



# AI and the Environment: Costs and Impact

*Prepared for the Illinois-Indiana Sea Grant*

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# Meet the Presenters



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<https://go.illinois.edu/LibEnvironmentAI>

Link is case sensitive.



# Outline for Today's Session



- Intro to AI & how data centers function
- The business of building data centers
- The environmental impact of data centers
- The human dimensions of data centers



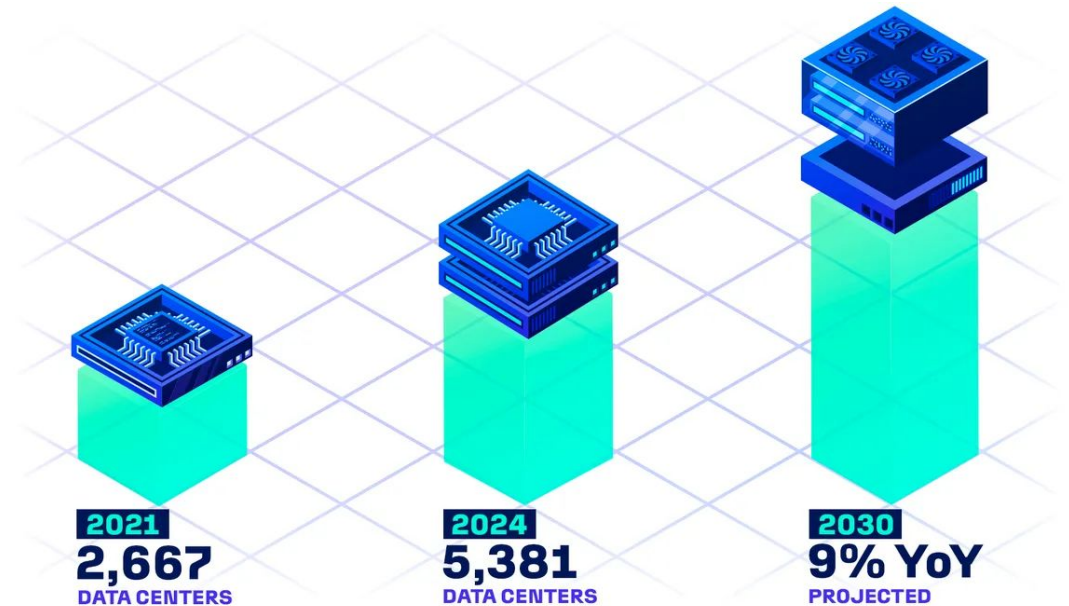
# Intro to AI & Data Centers



# Overview of Data Centers & how they function



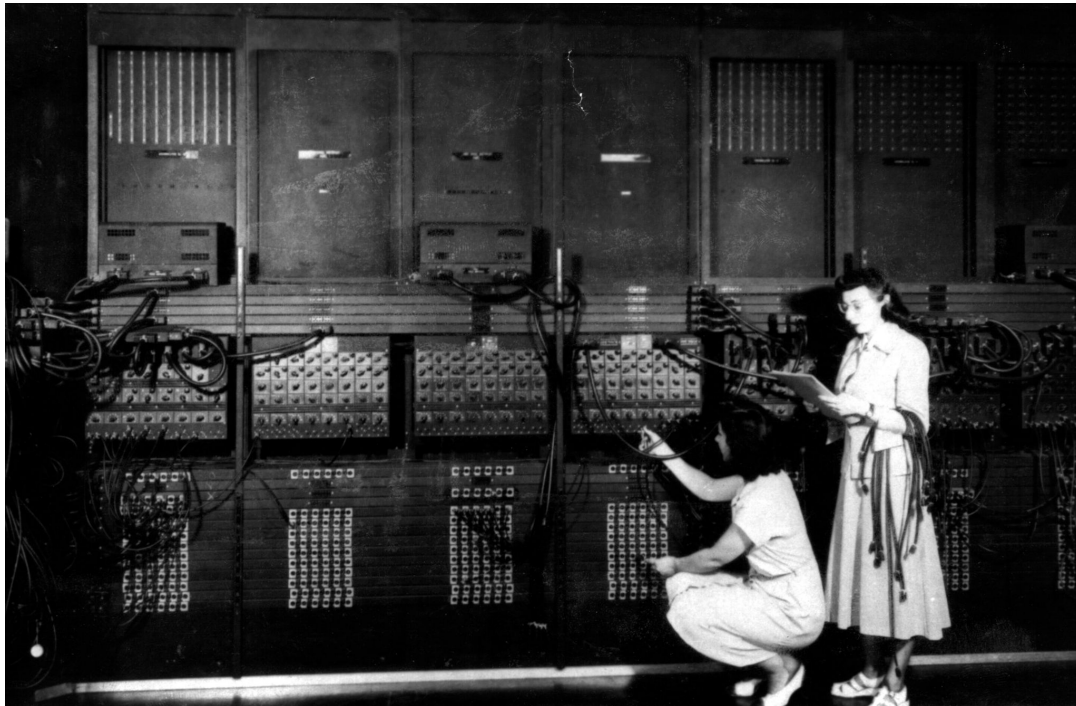
- Data centers are buildings that consist of IT infrastructure (servers, generators, cooling systems, networking equipment, etc.).
- They support the development and maintenance of data storage and management for a range of services and applications.
- They require access to an energy source and other resources like land and local power grids for power and functionality.
- The key issues are maintenance and support (temperatures, cables, etc.).



Source: CNET | Creator: Tharon Green

Image based on a report from Frontier Group, the Environment America Research & Policy Center and the US PIRG Education Fund

# A Look at Data Centers



Ruth Lichterman Teitelbaum (left) and Marlyn Wescoff Meltzer (right) in front of the Electronic Numerical Integrator and Computer (ENIAC).

Images from Penn University Archives, provided by Penn Today.



Aerial view of Microsoft's new AI datacenter campus in Mt. Pleasant, Wisconsin (September 2025).

Provided by Scott Guthrie, Executive Vice President, Cloud + AI.

# Overview of Data Centers & how they function



## Most common are...

- Hyperscale - Warehouse-sized capable of massive workload
- Enterprise (On-premise) - Owned and operated for private data storage and computing needs
- Colocation - Service providers who rent their facilities

## There's also...

- Edge Data Centers - Strategically placed closer to end users or cost-effective locations
- Public Cloud (Computing) - Access to resources for multiple clients via Internet connection, used in Hyperscale and Colocation
- Phantom Data Centers - Data centers that *might* be built

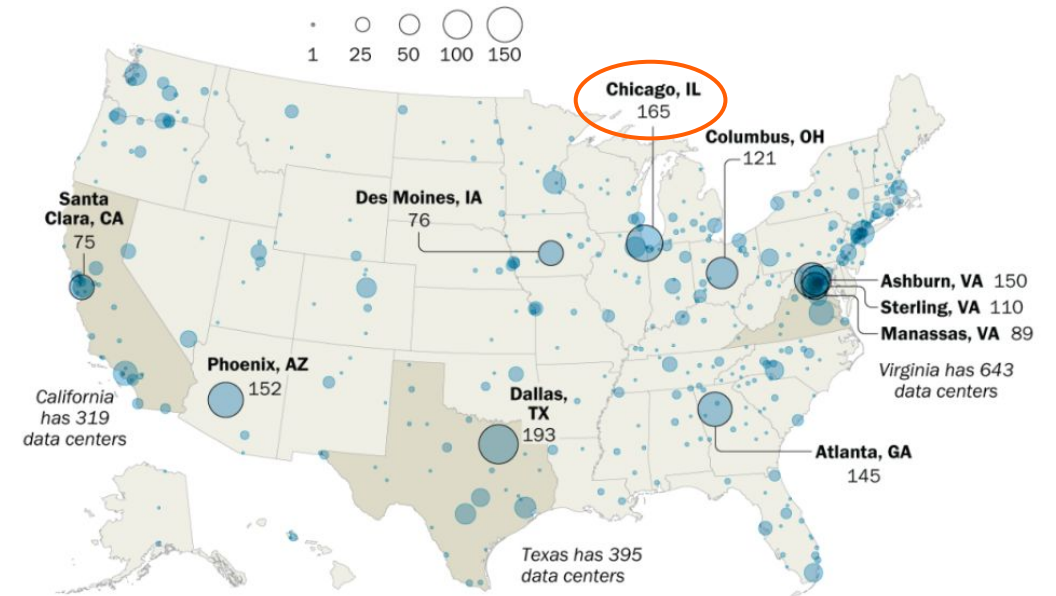


# How Data Centers Function: Why AI?

- Increase in data generation and consumption
- Critical to have quick access and scalability
- Data centers maintain and sustain AI training and inferencing
- High dependency on servers
  - Requires sophisticated maintenance and management
- Black Box in its data and prompt demands
  - Difficult to determine source and energy impact
- Colocation data centers are most popular due to its range of support and Hyperscale is popular for high-needs

## Virginia, Texas and California lead in number of data centers

Number of data centers, by market

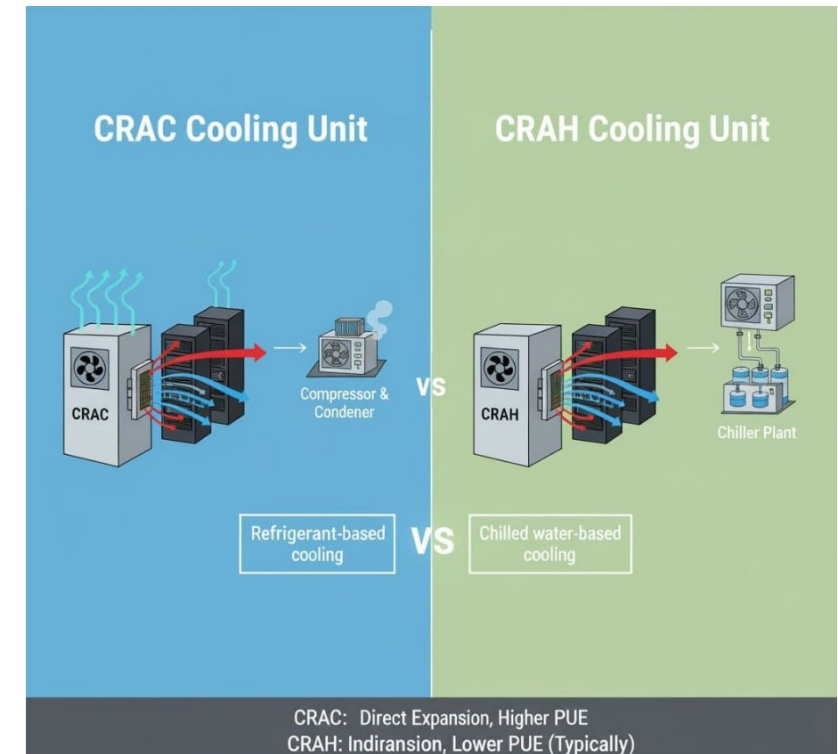


Note: Includes operational data centers and those in development. Refer to the Data Center Map methodology for more details.  
Source: Data Center Map, accessed Oct. 20, 2025.

