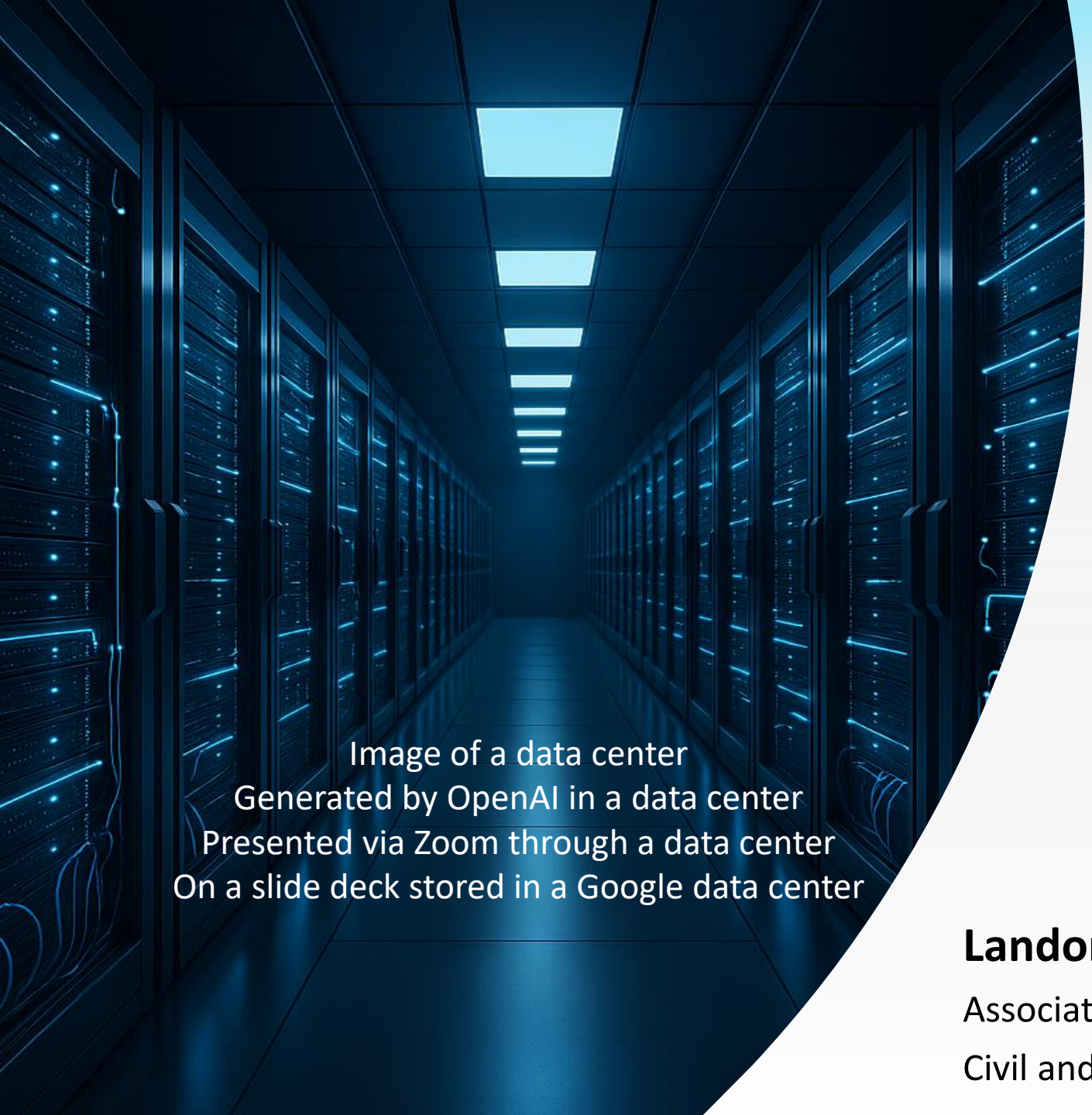


Image of a data center
Generated by OpenAI in a data center
Presented via Zoom through a data center
On a slide deck stored in a Google data center

