents

100 MW × 1,000 × 8,760 h × 85% = 744.6 GWh at the selected boundary. Multiply by PUE 1.25 to obtain facility energy. IT energy 744.6 GWh × 1,000,000 × 0.5 L/kWh ÷ 3.785411784 = 98.35 million gal. Grid-purchase equivalents = facility kWh ÷ 10,791.

02 / PEAK WATER CAPACITY

Does the daily balance have room?

All inputs below are illustrative maximum-day withdrawals or supply capacity, in million U.S. gallons per day (MGD). Do not mix with annual consumption from the first tool.

Usable maximum-day delivery capacity · MGD: 10

Existing and committed peak demand · MGD: 8

Proposed project maximum-day withdrawal · MGD: 1

1	90%	Surplus
MGD arithmetic balance after project	of entered capacity committed	arithmetic only; no approval judgment

10 − 8 − 1 = 1 MGD. This simple balance omits reserves, sustainable yield, maximum-hour limits, water rights and outage reliability.

What these tools cannot tell you

The energy tool is a steady annual accounting illustration. It does not predict a real load profile, marginal generation, emissions, shortages, retail bills or AI throughput. Entered average load is an electrical fraction, not GPU utilization. A constant PUE and WUE simplify real weather and operating variation.

The peak-water tool compares three entered daily volumes. A positive balance is not a water-availability approval: reserves, outages, water rights, sustainable yield, treatment quality, maximum-hour flow and other users’ commitments still matter. No calculator score here says to approve or reject a project.

The household baseline is the EIA’s 2022 average annual utility purchases of 10,791 kWh per residential customer; it excludes self-generated electricity, such as rooftop solar, and is labeled by year in this example. Water uses U.S. gallons (3.785411784 liters per gallon). No private data is sent or saved. S32S05

Read the proposal, not just the rendering.

22

A field guide for residents, officials and anyone trying to understand a campus.

CHAPTER SOURCES S07 S13 S17 S18 S21 S23

Start with a short public project record. Record the date of each document and distinguish the first building from the entire planned campus. Mark an item unanswered rather than replacing it with a national average.

- [ ] **Project identity**
  Owner, operator, tenant, first phase, full buildout and change-of-owner obligations.
- [ ] **Electricity boundary**
  IT or facility MW, expected average draw, peak draw and ramp-up schedule.
- [ ] **Power infrastructure**
  Study status, upgrades, new generation, connection milestones and emergency flexibility.
- [ ] **Financial protection**
  Minimum payments, term, collateral, parent guarantee and cancellation or exit costs.
- [ ] **Cooling design**
  Chip cooling and final outdoor heat rejection, including hottest-day operation.
- [ ] **Water source**
  Supplier, watershed or aquifer, quality and reclaimed-water feasibility.
- [ ] **Water quantities**
  Annual consumption, maximum-day and maximum-hour withdrawals, by phase.
- [ ] **Drought and cumulative demand**
  Priority, curtailment, other committed users and climate stress assumptions.
- [ ] **Wastewater and stormwater**
  Discharge destination, treatment acceptance, commissioning flows and runoff controls.

- ☐ **Air, sound and light**
  Equipment, permit limits, nighttime and tonal sound, setbacks and monitoring.
- ☐ **Public finances**
  Retained tax and fees, exemptions, annual public costs and downside fiscal scenario.
- ☐ **Employment and skills**
  Construction job-years, operating staff and contractors, wages, local hiring and training.
- ☐ **Emergency planning**
  Fire response, batteries, fuel, access, public service costs and coordination.
- ☐ **Public accountability**
  Which promises are binding, who enforces them, public reports and complaint remedies.