PEW RESEARCH CENTER

# How Data Centers Function: Cooling Systems

- High temperatures affect equipment, which affects the process, clients, and equipment
- Data center's environment can affect what cooling is used
- There are different types of cooling systems (how to transfer heat):
  - Computer Room Air Conditioning (CRAC) - refrigerant and compressors
  - Computer Room Air Handler (CRAH) - chilled water and valves
  - Liquid cooling
    - Direct-to-chip cooling - small tubes draw heat away
    - Single-phase/two-phase immersion cooling - sealed containers
  - Free cooling - natural air
- Other technologies include thermal wall units, airflow contaminants (hot or cold), etc.
- Department of Energy (DoE) specifies energy conservation standards and test procedures per the [Code of Federal Regulations](#) (CFR).



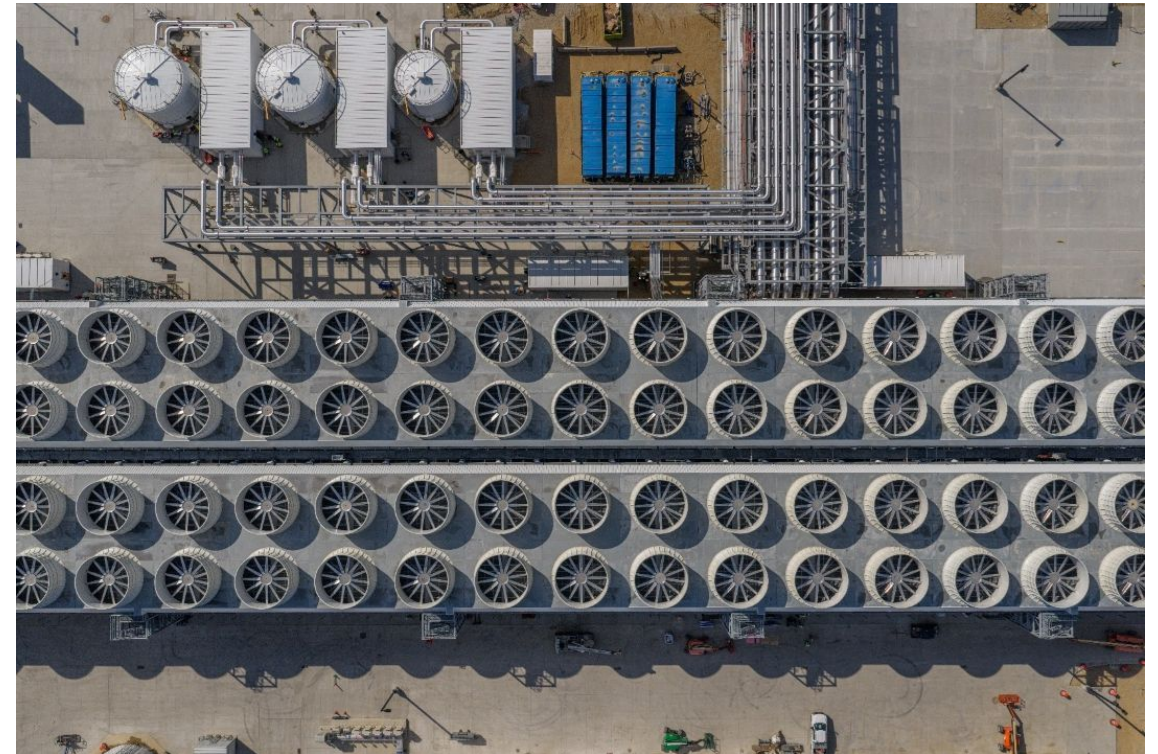
CRAC Cooling Unit and CRAH Cooling Unit comparison. Source: BlueChip Advanced Technologies

# How Data Centers Function: Cooling System Example



Oracle Nvidia GB200 racks inside Stargate I Abilene for Project Stargate

Source: OpenAI



Aerial view of part of the closed loop liquid cooling system at the Microsoft Fairwater datacenter in Wisconsin.

Source: Microsoft



# How Data Centers Function: Climate factor

Source: Microsoft

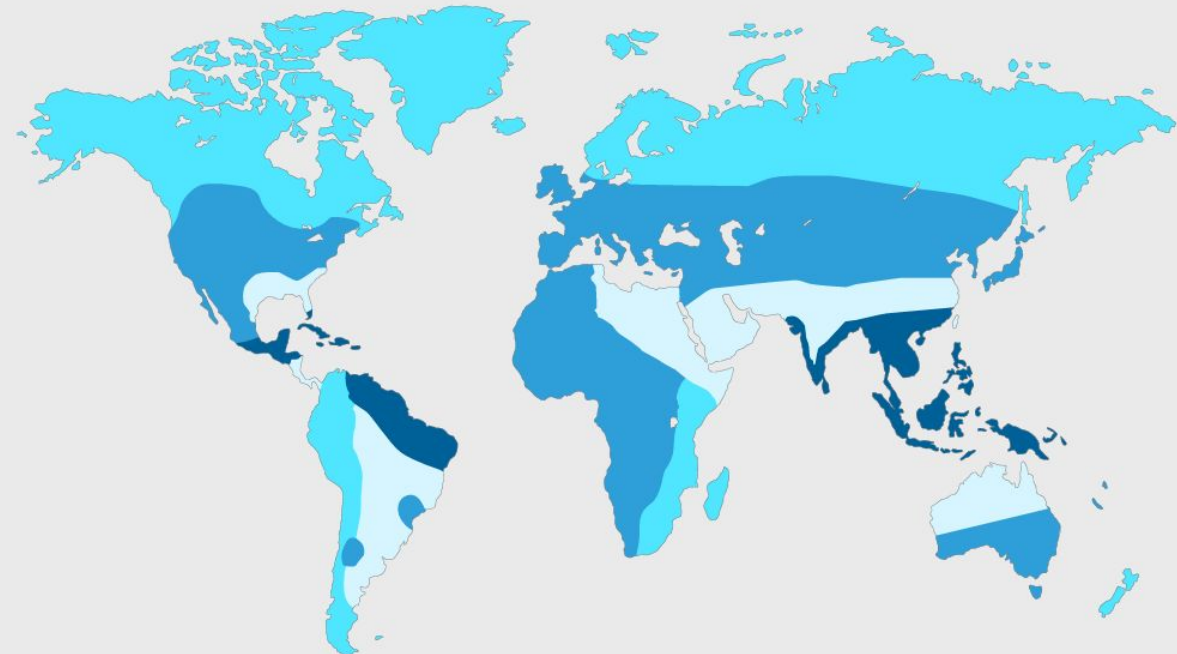
Modern datacenter cooling

Simplified key terms

- Mechanical - machine
- Adiabatic - liquid

## Cooling methods by climate

This map showcases how we use different cooling methods based on the climate of the region. Some datacenter cooling methods are not applicable everywhere, so we carefully consider the climate of each region we operate in to help minimize our impact in terms of energy and water usage.



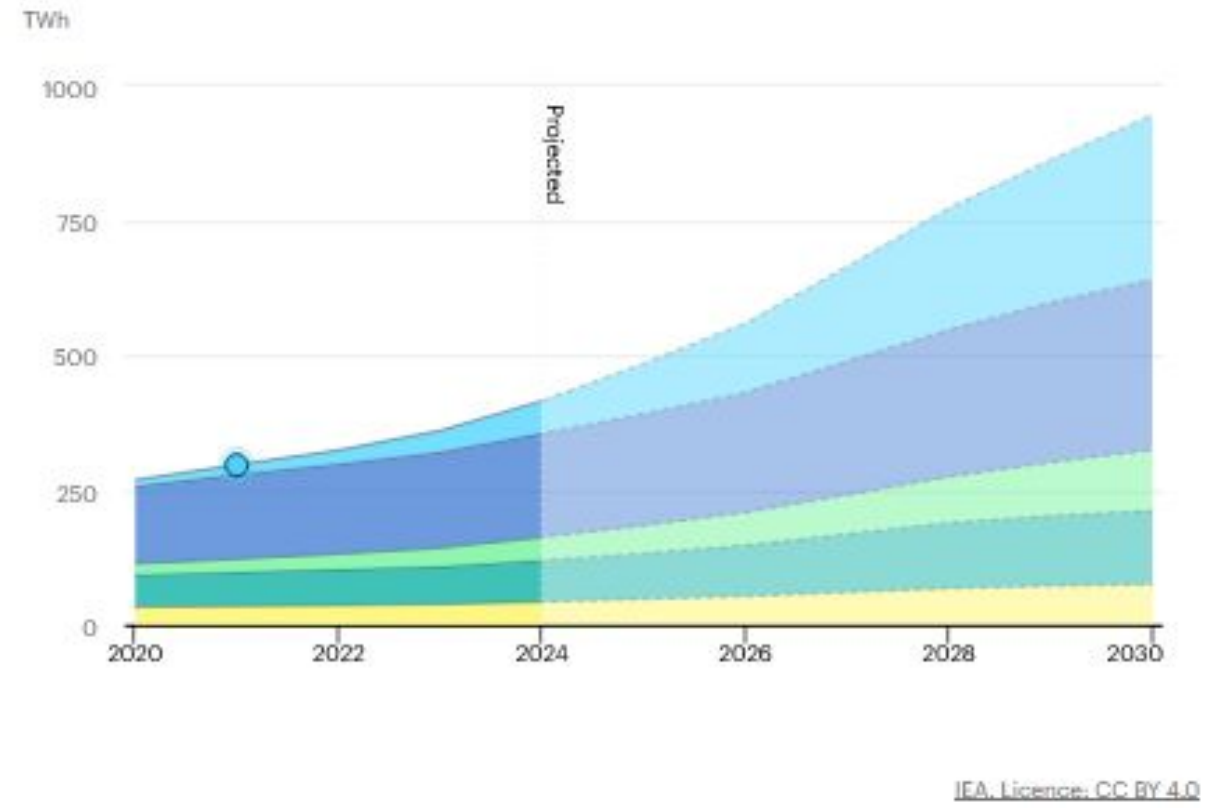
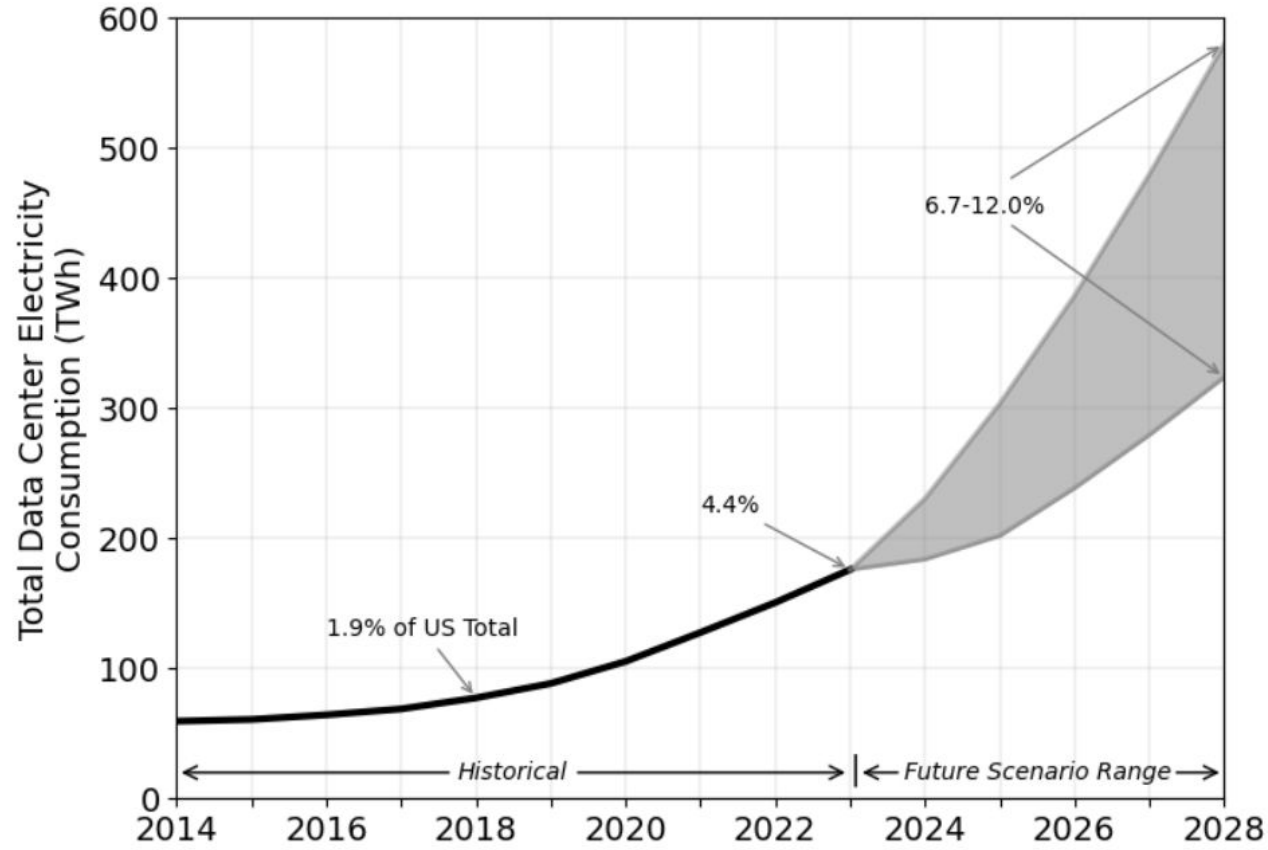
■ Mechanical cooling   ■ High-efficiency mechanical cooling   ■ Adiabatic cooling   ■ Free air cooling

