Hydropolitics of the cloud

Dr. Lauren E. Bridges
Assistant Professor of Media Studies
University of Virginia
December 10, 2024

Image source: Amanda Andrade-Rhoades / The Washington Post

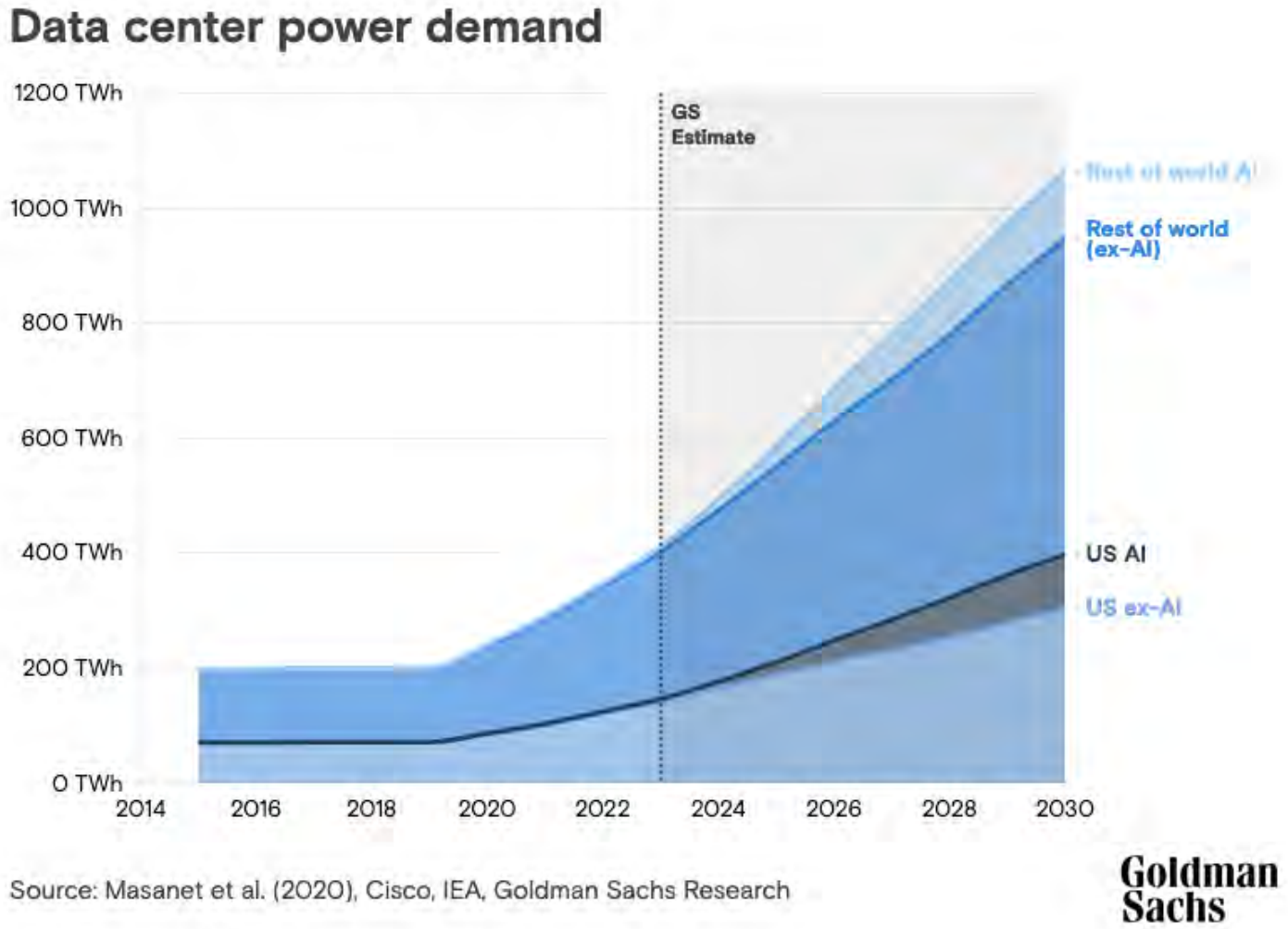
Overview

1. *Industry trends*
2. *Key terms*
3. *Latest academic research*
4. *Solutions / paths forward*

ARTIFICIAL INTELLIGENCE

AI is poised to drive 160% increase in data center power demand

"One ChatGPT query needs 10x as much electricity as a Google search" (Goldman Sachs)