Documents worth finding

DOCUMENT	WHAT IT CAN REVEAL
Site plan and land-use application	Phases, layout, setbacks, access, outdoor equipment and proposed operating conditions.
Utility study, tariff and service agreement	Capacity, energization milestones, upgrades, reserved-demand payments and exit risk.
Water agreement and supply analysis	Source, annual and peak volumes, delivery capacity, drought priority and infrastructure costs.
Air permit and wastewater conditions	Equipment, emission limits, operating assumptions and discharge obligations.
Fiscal analysis and development agreement	Tax treatment, public costs, enforceable benefits and downside exposure.
Operations and monitoring plan	Public reporting, testing schedules, complaints, corrective actions and responsible contacts.

> An answer becomes useful when it names a quantity, a date, a responsible party and a document that can be checked.

This is an original reading guide built from the distinctions in the source record. It is not a legal checklist for every jurisdiction or a substitute for the actual permit and agreement language.

See the infrastructure. Hear the explanation.

23

Selected media and primary documents, with context attached.

CHAPTER SOURCES S29 S30 S01 S07 S13 S14

GOOGLE / 2016 / OPERATOR-PRODUCED TOUR

A walk inside the cloud

A 360° view inside Google’s data center in The Dalles, Oregon. Useful for seeing the physical systems. It predates the present AI rack generation and does not document today’s local water impacts.

Watch on YouTube ↗ Publisher’s context ↗ S30

Select Watch on YouTube or Publisher’s context to open the video online. Internet access is required.

OAK RIDGE NATIONAL LABORATORY / 2023–2024 / LABORATORY DOCUMENTARY

Building Frontier

The Journey to Frontier follows a scientific supercomputer through engineering and supply-chain challenges. It is a useful view of large-scale computing, not a commercial AI campus impact study.

Watch on YouTube ↗ Publisher’s context ↗ S29

Select Watch on YouTube or Publisher’s context to open the video online. Internet access is required.

Read alongside the video

These tours make the machinery tangible. Google shows an operator-selected commercial facility; Frontier shows scientific supercomputing. Read them alongside the resource records to connect what you see with what a particular campus needs.

PRIMARY DOCUMENT

The U.S. electricity model

Inspect the 2026 reference case and sensitivity assumptions.

Open source record ↗

PRIMARY DOCUMENT

The water questions

Read the CRS explanation of sources, discharges and authority.

Open source record ↗

PRIMARY DOCUMENT

A community impact audit

Explore Virginia’s economic and local-impact evidence.

Open source record ↗

PRIMARY DOCUMENT

The market monitor’s analysis

See what capacity-market attribution measures and what it does not.

Open source record ↗

A shared vocabulary.

24

The words that make numbers comparable.

CHAPTER SOURCES S01 S05 S07 S23 S32

AI accelerator

A processor optimized for operations used in machine learning. GPUs and specialized ASICs are examples.

ASIC

Application-specific integrated circuit, designed for a particular class of work.

Capacity

A capability or reservation, usually expressed as power in MW or GW. Check whether it refers to IT, the facility or the grid connection.

Colocation

A facility providing space, power, cooling and connectivity to tenants.

Consumption, water

Water withdrawn and not promptly returned to the relevant local system, often through evaporation.

Demand response

An agreed change in load in response to system conditions or a program signal. Availability and performance must be specified.

GPU

Graphics processing unit; parallel processing hardware widely used for AI.

GW / MW / kW

Gigawatt, megawatt and kilowatt: units of power. 1 GW = 1,000 MW; 1 MW = 1,000 kW.

GWh / MWh / kWh

Energy units. A 1 MW load operating for 1 hour uses 1 MWh.

Hyperscale

Large-scale cloud or internet computing operated across extensive facilities and networks.

Inference

Running a trained model to produce a prediction or output.

Interconnection

The studied and agreed arrangement for connecting a load or generator to an electricity system.

IT load

The electrical load of computing, storage and network equipment, excluding facility overhead.

Job-year

One full-time job maintained for one year; different from peak headcount.

Load factor

Average electrical demand divided by a stated maximum or capacity over a period. Not the same as computational utilization.

MGD

Million U.S. gallons per day. A flow measure often used for water-system capacity.