# How Data Centers Function: Energy Consumption



- U.S. data center annual energy use in 2023 was approximately 176 terawatt-hours (TWh), **approximately 4.4% of U.S. annual electricity consumption**
  - About half of this goes to operation of IT equipment and the rest to cooling
  - AI applications are estimated to use 10%–20% of data center electricity in 2024
- Globally this number is between **1-2%**, but is predicted to rise to **3-4%** by end end of the decade based a study by Goldman Sachs
- Dramatic gains in efficiency for data centers in recent years. Power Usage Effectiveness (**PUE**) **has gone from 2.50 to 1.58** according to the Electric Power Research Institute.

# Energy use & Predictions:



IEA, Licence: CC BY 4.0

- Accelerated servers
- Conventional servers
- Other IT equipment
- Cooling
- Other infrastructure

Global data centre electricity consumption, by equipment, Base Case, 2020-2030

Figure ES-1. Total U.S. data center electricity use from 2014 through 2028.

Shehabi, A.; Newkirk, A.; Smith, S.; Hubbard, A.; Lei, N.; Siddik, M., et al. (2024). 2024 United States Data Center Energy Usage Report. Lawrence Berkeley National Laboratory. Report #: LBNL-2001637. <http://dx.doi.org/10.71468/P1WC7Q> Retrieved from <https://escholarship.org/uc/item/32d6m0d1>

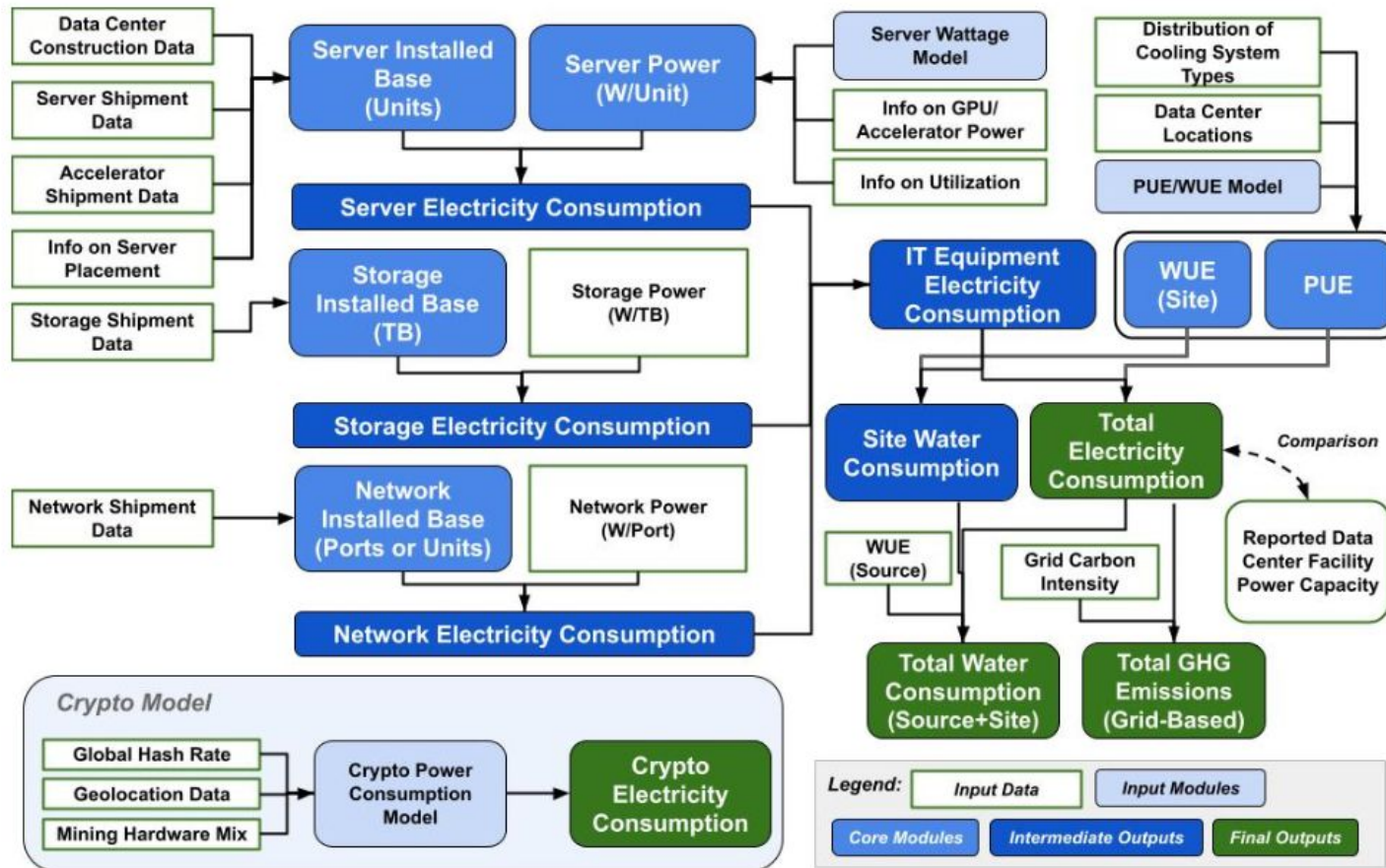


Figure 2.1. Flow chart for the data center electricity model used in this study.