Data Centers and Water Usage

A National Overview

Environmental Law Institute Webinar
July 30, 2025

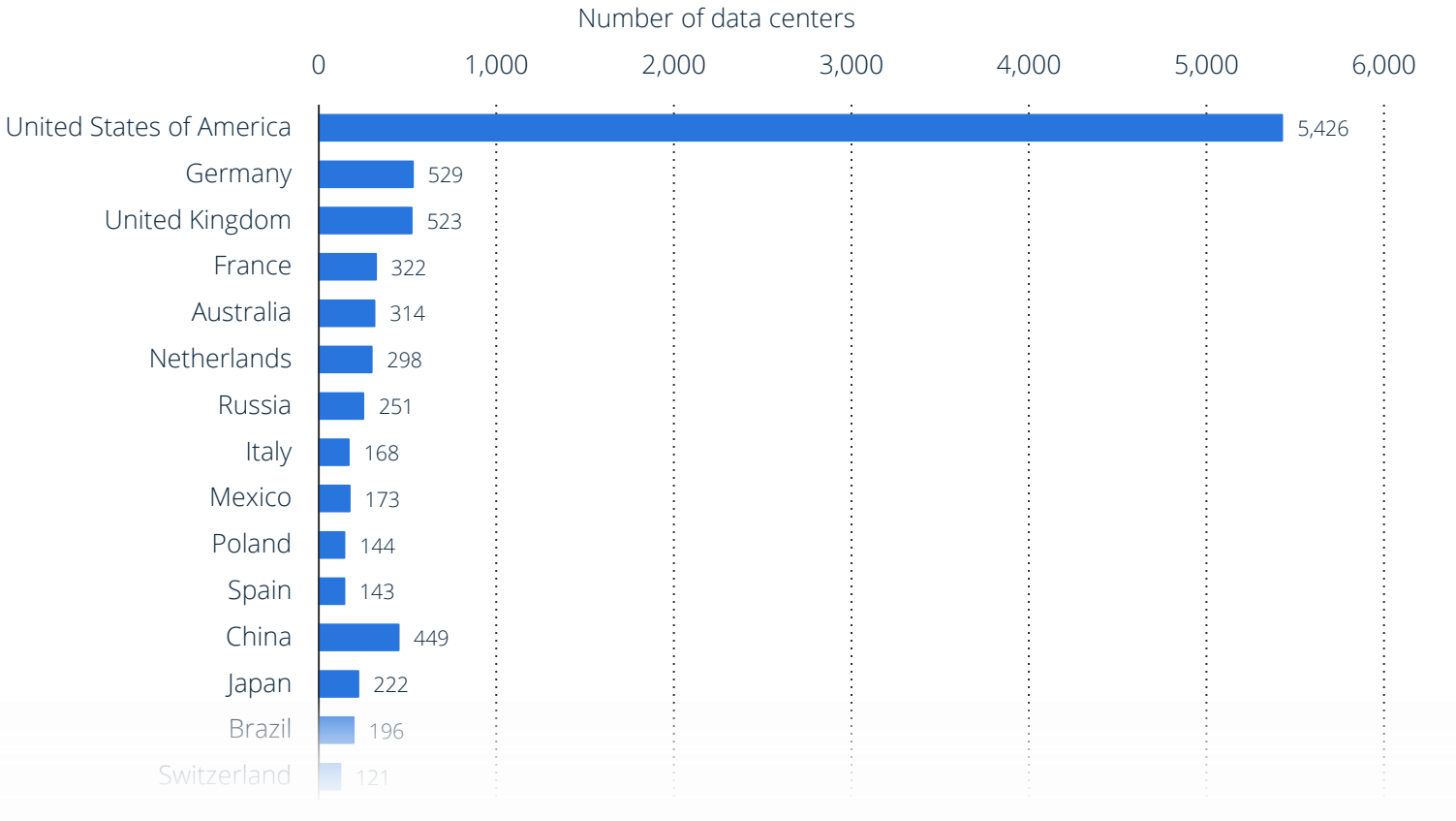
Landon Marston, Ph.D., P.E.