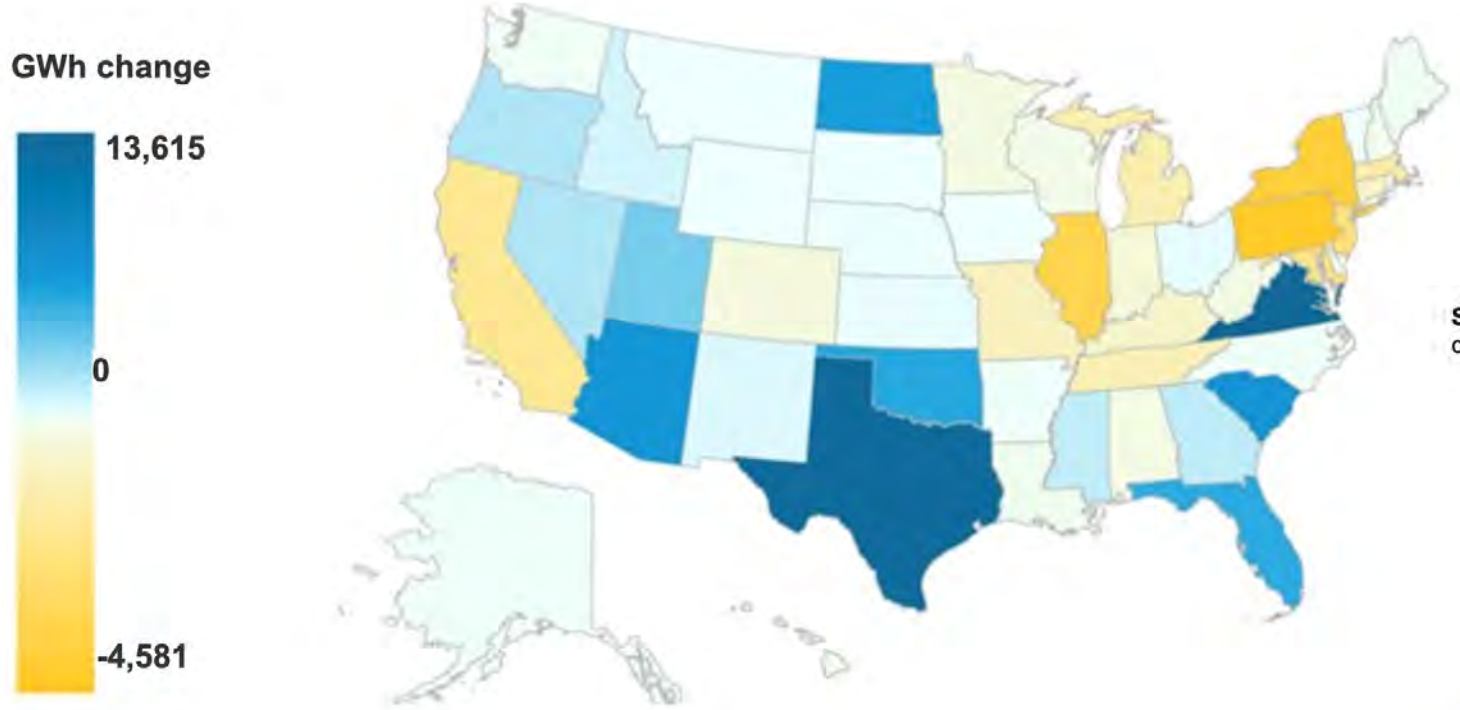


IN-BRIEF ANALYSIS

JUNE 28, 2024

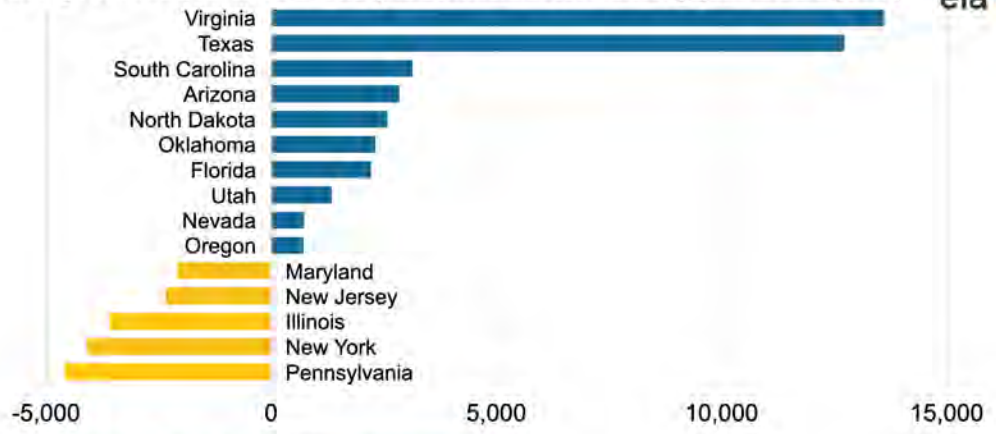
Commercial electricity demand grew fastest in states with rapid computing facility growth

U.S. states change in commercial sector electricity consumption (2019–2023)
change in annual sales of electricity to commercial customers, gigawatthours (GWh)