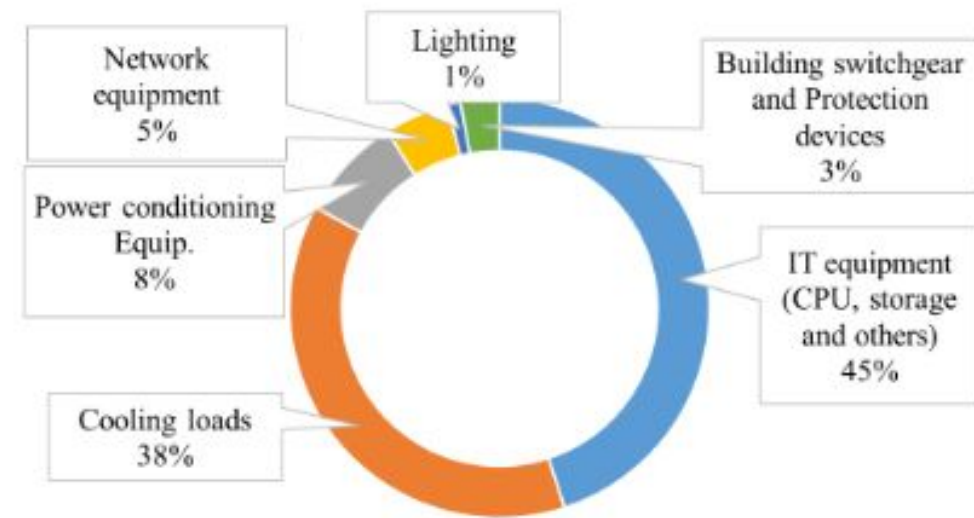
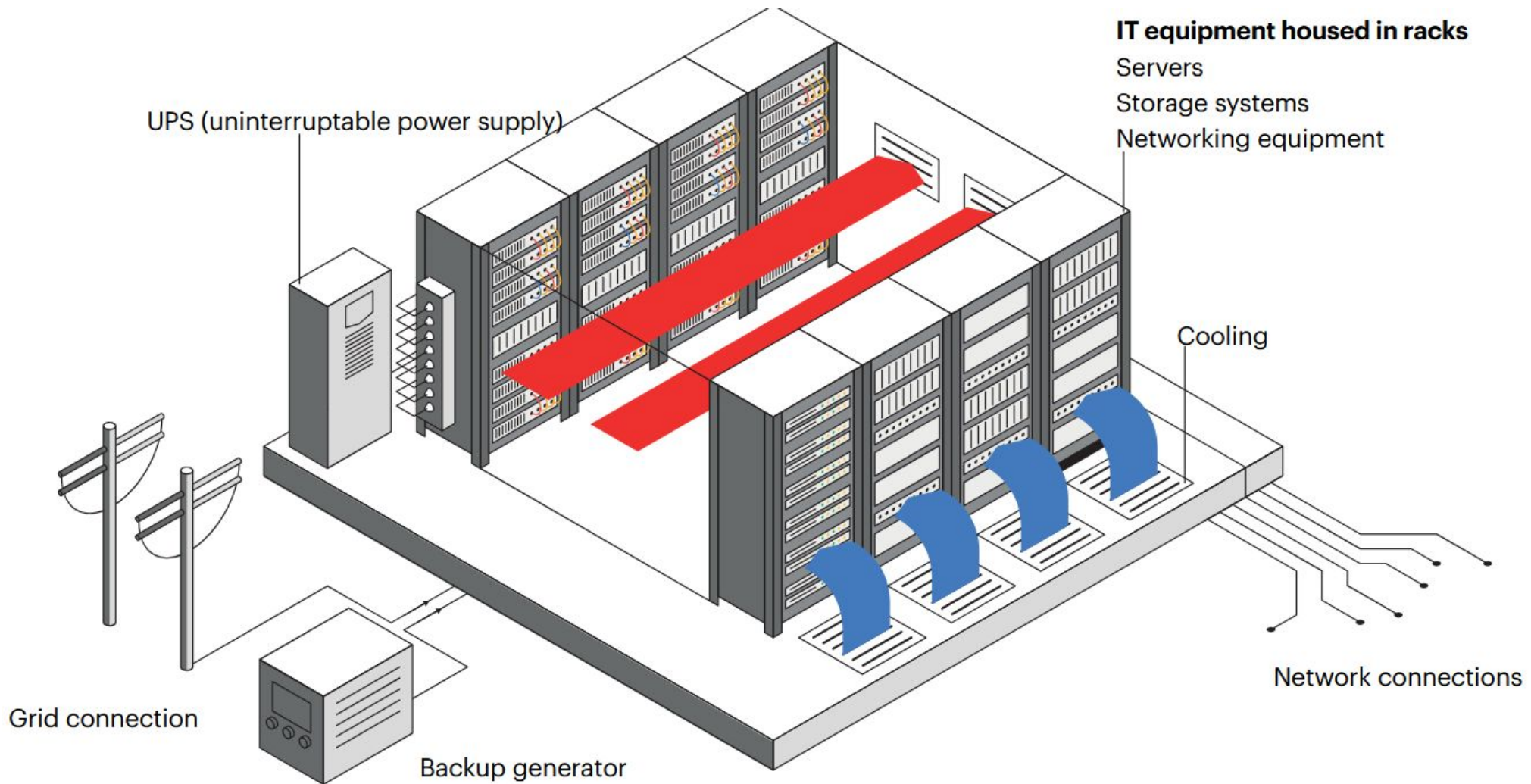


FIGURE 4. Analysis of power consumption proportionality in data center. [8], [24].



## Illinois

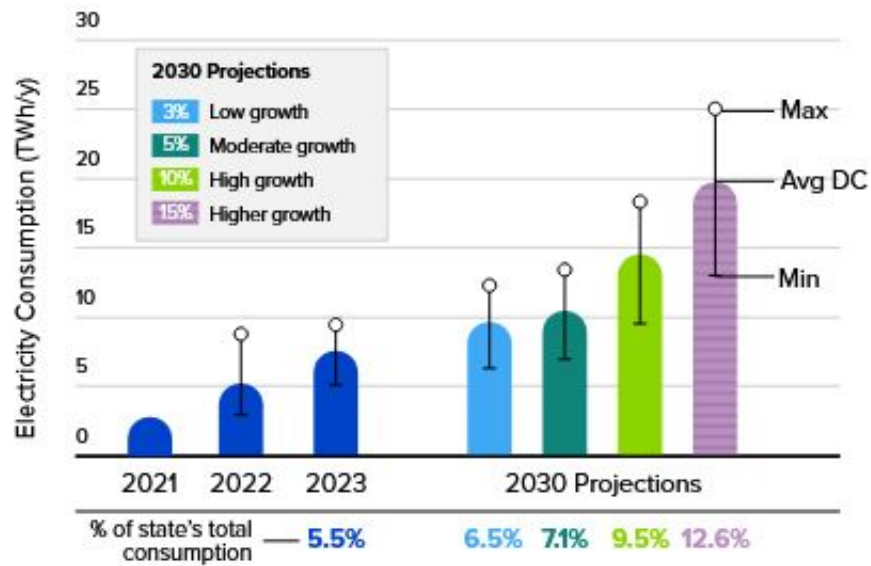


Figure A4.

Projected electricity consumption in Illinois data centers

**“Illinois has strategic location; significant tax incentives; nuclear generation and increasing renewable energy investments to address sustainability, but also challenges around transmission constraints and rapidity of development”** - EPRI’s 2024 White Paper on

analyzing artificial Intelligence and data center energy consumption

Table A1. Projections to 2030 of potential power consumption for states with significant data center load in 2023 [4, 8, 9]

FORECASTED SCENARIOS: PROJECTIONS OF POTENTIAL POWER CONSUMPTION BY STATE (2023–2030)										
STATE	2023 Load		Low-growth Scenario (3.71%)		Moderate-growth Scenario (5%)		High-growth Scenario (10%)		Higher-growth Scenario (15%)	
	MWh/y	% of Total State Electricity Consumed (%EC)	MWh/y	% of Total State Electricity Consumed (%EC)	MWh/y	% of Total State Electricity Consumed (%EC)	MWh/y	% of Total State Electricity Consumed (%EC)	MWh/y	% of Total State Electricity Consumed (%EC)
Illinois	7,450,176	5.48%	9,614,151	6.53%	10,483,145	7.08%	14,518,285	9.54%	19,781,455	12.56%
Indiana	192,720	0.19%	248,697	0.23%	271,176	0.25%	375,557	0.35%	511,704	0.48%

# Data Center Incentives: United States AI Action Plan



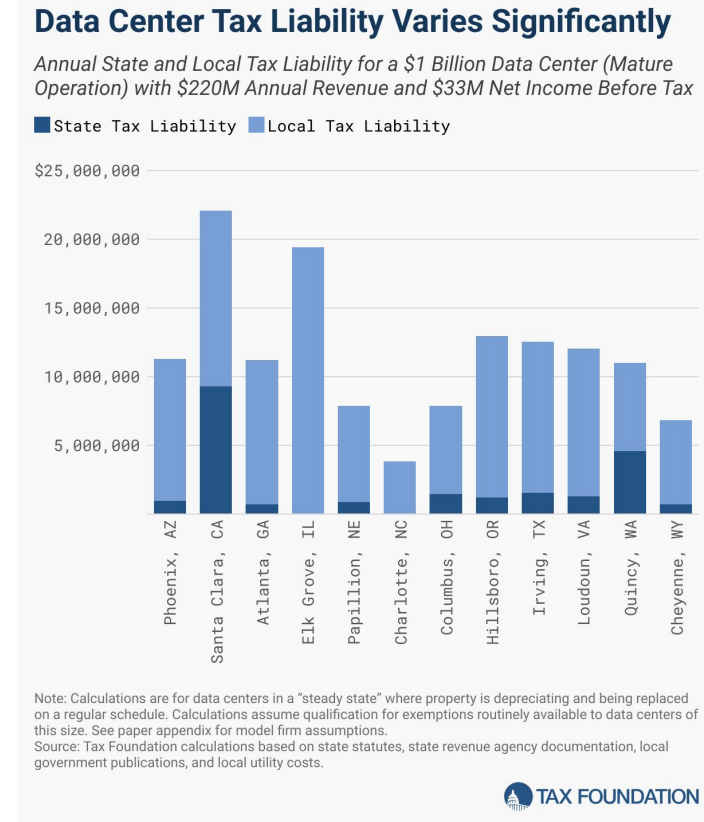
- **Executive Order 14141** (January 14, 2025)
- **DOE selected 4 sites (July 24, 2025)**
  - Idaho National Laboratory, Oak Ridge Reservation (TN), Paducah Gaseous Diffusion Plant (KY) and Savannah River Site (DC)
- **Pillar 1: Accelerate AI Innovation**
  - **Removing Red Tape and Onerous Regulation**
  - Ensure that Frontier AI Protects Free Speech and American Values
  - Encourage Open-Source and Open-Weight AI
  - **Enable AI Adoption**
  - Empower American Workers in the Age of AI
  - Support Next-Generation Manufacturing
  - **Invest in AI-Enabled Science**
  - Build World-Class Scientific Datasets
  - **Advance the Science of AI**
  - **Invest in AI Interpretability, Control, and Robustness Breakthroughs**
  - **Build an AI Evaluations Ecosystem**
  - Accelerate AI Adoption in Government
  - Drive Adoption of AI within the Department of Defense
  - **Protect Commercial and Government AI Innovations**
  - Combat Synthetic Media in the Legal System





# In the Business of Data Centers: Funding Aids

- **Accelerating Federal Permitting of Data Center Infrastructure | July 23, 2025**
  - **Policy and Purpose** - “...facilitate the rapid and efficient buildout of this infrastructure by **easing Federal regulatory burdens.**”
  - **Definition of “Data Center Project”** - a facility that requires greater than 100 megawatts (MW) of new load dedicated to AI inference, training, simulation, or synthetic data generation.
  - **Encouraging Qualifying Projects** - Secretary of Commerce, Director of the Office of Science and Technology Policy (OSTP) and others, “shall launch an initiative to provide financial support for Qualifying Projects, which could include **loans and loan guarantees, grants, tax incentives, and offtake agreements.**”
  - **Revocation of Executive Order 14141** - Advancing United States Leadership in Artificial Intelligence Infrastructure