PPA

Power purchase agreement: a contract for electricity or associated attributes. Terms determine what it actually provides.

PUE

Power Usage Effectiveness: total facility energy divided by IT equipment energy, using a consistent period and boundary.

Reclaimed water

Wastewater treated for another suitable use. It still needs infrastructure, quality controls and allocation.

Scenario

A modeled outcome conditional on assumptions, not an observed fact or a promise.

Stranded asset

Infrastructure whose costs cannot be recovered as expected because demand or use changes.

Training

Adjusting a model’s parameters from data; development can include repeated training and fine-tuning.

TWh

Terawatt-hour: one billion kWh or one million MWh.

UPS

Uninterruptible power supply, bridging power interruptions through stored energy and power electronics.

Withdrawal, water

Water taken from a source or delivered to a user, before accounting for consumption and discharge.

WUE

Water Usage Effectiveness. Check the denominator and boundary; the calculator here uses direct consumption in liters per IT kWh.

The evidence, within reach.

25

Search the source library. Inspect the boundary. Follow the original record.

CHAPTER SOURCES S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35

Each record identifies its publisher, date, use and limits. Select a source badge anywhere in this PDF to jump to its record; select Read the original record to open the publisher’s document online.

35 / 35 source records

S01 / RESEARCH / JUNE 2026

United States Data Center Energy Usage Report: 2025 Update

Berkeley Lab / U.S. Department of Energy

Updated U.S. bottom-up electricity model. Reference case and compounded uncertainty are scenarios, not metered future demand.

Where to look: Executive summary, printed p. 5; results pp. 8–10

Read the original record ↗

What are we building it to do? How big is big? What changes the outlook? See the infrastructure. Hear the explanation. A shared vocabulary.

S02 / RESEARCH / DECEMBER 2024

2024 United States Data Center Energy Usage Report

Berkeley Lab

Historical U.S. electricity and water estimates. Retained for 2023 water accounting; electricity outlook updated by S01.

Where to look: Executive summary; printed pp. 55–58, water and emissions

Read the original record ↗

The cloud has an address. Follow the water.

S03 / RESEARCH / APRIL 2026

Key Questions on Energy and AI

International Energy Agency

Latest IEA update used here: 485 TWh in 2025 and about 950 TWh in 2030. Global model, distinct from Berkeley Lab’s U.S. model.

Read the original record ↗

What are we building it to do? | How big is big? | From announcement to connection. | A global buildout, with local constraints. | What changes the outlook?

S04 / RESEARCH / APRIL 2025

Energy and AI: Energy demand from AI

International Energy Agency

Facility anatomy, regional distribution and the earlier global baseline. Historical 2024 estimate; forward outlook updated by S03.

Read the original record ↗

The cloud has an address. | Inside the machine. | What are we building it to do? | Why here? | A global buildout, with local constraints.

S05 / GOVERNMENT / 2019

Cooling Water Efficiency Opportunities for Federal Data Centers

U.S. Department of Energy / FEMP

Engineering explanation of separate coolant loops and cooling towers; PUE definition. Older engineering guidance, not a current fleet-average PUE estimate.

Read the original record ↗

Two cooling questions. One crucial distinction. | Questions behind the headline. | Put a proposal in perspective. | A shared vocabulary.

S06 / GOVERNMENT / JULY 2024

Best Practices Guide for Energy-Efficient Data Center Design

U.S. Department of Energy / FEMP

Design reference for energy management, cooling, heat recovery and IT efficiency. Applicable measures depend on the site.

Read the original record ↗

Inside the machine. | Two cooling questions. One crucial distinction. | Beyond the water meter. | Life on the other side of the fence.

S07 / GOVERNMENT / JULY 31, 2026

Data Centers and Water: Frequently Asked Questions (R49057)

Congressional Research Service

CRS report read through a public mirror because the Congress.gov endpoint was unavailable. Covers water sources, local authority, wastewater and stormwater.