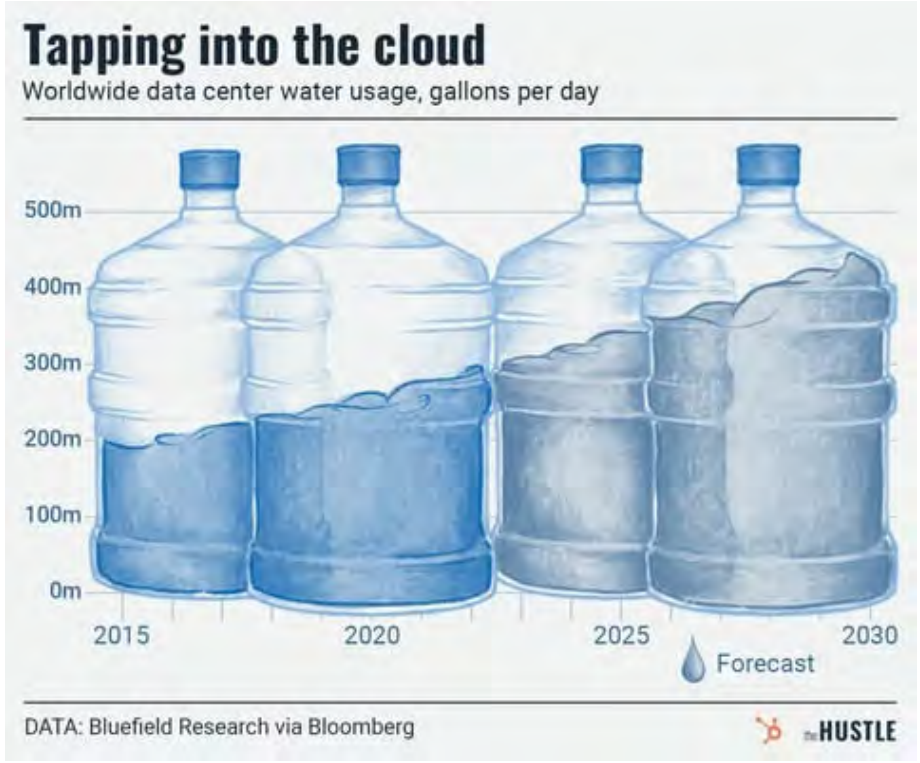
Data source: U.S. Energy Information Administration, *Electricity Data Browser*

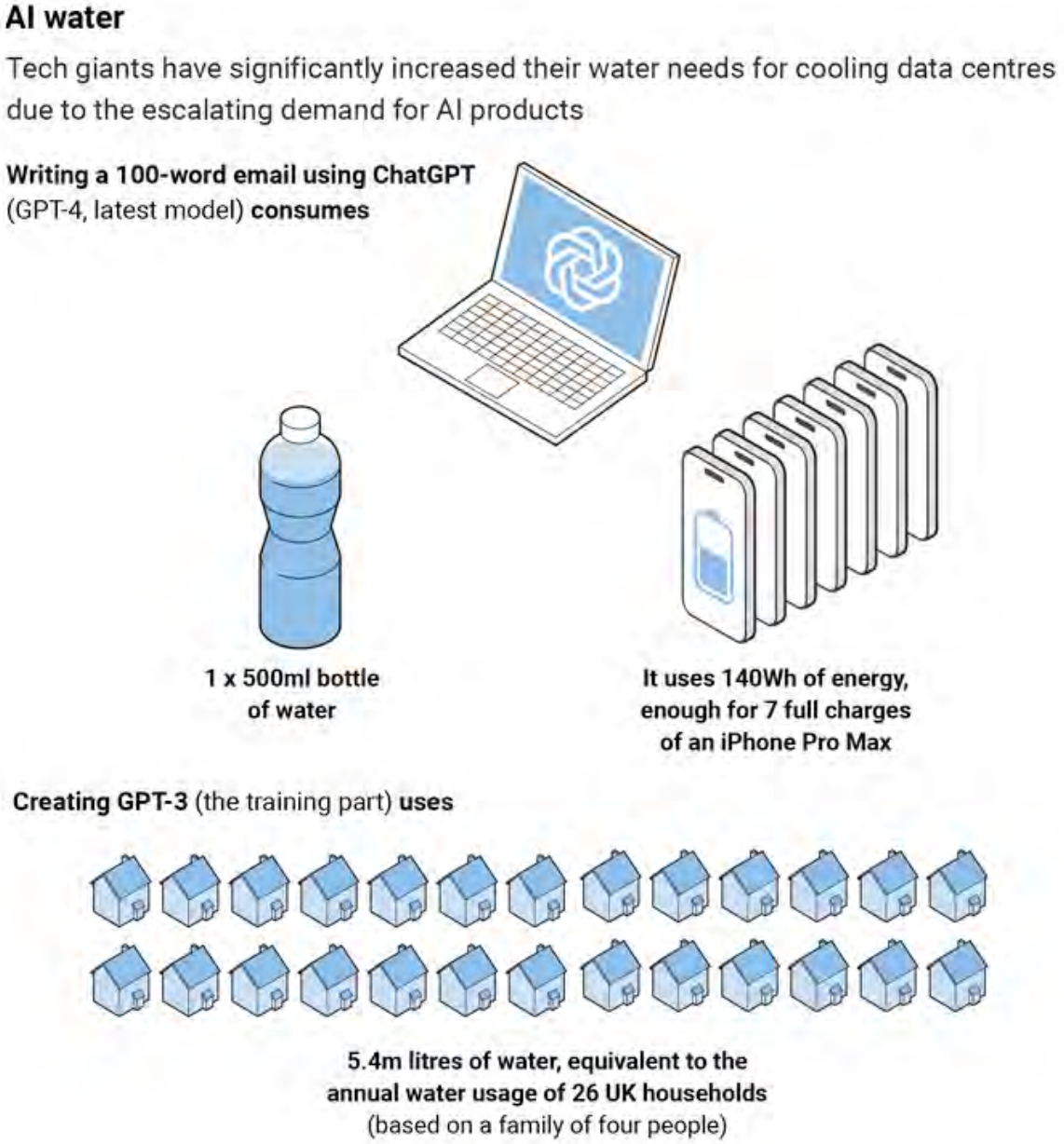
Select states by growth in commercial sector electricity consumption (2019–2023)
change in annual sales of electricity to commercial customers, gigawatthours (GWh)