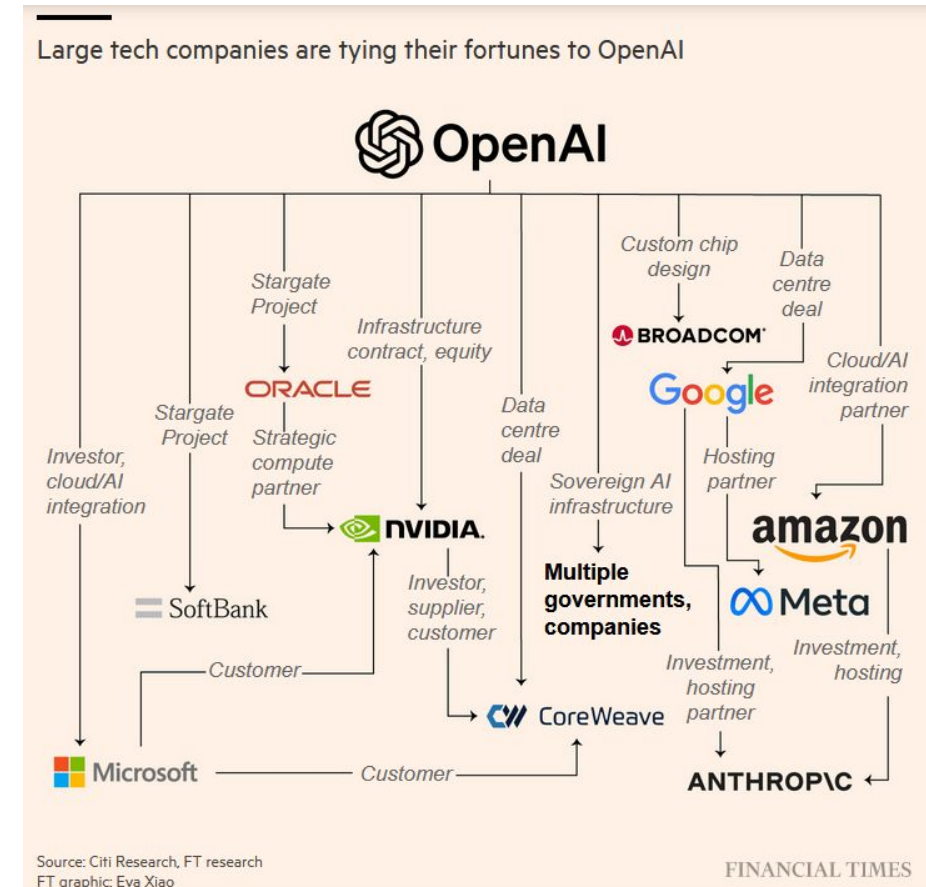
Source: Tax Foundation

Graphic: Rob Wile, Melinda Yao and Joe Murphy / NBC News



# In the Business of Data Centers: Investors

- Magnificent 7
  - Alphabet (Google), Amazon, Apple, Tesla, Meta, Microsoft, and Nvidia
- AI Interconnected Investment / Circularity
  - Microsoft, OpenAI, Anthropic, Google, Nvidia, Oracle, xAI, AMD, CoreWeave, Intel, SoftBank, Broadcom, Scale, and more!
  - Open AI \$1 trillion of AI deals (October 15, 2025)
  - Chips, equity, infrastructure, rentals, revenue sharing



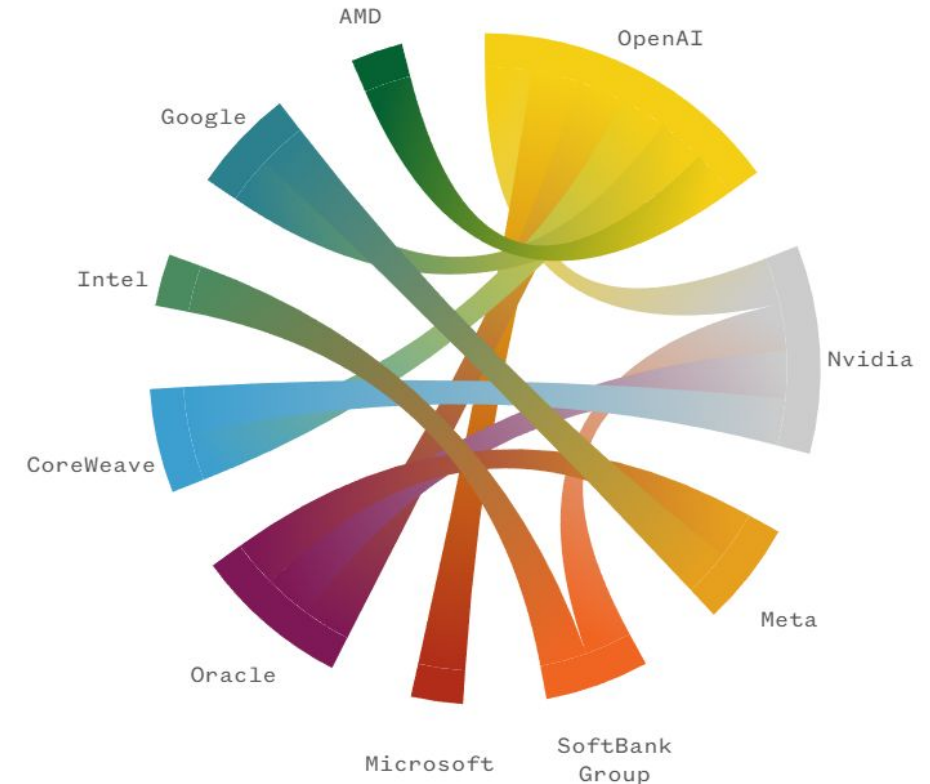
Source: CM Research, Financial Times Research | Creator: Eva Xiao

Deal list is not exhaustive



# In the Business of Data Centers: Flagship Projects

- **The Stargate Project (January 2025)**
  - A network of data centers or “a factory of factories” led by OpenAI, Oracle, and SoftBank.
  - \$500 billion (\$100 billion so far)
  - 10 gigawatt investment
- **Who’s involved?**
  - U.S. Government (announcement) and private sector investment.
  - Equity funders include SoftBank, OpenAI, Oracle, and MGX.
  - Technology partners include Arm, Microsoft, and NVIDIA.
  - Crusoe Energy and CoreWeave for infrastructure (facility and cloud-computing)



Source: NBC News reports

Graphic: Rob Wile, Melinda Yao and Joe Murphy / NBC News



# In the Business of Data Centers: Project Ludicrous

- Abilene, TX - Codename “Project Ludicrous”
  - Crusoe Energy, with investment from Blue Owl Capital and Primary Digital Infrastructure
  - 100K Nvidia GPUs into each of the first two 500,000 square foot buildings
  - Draw 100 megawatts of electricity (city of 100k) deals with windmill owners (100s of wind turbines) and General Electric Vernova (5 gas turbines)
  - Concerns over Texas power grid (2021 Texas blackouts)
- Housing crisis
  - Average rent \$2,395
  - Out of state workers competing
  - Low-income residents struggling
  - Landlords profiting



Source: OpenAI

*The future home of the first Stargate site in Abilene, Texas.  
Photographer: Bobby Scheidemann for Bloomberg Businessweek*

# In the Business of Data Centers: Stargate Impact

- AI Race
  - Open AI for Countries
    - Stargate Norway, Stargate UAE
  - Competition
    - Stargate of China, “Data Island” four new AI data centers
    - Meta, 30 data centers, Prometheus, 1-gigawatt site, in Ohio and Hyperion, 5-gigawatt site, in Louisiana
- Technology
  - Meta and Nvidia bigger partnership deal - CPUs, GPUs, and Vera Rubin rack-scale systems (Meta already sources chips from AMD and Google)
  - Consumer technology prices rising as investment turns to AI and results in shortages



Source: Planet Labs

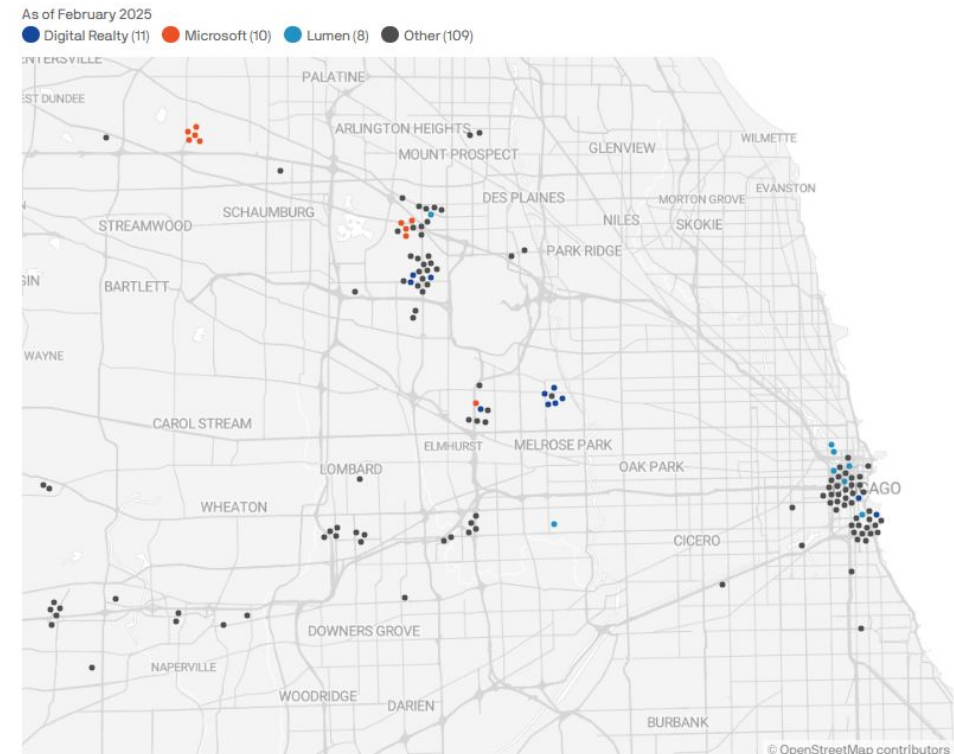
*A three year difference, development of the Huawei site of the “Data Island.”*



# In the Business of Data Centers: Illinois

- Chicago is the 3rd largest data center location with ~164 operating data centers (210 data centers exist)
  - Grid concerns- Illinois Environmental Protection Agency, Illinois Power Agency, and Illinois Commerce Commission report energy shortfalls will begin in northern Illinois by 2029
- **Clean and Reliable Grid Affordability Act (CRGA)** address utility bills and power grid
  - Pressure to continue fossil fuel plants
- Illinois Department of Commerce & Economic Opportunity **Data Center Investment Tax Exemptions and Credits**
  - “Only Illinois, Nevada, Missouri and Washington itemize how much companies are getting by recipient...one Microsoft data center in Illinois received more than \$38 million in data center sales tax exemptions but created just 20 permanent jobs.”