Where to look: Summary and water-use, water-sources and discharges sections

Read the original record ↗

The people behind the buildout. | Why here? | Follow the water. | The hottest day is a different question. | Beyond the water meter. | One project. Several decision rooms.

Questions behind the headline. | Read the proposal, not just the rendering. | See the infrastructure. Hear the explanation. | A shared vocabulary.

S08 / RESEARCH / MARCH 2026

Small Bottle, Big Pipe: Quantifying and Addressing the Impact of Data Centers on Public Water Systems

Han, Li, Wierman & Ren

Research preprint. Highlights peak withdrawal and water-system capacity. National 2030 capacity projections are conditional; not a measured local forecast.

Read the original record ↗

The hottest day is a different question. | Questions behind the headline. | Put a proposal in perspective.

S09 / COMPANY / DECEMBER 9, 2024

Sustainable by design: Next-generation datacenters consume zero water for cooling

Microsoft / Steve Solomon

Company design announcement. Zero water for cooling is a defined design boundary, not zero water across buildings, electricity and manufacturing.

Read the original record ↗

Two cooling questions. One crucial distinction. | Questions behind the headline.

S10 / COMPANY / 2026, REPORTING 2025

2026 Environmental Report

Google

Company environmental disclosure, including location-level water tables. Company totals and replenishment claims require their stated accounting boundaries. Table footnote 224 says withdrawals are potable unless otherwise specified; the three selected rows have no alternative-source qualifier.

Where to look: 2026 report, water use by data center location — 2025, printed p. 97; selected location rows checked in the downloaded PDF

Read the original record ↗

Follow the water. | The hottest day is a different question. | Questions behind the headline.

S11 / COMPANY / AUGUST 2025

Measuring the environmental impact of delivering AI at Google Scale

Elsworth et al. / Google

Instrumented company study of Gemini Apps text inference. Median prompt: 0.24 Wh and 0.26 mL; not every prompt or a full AI life-cycle estimate.

Read the original record ↗

Questions behind the headline.

S12 / RESEARCH / 2023; REVISED MARCH 2025

Making AI Less “Thirsty”

Li, Yang, Islam & Ren

Modeling methodology for AI water withdrawal and consumption, including indirect electricity-related water. Older model estimates should not be transferred to every current AI product.

Read the original record ↗

Questions behind the headline.

S13 / GOVERNMENT / DECEMBER 2024

Data Centers in Virginia

Virginia Joint Legislative Audit and Review Commission

Final published legislative audit (Report 598), replacing the draft PDF cited in review 01. Virginia-specific economic, fiscal, energy and residential evidence.

Where to look: Printed pp. 13–14 (jobs), 17–18 (equipment-tax comparison and local uses), 43 onward (energy costs), 73 onward (residential impacts)

Read the original record ↗

Why here? A large investment is not a local balance sheet. The jobs arrive in different waves. Life on the other side of the fence. Four places. Four different questions.

Questions behind the headline. Read the proposal, not just the rendering. See the infrastructure. Hear the explanation.

S14 / MARKET / JULY 2026

Market Monitor Report: July 27, 2026

Monitoring Analytics / PJM Independent Market Monitor

Market monitor’s modeled attribution of capacity-market charges. Includes actual and forecast load; not a direct measurement of household bill changes.

Where to look: Slides 4–6 and 13–14

Read the original record ↗

Who pays for the new demand? Questions behind the headline. See the infrastructure. Hear the explanation.

S15 / RESEARCH / MARCH 2026

Retail Electricity Price Trends and Drivers: 2026 Edition

Berkeley Lab / Brattle

Historical price and load relationships, plus PJM capacity-market context. Correlation does not establish the effect of a particular proposed campus.

Read the original record ↗

Who pays for the new demand? Questions behind the headline.