Data source: U.S. Energy Information Administration, *Electricity Data Browser*

Power & water demand are entangled





Key terms

Direct Water Usage (onsite)

water used for air-conditioning / cooling servers, building (Scope 1)

a lot of variation on usage numbers – depends on climate, cooling technology, transparency in reporting

Indirect Water Usage (offsite)

~75% water consumption for data centers happens in energy production (Scope 2)

Water also used in the tech supply chain (manufacturing semiconductors, computer hardware etc.) (Scope 3)

Impacts to watershed

Considers threats to water quality and sustainability of water source

e.g impervious surfaces → increased run-off → decreased infiltration (ground water) → rising water salination

Water Usage Effectiveness (WUE)

an industry metric to measure water usage

doesn't measure total usage but usage in relation to power consumption

can obscure important info

Net Water Positive

putting back more water into the environment than they consume

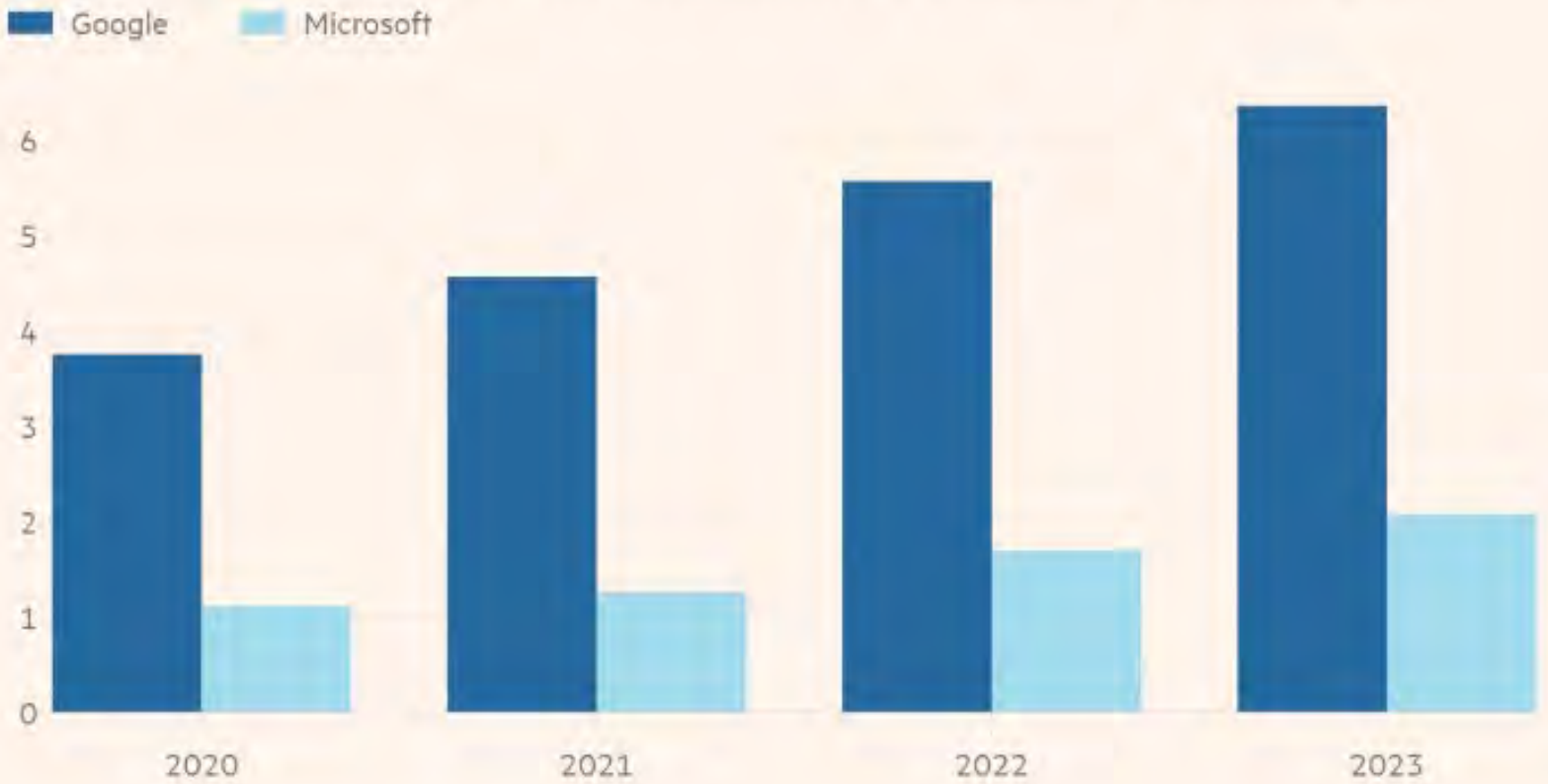
BUT often doesn't go back to the same source

Sources:

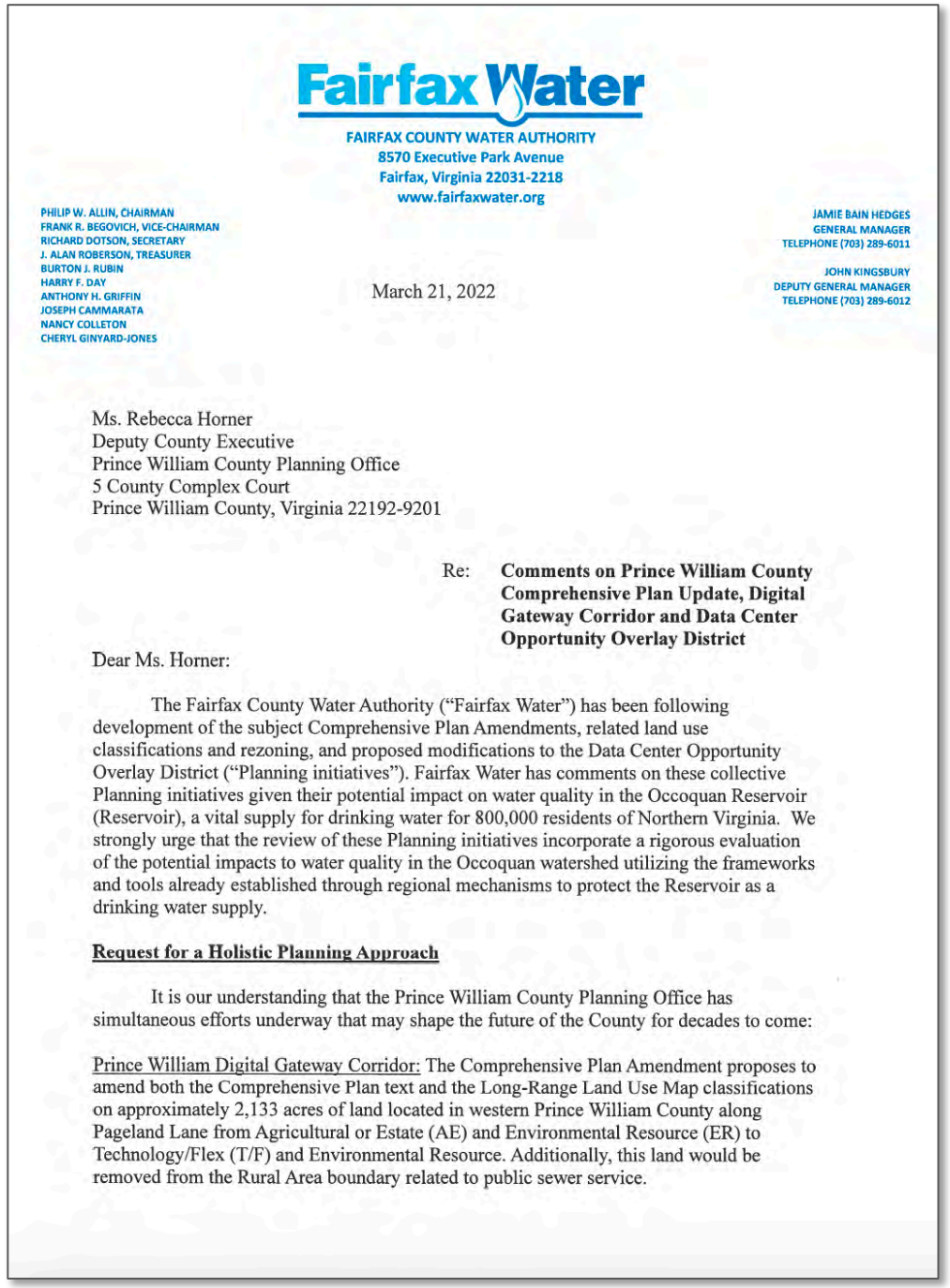
- Li, P., Yang, J., Islam, M. A., & Ren, S. (2023). *Making AI Less "Thirsty": Uncovering and Addressing the Secret Water Footprint of AI Models* (arXiv:2304.03271)
- Siddik, M. A. B., Shehabi, A., & Marston, L. (2021). The environmental footprint of data centers in the United States. *Environmental Research Letters*, *16*(6), 064017. https://doi.org/10.1088/1748-9326/abfba1

Google's and Microsoft's water consumption is rising

Billion gallons per year. Amazon Web Services does not report its annual water consumption



Google 2020-2023, Microsoft FY2020-2023
Source: Company reports



Fairfax Water

FAIRFAX COUNTY WATER AUTHORITY
8570 Executive Park Avenue
Fairfax, Virginia 22031-2218
www.fairfaxwater.org

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JAMIE BAIN HEDGES
GENERAL MANAGER
TELEPHONE (703) 289-6011

JOHN KINGSBURY
DEPUTY GENERAL MANAGER
TELEPHONE (703) 289-6012

March 21, 2022

Ms. Rebecca Horner
Deputy County Executive
Prince William County Planning Office
5 County Complex Court
Prince William County, Virginia 22192-9201

Re: **Comments on Prince William County Comprehensive Plan Update, Digital Gateway Corridor and Data Center Opportunity Overlay District**

Dear Ms. Horner:

The Fairfax County Water Authority ("Fairfax Water") has been following development of the subject Comprehensive Plan Amendments, related land use classifications and rezoning, and proposed modifications to the Data Center Opportunity Overlay District ("Planning initiatives"). Fairfax Water has comments on these collective Planning initiatives given their potential impact on water quality in the Occoquan Reservoir (Reservoir), a vital supply for drinking water for 800,000 residents of Northern Virginia. We strongly urge that the review of these Planning initiatives incorporate a rigorous evaluation of the potential impacts to water quality in the Occoquan watershed utilizing the frameworks and tools already established through regional mechanisms to protect the Reservoir as a drinking water supply.