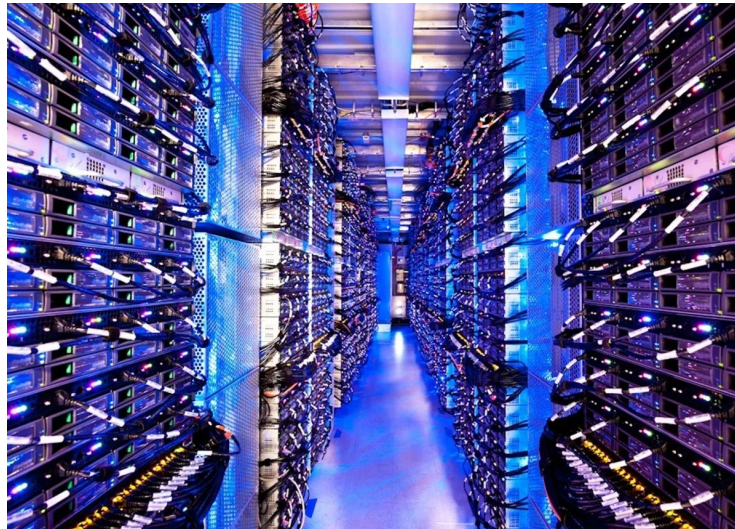
Data centers in the Chicago metro area



Source: AXIOS Chicago | Map: Erin Davis/Axios Visuals

Data: Data Center Map; Note: Dots have been shifted to avoid overlaps and locations are approximate;

# Microsoft's Chicago Data Center



**Microsoft's Chicago Data Center | Photographer: Ina Fried**

# In the Business of Data Centers: Indiana

- Indiana has 88 data centers
- **Project Rainier (Amazon)**
  - \$11 billion
  - AI training and inference for Anthropic
- **Who's involved?**
  - Amazon, Anthropic, American Electric Power, and the Northern Indiana Public Service Company (NIPSCO)
- **Costs**
  - 30 buildings and 2.2-2.4 gigawatts of electricity (power for 1.6 million homes)
  - “Indiana offers some of the country’s most generous subsidies, including a sales tax exemption on energy and equipment for up to 50 years for data centers that invest more than \$750 million.”
  - Data center boom- Meta’s \$10 billion Lebanon, Indiana Data Center



Project Rainier, an \$11 billion Amazon AI data center, on Thursday, Oct. 30, 2025, between New Carlisle and South Bend.

Michael Clubb/South Bend Tribune, Christine Tannous/IndyStar



# Environmental Impact of Data Centers

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# The Impact on Water

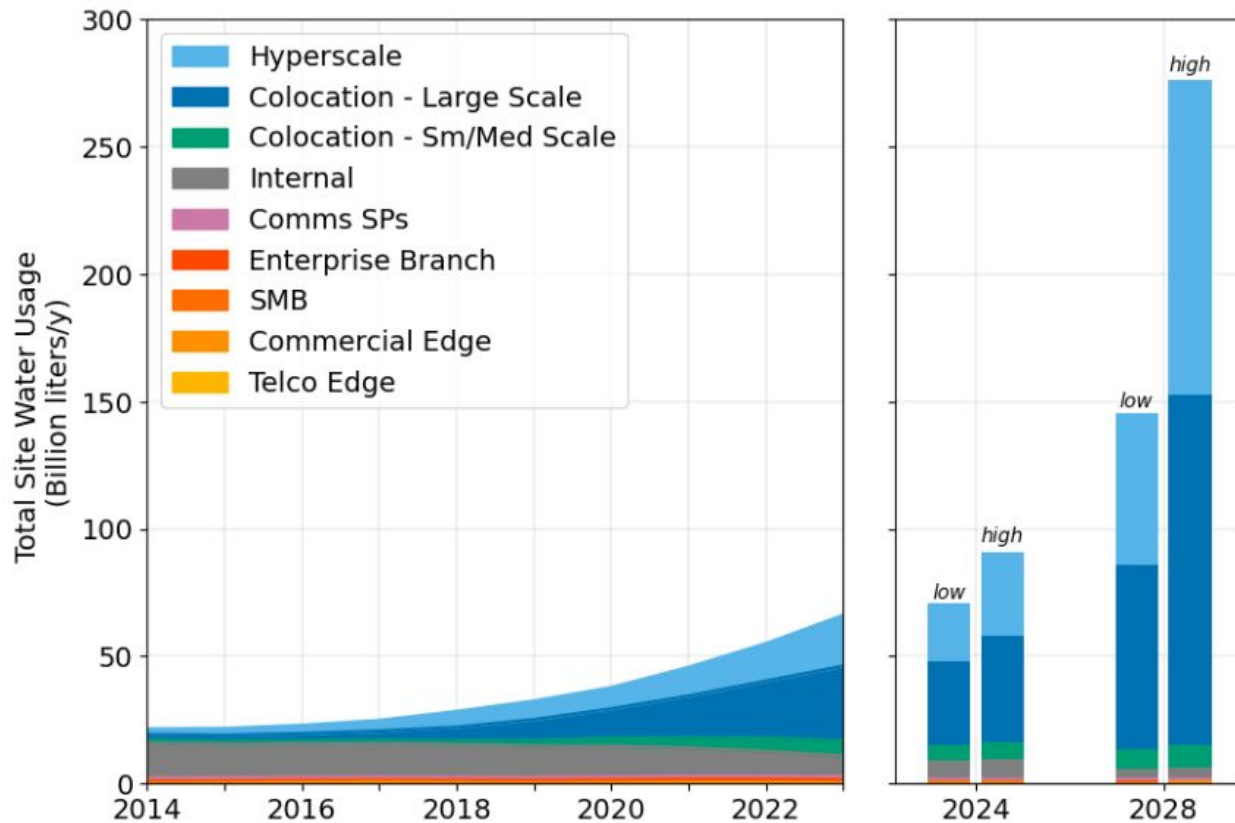
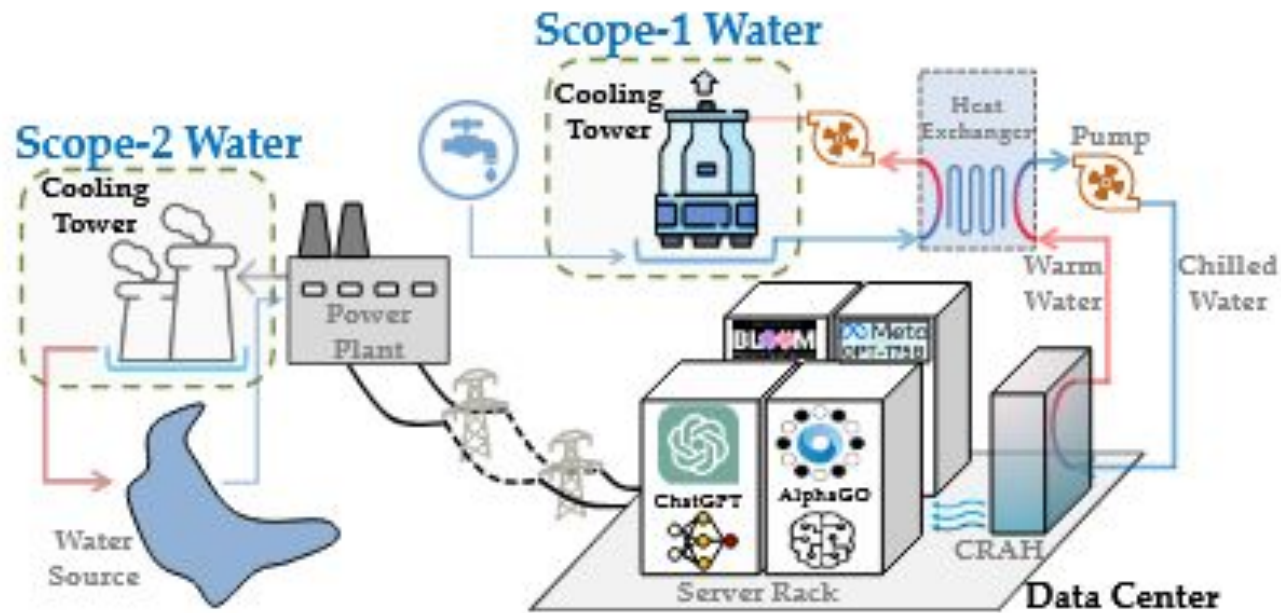


Figure 5.9. Direct water consumption by data center type.

*It is important to note that the methodology used here to calculate indirect water and emission impacts does not incorporate any power purchase agreements between individual data center facilities and their electricity providers or on-site “behind the meter” generation, which could significantly affect water consumption and emissions estimates, depending on the electricity source.*

- **Less than a third** of data centre operators actively track water usage metrics
  - Non-disclosure agreements that companies ask municipalities to sign when they propose a data center further obscure water usage
- Hyperscale facilities alone are projected to consume between **16 billion and 33 billion gallons annually by 2028**. (Shehabi et al., 2024)
- It is estimated that GPT-3 needs to consume a **500ml bottle of water for roughly 10 – 50** medium-length responses, depending on when and where it is deployed (Li et al., 2025)
- Average WUE for data centers is just over **0.36 L/kWh in 2023** (Shehabi et al., 2024)
- A majority of AI’s water footprint is blue water extracted from rivers, lakes, or groundwater, which is directly accessible for human use but often more limited in availability. (Li et al., 2025)



**Figure 1:** An example of data center's operational water usage: on-site scope-1 water usage for data center cooling (via cooling towers in the example), and off-site scope-2 water usage for electricity generation. The icons for AI models are only for illustration purposes.

- **AI Water usage scopes:**
  - Scope 1
    - server-level cooling
    - facility-level cooling
  - Scope 2
    - water use by power plant facilities that supply power to data centers
  - Scope 3
    - water consumption during the manufacturing process of processor chips
- We may see more accurate information with the the **Illinois Data Center Energy and Water Reporting Act**. The bill will require all data centers operating within the State shall annually report the data center's energy and water consumption to the Illinois Power Agency

# The Impact on Land Usage

- Power grids and power lines
- Noise pollution
  - Loudoun County, Virginia
- Rezone farmlands/land - 2024 average data center ~224 acres/0.35 square miles (450 football fields) and hyperscale can exceed 1,000 acres/1.6 square miles
  - Pittsboro, Indiana for Vantage Data Centers project
  - Caledonia, Wisconsin for Microsoft
- Affects land development projects and property values



**Source: Associated Press | AP Photo: Marc Levy**

Mike Petak of Spring City gestures while speaking to East Vincent Township supervisors in opposition to a data center proposal at the formal Pennhurst state hospital grounds, Dec. 17, 2025, in Spring City, Pa.