S16 / RESEARCH / SUBMITTED JUNE 2026; MANUSCRIPT DATED AUGUST 24, 2026

Have Data Centers Raised Your Electric Bill? Causal Evidence from the United States

Watten, Bistline & Blanford

Working paper, not identified here as a peer-reviewed final article. Author affiliations in the manuscript: Watten and Blanford, EPRI; Bistline, Watershed. Instrumental-variables study of 2015–2024, finding modest average rate reductions; authors warn future supply constraints could reverse them.

Read the original record ↗

Who pays for the new demand? Questions behind the headline.

S17 / GOVERNMENT / 2025 ORDER; LATER APPEAL NOTED

Data Center Costs: PUCO Case 24-0508-EL-ATA

Office of the Ohio Consumers' Counsel

State consumer advocate's summary: 85% minimum contracted capacity payment, up to 12 years. Notes November 2025 industry appeal. Use the docket for later legal status.

Read the original record ↗

Who pays for the new demand? Four places. Four different questions. Read the proposal, not just the rendering.

S18 / GOVERNMENT / 2025

Senate Bill 6, enrolled text, 89th Legislature

Texas Legislature

Primary statutory text on large loads in ERCOT. Implementation depends on PUCT rules and current orders. Thresholds and exceptions are statutory details, not nationwide requirements.

Read the original record ↗

From announcement to connection. | One project. Several decision rooms. | Four places. Four different questions. | Read the proposal, not just the rendering.

S19 / GOVERNMENT / SEPTEMBER 21, 2026

Governor Abbott Directs TCEQ To Halt Data Center Permits

Office of the Texas Governor

Dated directive tied to electricity and water audits. This presentation describes the announcement, not a project-by-project finding that all permitting activity has stopped.

Read the original record ↗

Four places. Four different questions.

S20 / COMPANY / MARCH 27, 2026

New agreement with Meta: infrastructure and projected customer savings

Entergy Louisiana

Utility announcement of planned generation, transmission, storage and projected savings. Projections and commitments, not completed assets or independently demonstrated savings.

Read the original record ↗

The people behind the buildout. | A large investment is not a local balance sheet. | The jobs arrive in different waves. | Four places. Four different questions. | What changes the outlook?

S21 / GOVERNMENT / 2026 GUIDANCE COLLECTION

Clean Air Act Resources for Data Centers

U.S. Environmental Protection Agency

Primary permitting guidance, including emergency engines. Exact requirements vary by equipment, operating use, jurisdiction and permit.

Read the original record ↗

Beyond the water meter. | Life on the other side of the fence. | Read the proposal, not just the rendering.

S22 / GOVERNMENT / JULY 27, 2026, INITIAL PUBLIC DRAFT

SP 800-239: AI Data Center Security Analysis

NIST / Guo & Tomlinson

Initial public draft, not a final standard. Examines AI infrastructure security relative to high-performance computing.

Read the original record ↗

One project. Several decision rooms.

S23 / GOVERNMENT / JUNE 18, 2026

Targeted action on large-load integration

Federal Energy Regulatory Commission

Dated orders asking six jurisdictional regional grid operators to justify or reform large-load rules. Not a single final nationwide interconnection tariff.

Read the original record ↗

The people behind the buildout. | From announcement to connection. | One project. Several decision rooms. | Read the proposal, not just the rendering. | A shared vocabulary.

S24 / COMPANY / PRODUCT REFERENCE

GB200 NVL72 product specification

NVIDIA

Rack-scale example: 36 Grace CPUs and 72 Blackwell GPUs, liquid-cooled. Manufacturer claims and specifications; not representative of every AI rack.

Read the original record ↗

Inside the machine. The people behind the buildout.

S25 / PROFILE / ACCESSED OCTOBER 2026

Jensen Huang: official biography

NVIDIA

Official biography for identity and role only. Does not establish independent evidence for market or environmental claims.

Read the original record ↗

The people behind the buildout.

S26 / PROFILE / ACCESSED OCTOBER 2026

Lisa Su: official biography

AMD

Official biography and portrait source. AMD supplies CPUs and AI accelerators; biography used only for role and background.

Read the original record ↗

The people behind the buildout.