Request for a Holistic Planning Approach

It is our understanding that the Prince William County Planning Office has simultaneous efforts underway that may shape the future of the County for decades to come:

Prince William Digital Gateway Corridor: The Comprehensive Plan Amendment proposes to amend both the Comprehensive Plan text and the Long-Range Land Use Map classifications on approximately 2,133 acres of land located in western Prince William County along Pageland Lane from Agricultural or Estate (AE) and Environmental Resource (ER) to Technology/Flex (T/F) and Environmental Resource. Additionally, this land would be removed from the Rural Area boundary related to public sewer service.

"The Occoquan Reservoir also faces challenges from threats such as increasing trends in concentrations of sodium and other salt-related constituents, which are related to the impervious area, and cooling blowdown from industrial uses such as water-cooled data centers ."

*". . . we encourage Prince William County to embrace a **holistic** and **comprehensive approach** to land use analysis."*

Industry solutions

Microsoft's Project Natick (Image Source: Green Marine)

Liquid Immersion Cooling (Image Source:)

- Alternative water sources
  - Sea water
  - Underwater data centers
- Immersion cooling
- Closed-loop cooling systems
- Direct-to-chip cooling plates
- Ambient cooling in cool climates
  - Underground data centers
- Recycling excess heat
  - District heating
  - Swimming pools
  - Greenhouses
  - Turbines
- AI tools to find water efficiency

Delayed retirement of coal

Duke Energy plans to delay Gibson coal plant retirement. Activists say it's a 'step backward'

Lakeshore Public Media | By Rebecca Thiele
Published October 7, 2024 at 2:00 PM CDT

Coal

PJM Urges Delayed Retirement of 840-MW Fossil Fuel Power Plant, Citing Reliability Impacts

ENVIRONMENT

Two major Utah coal plants will live years longer

With a longer coal run, Rocky Mountain Power is also expecting to cut back on renewables

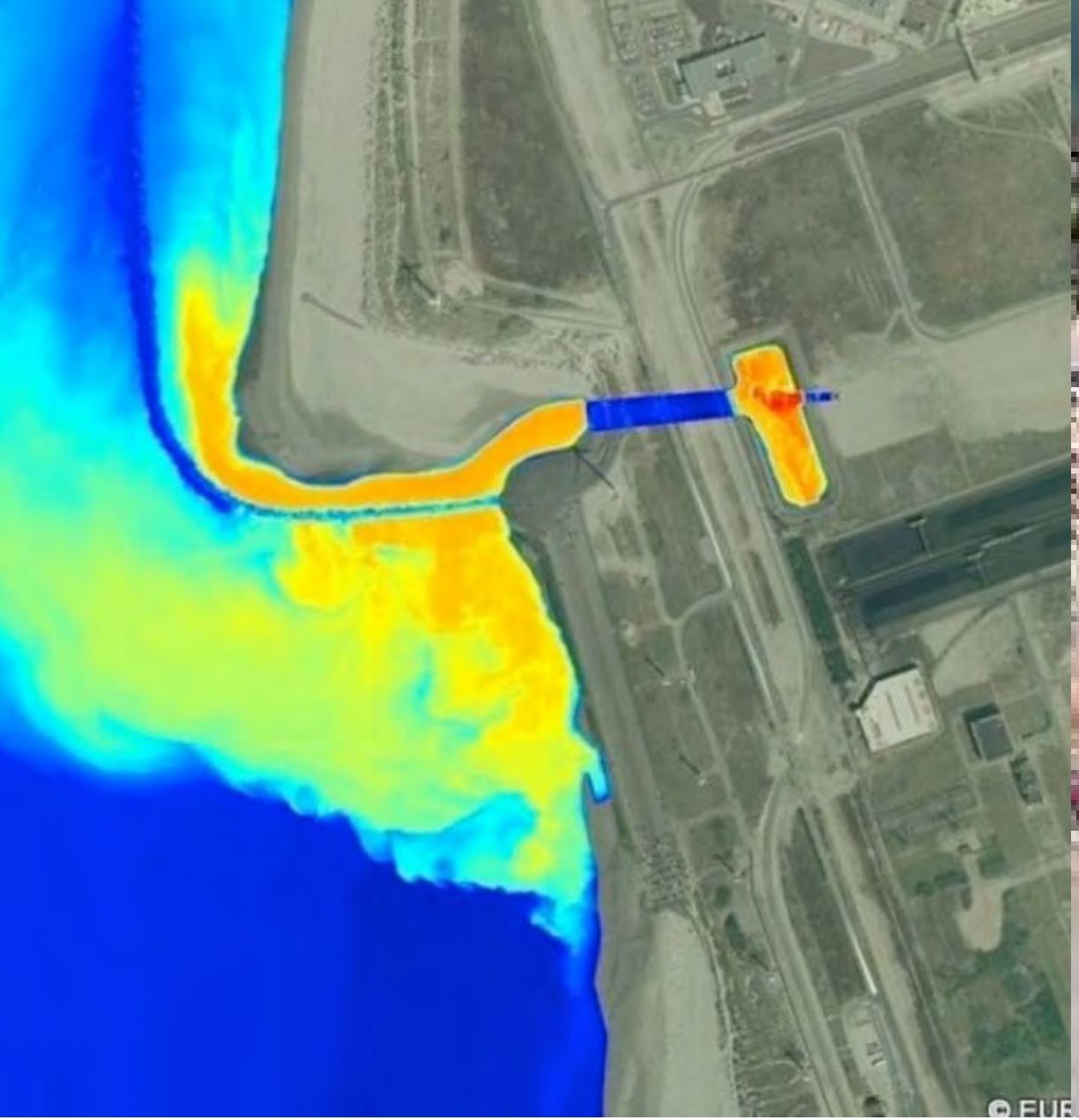
Grid capacity concerns & potential water impacts