Associate Professor

Civil and Environmental Engineering

VIRGINIA TECH

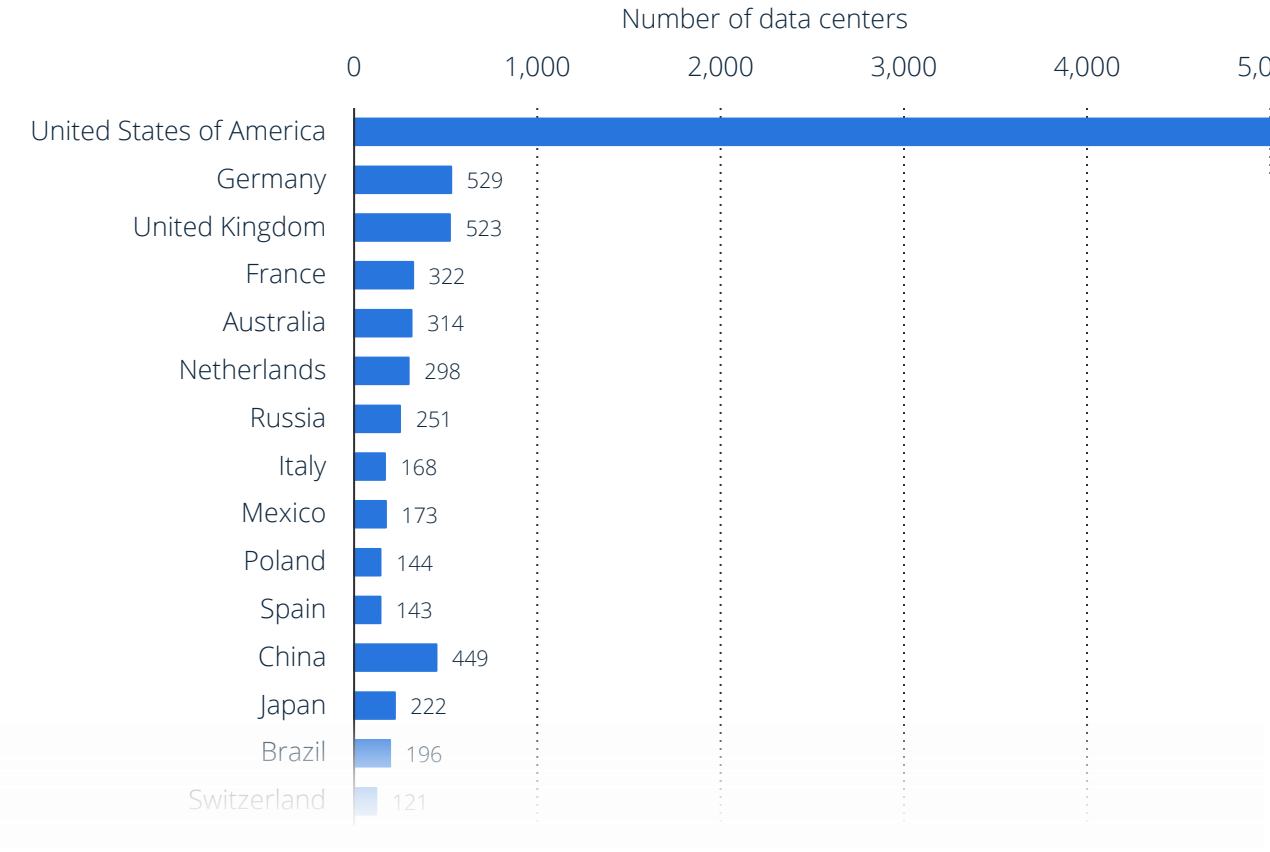
The US dominates the global data center market.



Note(s): Worldwide; 2025
Further information regarding this statistic can be found on page 8.
Source(s): Cloudscene; ID 1228433 statista

Cropped Version
Double click to open excel file with complete data

The US dominates the global data center market.