# What is being done to mitigate the impact?

- Company Statements
  - Communicate through websites and press releases
  - Climate pledges - Invest in AI to get a chance at better outputs and long-term environmental impact by 2030 (Google, Microsoft, and Meta)
- Company Actions
  - Funding
    - OpenAI Stargate, “commit to paying our own way on energy,” working with utilities and contributing to grid upgrades
  - Research in updating technical equipment
    - Chips, Racks, etc.
    - Innovative water cooling
- Greenwashing
  - AI as umbrella term

But community voices are rising in opposition as questions about the expected value start impacting policies and policy makers.

# What is being done to mitigate the impact? Technical Side of things



- As of right now, clean energy cannot meet all the needs of data centers. They rely heavily on fossil fuels power plants.
  - Interest in small modular reactors (SMRs). However, these SMRs remain largely theoretical, with no commercially viable models yet in operation. (Green & Nguyen, 2025)
- Heat Waste Recoveries
  - Produces power by utilizing the heat energy lost to the surroundings from thermal processes, at no additional fuel input
  - Over 70 data centers worldwide, with an additional 12+ under construction. (Latif et al., 2025)
- Sustainable Manufacturing & E-waste Management
  - 6R concept for promoting green manufacturing technologies which is reduce, reuse, recover, redesign, remanufacture and recycle
- Sustainable Computing
  - Field Programmable Gate Arrays (FPGAs)
- Closed-loop Cooling Systems
  - Enable the reuse of both recycled wastewater and freshwater, allowing water supplies to be used multiple times.



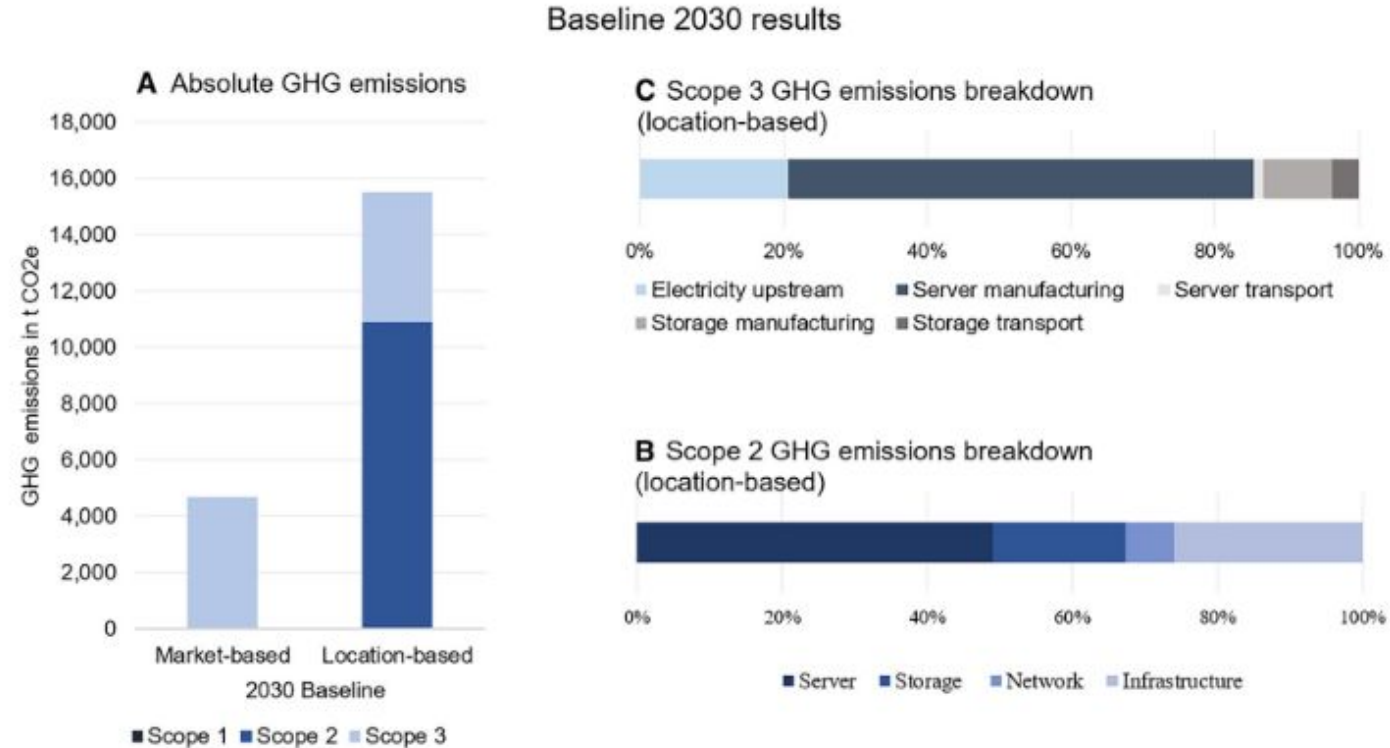
# Community Impact of Data Centers



# Pollution and Health



- About 1.4% of global greenhouse gas emissions in 2020 originate from the information and communication technology sector, of which 16% are attributable to data centers. (Aslan et al., 2025)
- The current administration is proposing as part of the “Winning the Race: America’s AI Action Plan” to:
  - “Expedite environmental permitting by streamlining or reducing regulations promulgated under the Clean Air Act, the Clean Water Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and other relevant related laws.”
- EPA: Rescission of the Greenhouse Gas Endangerment Finding and Motor Vehicle Greenhouse Gas Emission Standards Under the Clean Air Act



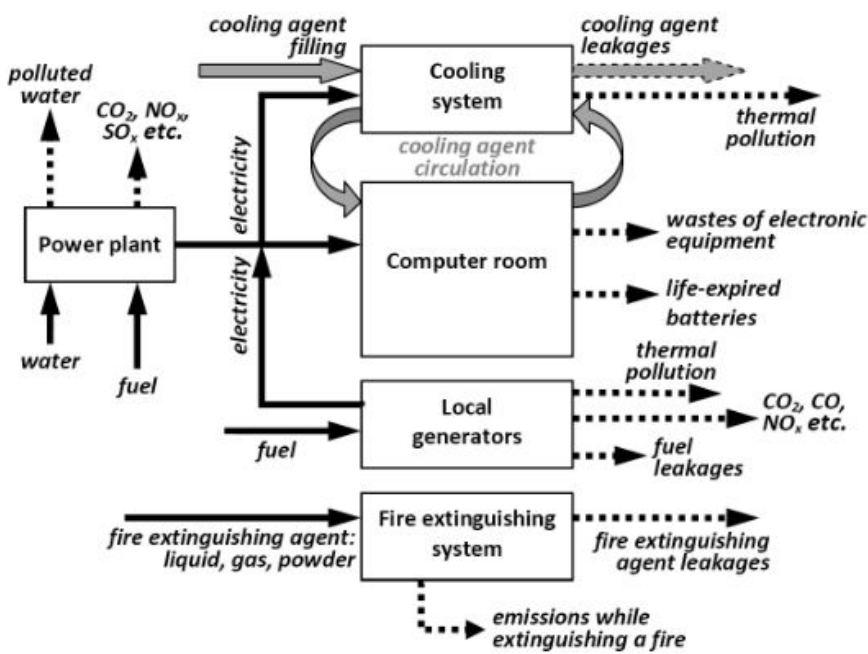
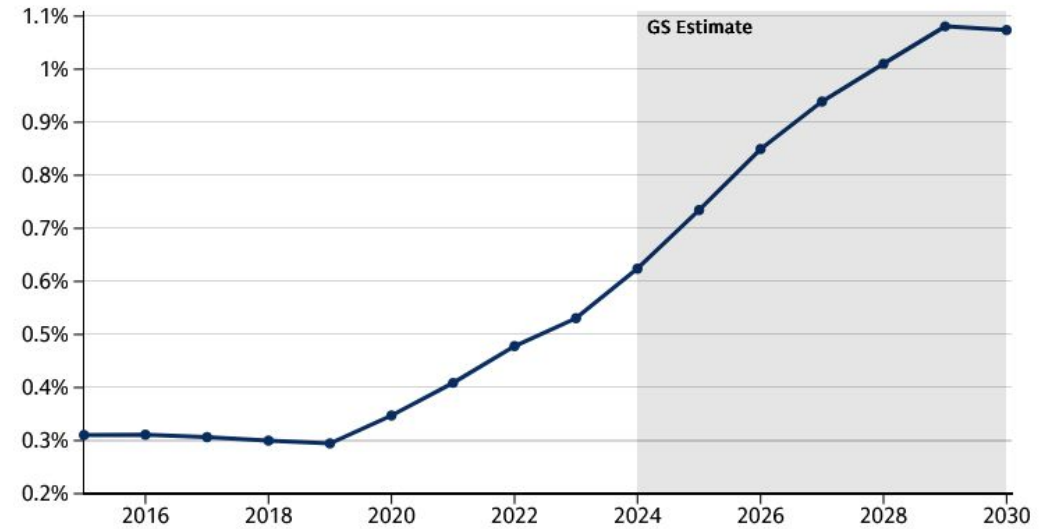
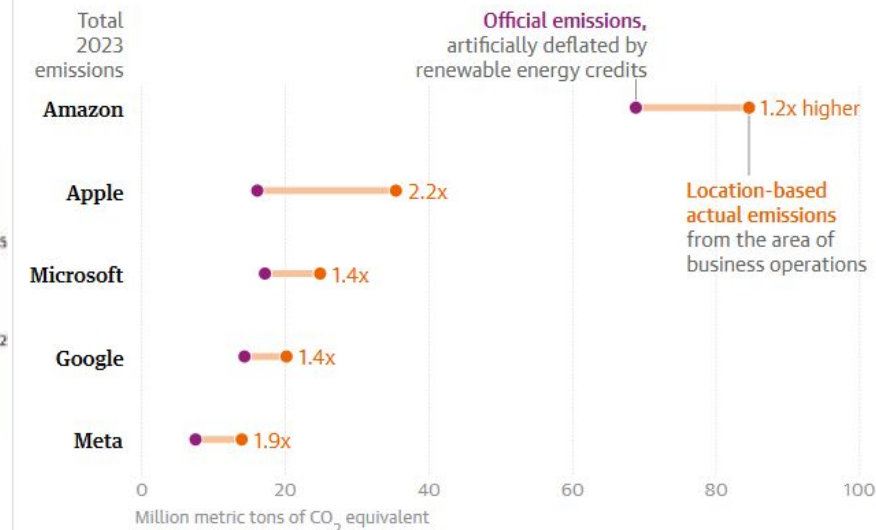


Fig. 1. Data center main resources, emissions and wastes.