NEWS | 30 September 2024

Nuclear power for AI: what it will take to reopen Three Mile Island safely

As Microsoft strikes a deal to restart a reactor at the notorious power station, *Nature* talks to nuclear specialists about the unprecedented process.

By Michael Greshko



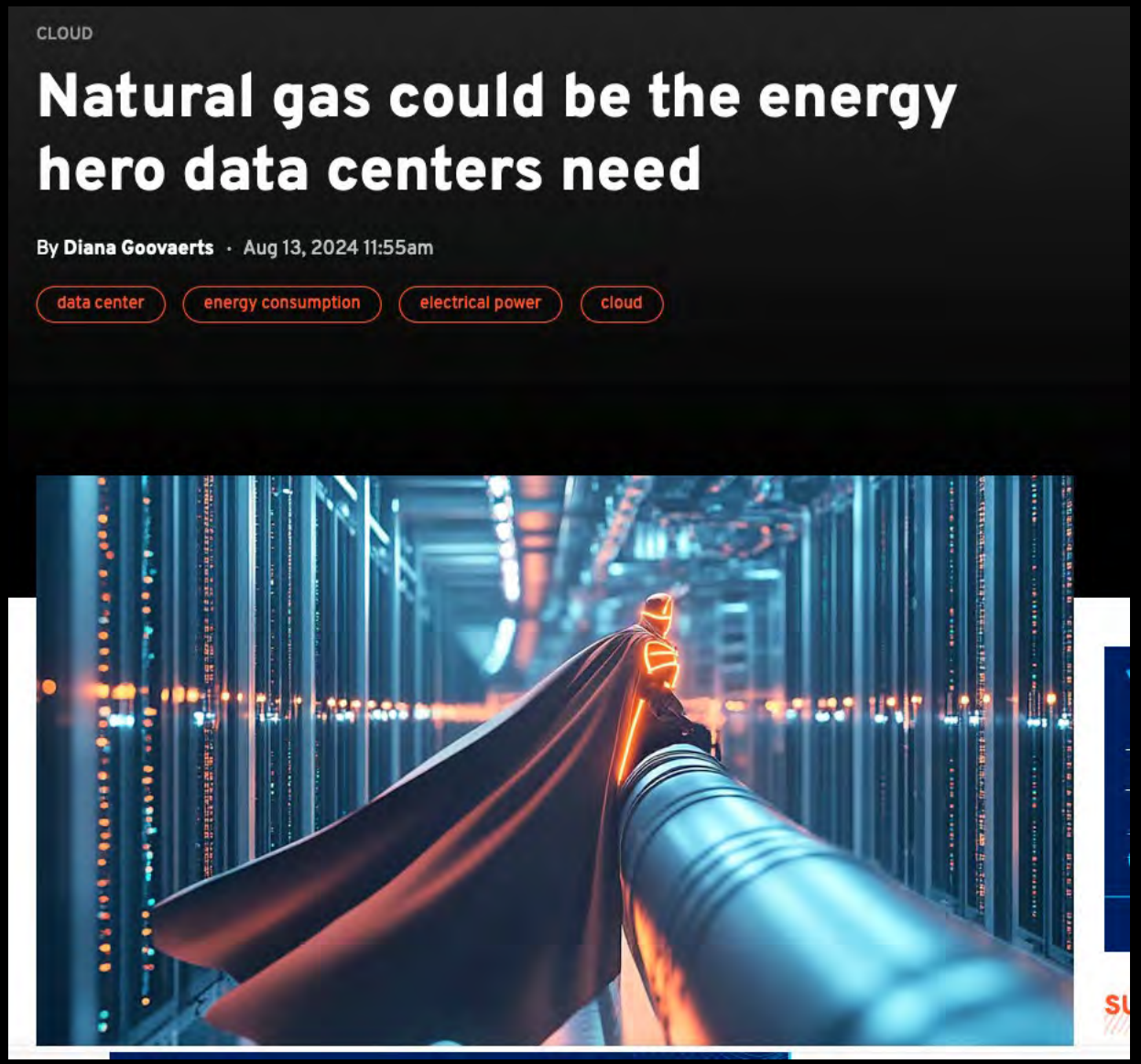
Thermal water pollution

Source: Pontchartrain Conservancy

Return flow of heated water to San Francisco Bay from the Potrero Generating Station.
(Source: Wikimedia Commons)

“In terms of the hyperscalers and their approach right now, we are seeing them look all the way back into areas where the gas resource is abundant, and the permitting allows for getting on with developing the infrastructure that they need to have reliable and affordable power into those markets.”