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Further information regarding this statistic can be found on page 8.
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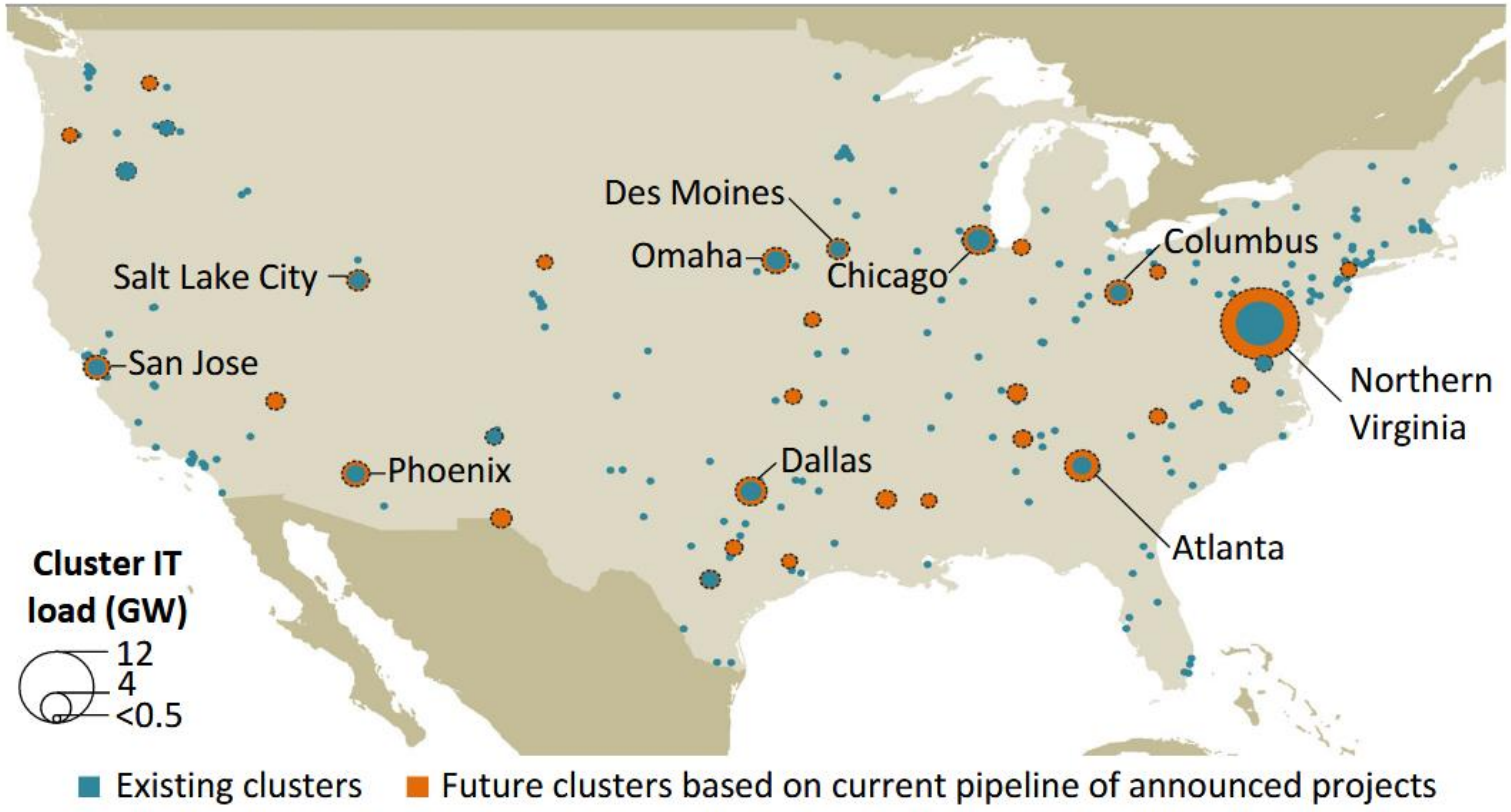
Global map of large data center clusters, 2024

(IEA, 2025)

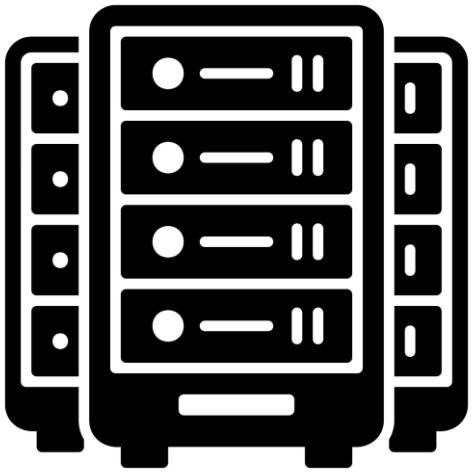
Data centres are often located in large clusters, potentially creating challenges for local electricity systems

Virginia is the global hub of current and planned data center development.

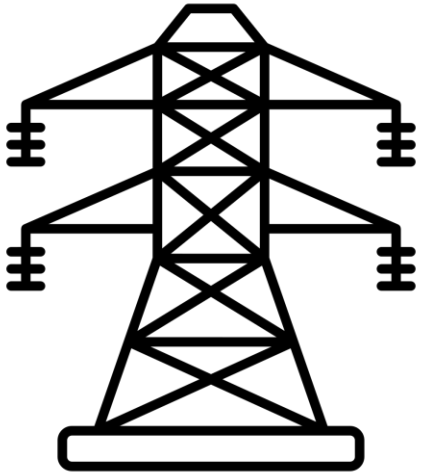


Expansion into new locations but most new development to existing large markets.