DATA CENTER EMISSIONS AS % of 2022 GLOBAL ENERGY EMISSIONS

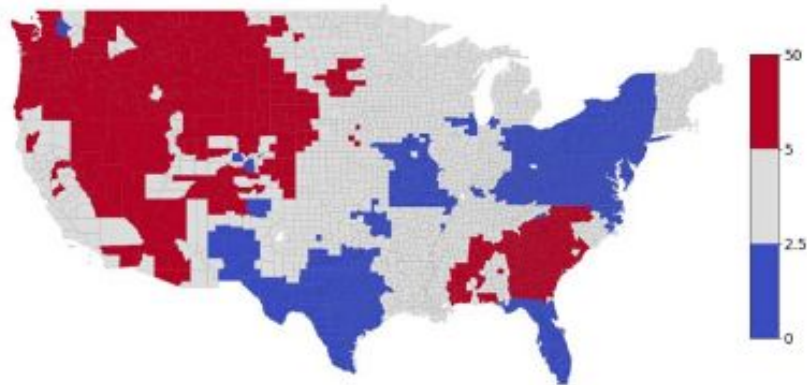


The gap between tech companies' official and actual emissions



Guardian graphic. Source: Various company reports. Note: Google and Microsoft do not make their location-based scope 3 figures available – their official numbers were used instead. Apple only provides a partial location-based scope 3 number. All three firms' total emissions are likely understated.

(A) Water consumption intensity (L/kWh)



(B) GHG emission intensity (kg/kWh)



Figure 5.10. Water consumption and GHG emission intensity factors of electricity use by county.

Semenov, A., & Oganessian, E. (2021). Data centers environmental impact assessment features. *E3S Web of Conferences*, 311, 04007. <https://doi.org/10.1051/e3sconf/202131104007>

How AI Is Transforming Data Centers and Ramping Up Power Demand. (n.d.). Retrieved February 13, 2026, from <https://www.goldmansachs.com/insights/articles/how-ai-is-transforming-data-centers-and-ramping-up-power-demand>

Shehabi, A.; Newkirk, A.; Smith, S.; Hubbard, A.; Lei, N.; Siddik, M., et al. (2024). 2024 United States Data Center Energy Usage Report. Lawrence Berkeley National Laboratory. Report #: LBNL-2001637.

<http://dx.doi.org/10.71468/P1WC7Q> Retrieved from <https://escholarship.org/uc/item/32d6m0d1>



# Pollution & Health: Environmental Racism

“Environmental health research in the US has shown that racial and ethnic minorities and members of low-socioeconomic groups, are disproportionately burdened by harmful environmental exposures, in their homes, workplace, and neighborhood environments that impact their overall health and well-being.” (Beard et al., 2024)

POLITICO

## 'How come I can't breathe?': Musk's data company draws a backlash in Memphis

The company's turbines — enough to power 280,000 homes — run without emission controls in an area that leads Tennessee in asthma hospitalizations.



An aerial view of the xAI data center. | Steve Jones/Flight by Southwings for SELC

By ARIEL WITTENBERG  
05/06/2025 10:32 AM EDT



TABLE 2

Top 10 Metropolitan Areas by African American Health Impacts Attributable to Ozone caused by Natural Gas Pollution

Metropolitan Area	Asthma Attacks (per year)	Lost School Days (per year)
Dallas-Fort Worth (TX, OK)	8,059	5,896
Atlanta (GA)	7,499	5,469
Washington-Baltimore (DC, MD, VA, WV, PA)	7,216	5,269
New York-Newark (NY, NJ, CT, PA)	5,235	3,821
Houston (TX)	4,256	3,111
Chicago (IL, IN, WI)	3,777	2,760
Memphis (TN, MS, AR)	3,674	2,692
Philadelphia (PA, NJ, DE, MD)	2,887	2,104
Shreveport-Bossier City (LA)	2,536	1,871
Detroit (MI)	2,402	1,751
<b>National African American Total</b>	<b>137,688</b>	<b>100,564</b>

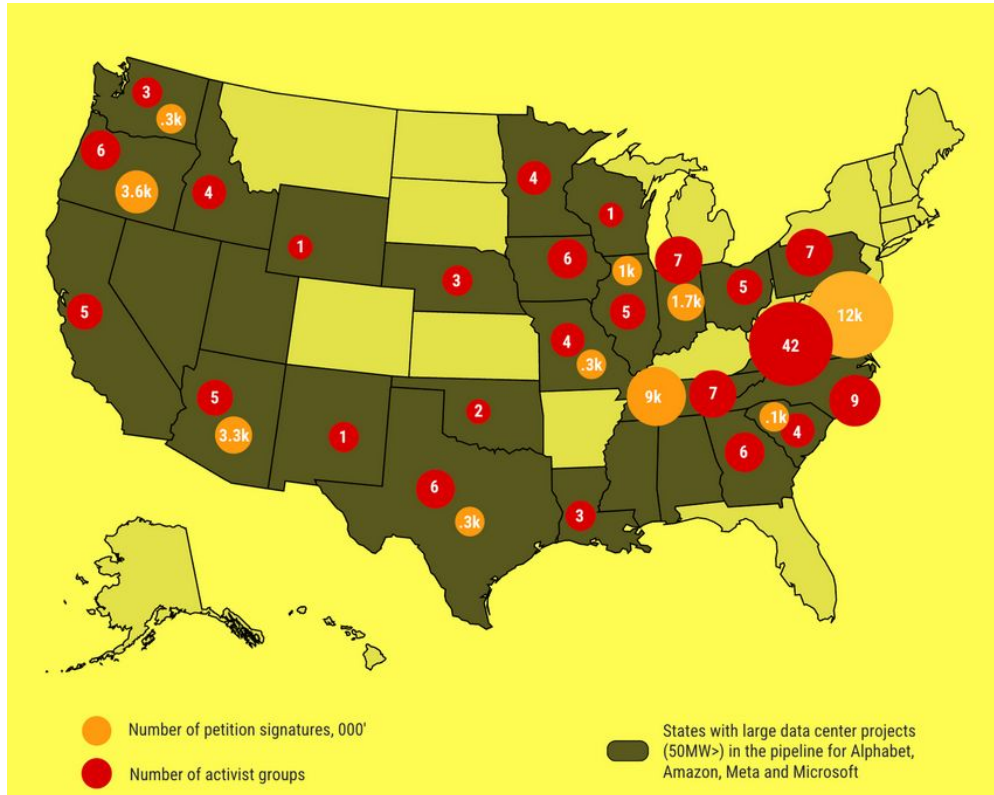
Source: "Gasping for Breath," US Census Bureau

**Black Americans are 75% more likely than others to live near facilities that produce hazardous waste.**

-Fumes Across the Fence-Line: The Health Impacts of Air Pollution from oil & Gas Facilities on African American Communities



# Community Response



- Communities in Indiana have pushed back on two different Data Center development project and have them either blocked or delayed.
  - Burns Harbor, Indiana (delay)
  - Chesterton, Indiana (blocked)

Politics

**Data center building boom stirs pushback in state and local politics**

By Natalie Brand

February 11, 2026 / 11:14 AM EST / CBS News

U.S. NEWS

SCIENCE FACT CHECK ODDITIES MORE

Market today Bruce Springsteen tour

**Big Tech's fast-expanding plans for data centers are running into stiff community opposition**

**Massive data center plans in Van Buren Township move forward, despite pushback**

By Scott Wolchek and David Komer | Published February 12, 2026 7:14pm EST | Wayne County | FOX 2 Detroit |

FIRST ON NBC NEWS

ARTIFICIAL INTELLIGENCE

**Gov. JB Pritzker to propose suspending tax incentives for data centers in Illinois**

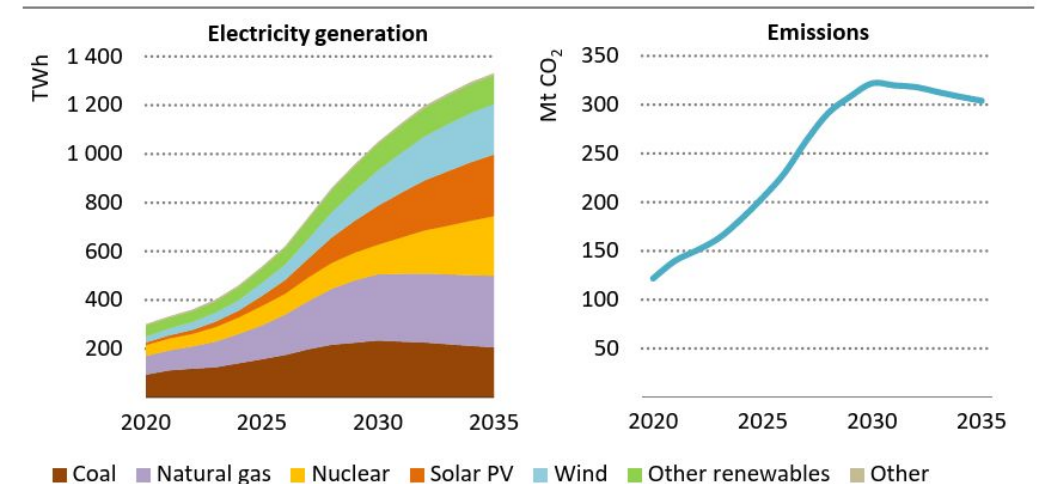
Pritzker, seen as a potential Democratic presidential candidate, is set to call for a two-year pause on the incentives in his State of the State address Wednesday.



# Energy costs

- Two-thirds of power consumed in the US rely on state or regional grids. Proximity to a data center doesn't matter as energy relies on the same grid.
- “(Wholesale) Electricity now costs as much as 267% more for a single month than it did five years ago in areas located near significant data center activity.” (Bloomberg News)
- [International Energy Agency Energy and AI report](#) (2025) estimated that 45% of all data center energy consumption worldwide was in the United States.
- [Scaling Intelligence: The Exponential Growth of AI's Power Needs](#)

**Figure 2.20** ▶ Global electricity generation for data centres and the associated CO<sub>2</sub> emissions in the Base Case, 2020-2035



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*Between now and 2030, renewables meet nearly half of the increase in global data centre electricity demand, followed closely by natural gas and coal-fired electricity generation*



# Library Resources

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## LibGuides

- [Generative AI for Research](#): This guide for researchers contains guidance over how and when to responsibly engage with AI during the research process.
- [Introduction to Generative AI](#): This guide is a general overview and introduction to generative AI technology for instructional, professional, and personal learning.

## Workshops

- [Detecting AI Generated Content](#): Savvy Researcher workshop on March 4<sup>th</sup> by Mary Ton and Sarah Christensen.
- [Considering AI for Qualitative Research](#): Savvy Researcher workshop on March 11<sup>th</sup> by Jess Hagman.



# Thank You

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## Any Questions?

Access slides at <https://go.illinois.edu/LibEnvironmentAI>

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