S27 / PROFILE / ACCESSED OCTOBER 2026

Arman Shehabi: staff profile

Berkeley Lab

Institutional profile. Coauthor of the Berkeley Lab energy reports used in this presentation.

Read the original record ↗

The people behind the buildout.

S28 / PROFILE / ACCESSED OCTOBER 2026

Fatih Birol: official profile

International Energy Agency

Institutional biography for identity and executive-director role. IEA is an intergovernmental energy organization.

Read the original record ↗

The people behind the buildout.

S29 / MEDIA / 2023–2024

The Journey to Frontier

Oak Ridge National Laboratory

Laboratory account of Frontier’s development. Scientific supercomputing example, not a typical commercial AI campus.

Read the original record ↗

See the infrastructure. Hear the explanation.

S30 / MEDIA / MARCH 23, 2016

Google Data Center 360° Tour

Google Cloud

Operator-produced historical facility tour at The Dalles. Useful for physical orientation; not a current AI rack specification or independent impact assessment.

Read the original record ↗

See the infrastructure. Hear the explanation.

S31 / RESEARCH / APRIL 2025

Energy and AI: Energy supply for AI

International Energy Agency

Physical supply mix differs from contractual procurement. Earlier base-case supply analysis; not an operating inventory for any one campus.

Read the original record ↗

Beyond the water meter. A global buildout, with local constraints. Questions behind the headline.

S32 / GOVERNMENT / 2022 REFERENCE YEAR

How much electricity does an American home use?

U.S. Energy Information Administration

10,791 kWh is 2022 electricity PURCHASED per residential utility customer, not total household electricity including self-generated solar. Calculator uses this editable historical grid-purchase comparison; not a city-demand or peak-load estimate.

Read the original record ↗

How big is big? Questions behind the headline. Put a proposal in perspective. A shared vocabulary.

S33 / COMPANY / PRODUCT REFERENCE, CHECKED OCTOBER 2026

AWS Trainium

Amazon Web Services

Official description of AWS custom AI accelerators. Used to identify the supplier/platform role, not to endorse performance or cost claims.

Read the original record ↗

The people behind the buildout.

S34 / COMPANY / PRODUCT REFERENCE, CHECKED OCTOBER 2026

Tensor Processing Units

Google Cloud

Official description of Google’s custom AI accelerators for training and inference. Used for ecosystem examples only.

Read the original record ↗

The people behind the buildout.

S35 / COMPANY / SERVICE REFERENCE, CHECKED OCTOBER 2026

Azure AI apps and agents

Microsoft Azure

Official cloud-platform description. A service offering is distinct from ownership of every physical campus used to deliver it.

Read the original record ↗

The people behind the buildout.

Editorial method

This presentation was developed from a supplied 25-page explainer and website package, then reorganized and researched independently. It preserves useful questions while adding newer reports, clearer accounting boundaries, community decision tools and a richer chapter structure. It is intended for public education, not an endorsement or rejection of data-center development.

The research cutoff is **October 21, 2026**. Dates on sources and numbers remain visible. “Historical estimate” means an estimate of a past period; “scenario” means a conditional future result; “company disclosure” identifies information reported by an interested operator or supplier; “illustrative” means inputs selected to explain a calculation. A source record describes what was checked; it does not imply every page of every report was audited.

Primary research, government documents, market-monitor records and original company disclosures receive priority. Company plans remain plans. A working paper or initial public draft is labeled as such. Where a public mirror was needed, it is identified. All chapter citations link to annotated source records in this PDF; external documents and videos require internet access.

Coverage and limits

This is a broad U.S.-focused guide with international context, not an inventory of every facility or a site-specific engineering, environmental or fiscal study. Public data often lack comparable facility-level detail. The 2023 national water estimates remain labeled historical because a newer electricity forecast is not a new water measurement. The presentation does not claim a universal percentage of U.S. water consumption, a universal permanent-job count, or a universal resource cost per AI prompt.

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