– Alan Armstrong, CEO of natural gas supplier Williams Companies



Policy landscape

VIRGINIA

STATE GOVERNMENT

***VIRGINIA CODE* §58.1-609.3 (18) SALES AND USE TAX EXEMPTION (EXTENDED)**

VIRGINIA CLEAN ECONOMY ACT (VCEA) (SIGNED INTO LAW: 2020)

HB 1834 ELECTRIC GENERATING FACILITY CLOSURES; PUBLIC DISCLOSURE (SIGNED INTO LAW 2021)

HB116: ENERGY EFFICIENCY FOR DATA CENTER TAX BREAK (FAILED 2024)

YOUNGKIN'S PROPOSAL TO WITHDRAW VA FROM THE REGIONAL GREENHOUSE GAS INITIATIVE (RGGI) – OVERTURNED BUT HE PLANS ON APPEALING

HB636 – SCC TO OVERTURN SOLAR DENIALS (DEL RIP SULLIVAN)

SCC TECHNICAL CONFERENCE TO EVALUATE IMPACTS OF DATA CENTERS

JLARC – VIRGINIA JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION

LOCAL GOVERNMENT

FAIRFAX:

ZONING ORDINANCE AMENDMENT (ADOPTED)

WATER AND POWER TRANSPARENCY (PROPOSAL TO VA GEN ASSEMBLY JAN 2025)

LOUDOUN COUNTY CPAM AND ZOAM 2024 – PENDING IN 2025

PRINCE WILLIAM COUNTY – ORDINANCES

DATA CENTER OVERLAY DISTRICT

ARCHITECTURE RULES

NOISE ORDINANCES

FAUQUIER COUNTY VA – (PCID AND BP DISTRICTS) BURIED TRANSMISSION LINES AND LIMITS POTABLE WATI USE (STATE/LOCAL POWER DISPUTES)

PRINCE GEORGE COUNTY, VA

TOWN OF LEESBURG, VA

ARIZONA

CHANDLER AZ 2023 – NEW ORDINANCE NO DC IN CITY

GEORGIA

HB 1192 – 2 YR MORATORIUM ON TAX EXEMPTION FOR BUILDING AND EQUIPMENT (GOV. KEMP – R - VETOED MAY 7, 2024)

PROPOSAL TO BAN DATA CENTERS NEAR TRANSIT STATIONS AND BELTLINE WALKING TRAIL

ARKANSAS

TWO BILLS SIGNED INTO LAW 2024 AROUND CRYPTOCURRENCY MINING (NOISE LIMITS AND IMPACTS COMMUNITY)

CONNECTICUT

HB 6514. THE DATA CENTER TAX INCENTIVE PROGRAM 2021
GENERAL ASSEMBLY RAISED BILL NO. 299 (LCO NO. 753) TO STUDY IMPACT OF DCS ON ELECTRIC DISTRIBUTION AND GRID RELIABILITY (FEB SESSION 2024)

SOUTH CAROLINA

H5118 UTILITY REFORM BILL (2023-2024)
ACT NO. 222. 2023-2024 BILL 4087 INCOME TAX CREDITS (CHANGE IN CRITERIA)

OHIO

DOCKET 24-05058 – PUBLIC UTILITIES COMMISSION OF OHIO NEW TARIFFS FOR LOAD GROWTH

Lessons to be learned from Virginia

Key findings around Energy and Water:

(1) Power demands will be very hard to meet while upholding VCEA
(2) Need to expand renewables
(3) Explore separate rate classes (Ohio)
(4) Air quality concerns with diesel generators
(5) Need proper oversight from DEQ for water withdrawals
(6) Local governments should consider requiring water use estimates in permitting process
(7) Noise pollution
(8) Land Use and Aesthetic Concerns

What's missing?

Environmental impacts:

(1) Cumulative Environmental Impacts
(2) Climate Resilience (resource availability)
(3) Lifecycle Carbon Emissions (e.g. embodied carbon in building materials)
(4) E-waste
(5) Soil and Land Degradation (loss of ag land / forests)

What's missing?

Social impacts:

(1) Community inequities (eg. Increased rate hikes)
(2) Cultural and Historical Preservation (inc. Native American Sites)
(3) Housing Burden
(4) Public Health Impacts (stress and mental health concerns from noise)
(5) Workforce and Labor Dynamics (long-term positions for residents & workforce development).

Recommendations for Policymakers

1. **Mandate Transparency BEFORE approving rezoning permits:** Require data centers to disclose environmental and social impact data (Scope 1, 2 & 3) as part of their permitting process; and mandate audits
    - Includes water consumption, energy consumption, impacts to water and energy resilience, noise studies, air quality studies / estimates, transmission line studies, est. cumulative impacts
2. **Strengthen Oversight:** Require on-going evaluation of impacts to water supply, energy grids, air quality, waste management for **cumulative development** (not just site by site basis)
3. **Ensure Equity:** require data center operators to contribute for transmission upgrades**,**mandate higher rates for data centers and crypto miners to offset increased rates for non-data centers
4. **Restrict Development in Vulnerable Communities**: ban development in water-stressed regions, in areas with grid reliability/capacity concerns; mandate job training, employment requirements
5. **Regional Collaboration:** Establish a regional Data Center Development Council to coordinate policies, share resources, and address cross-border impacts.
6. **Incentivize Sustainability:** Provide tax credits or grants for projects demonstrating high environmental standards (e.g. waterless or low-water cooling; recycled over potable water) and community benefits (e.g. CBAs)

Thank you.

lbridges@virginia.edu