How do data centers use water?



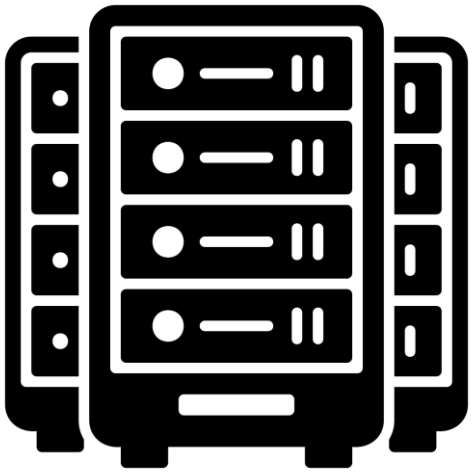
Scope 1 /
Direct Water Footprint
[On-site water consumption]



Scope 2 /
Indirect Water Footprint
[Water consumption from energy]

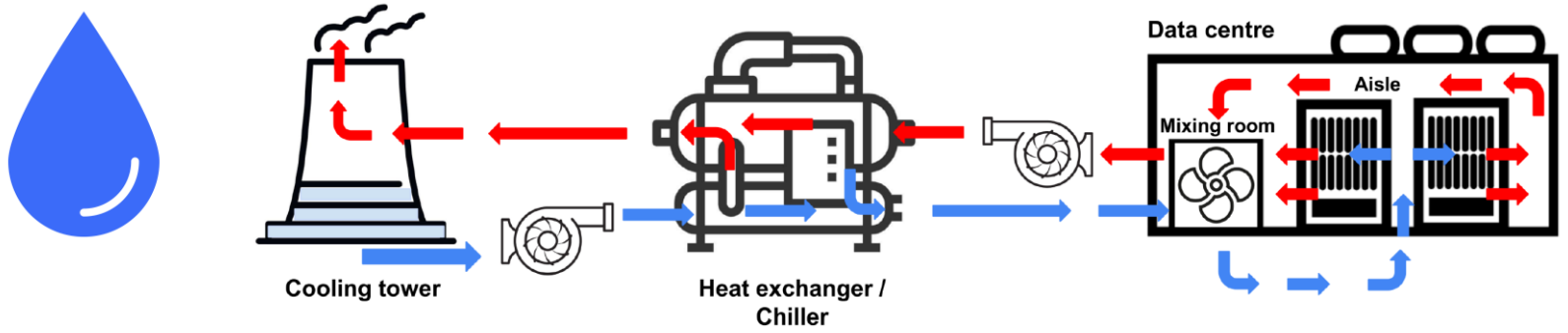
Scope 3 /
Indirect Water Footprint
[Water consumption of supply chain]

How do data centers use water?

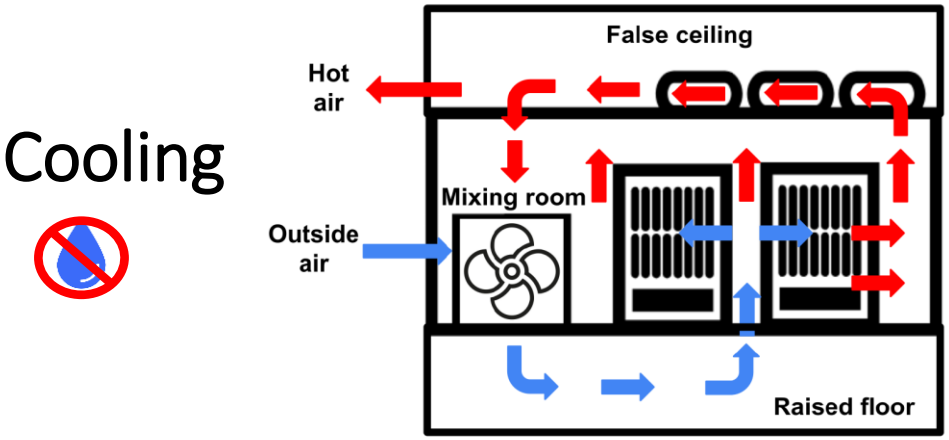


Scope 1 /
Direct Water Footprint
[On-site water consumption]

Evaporative Cooling

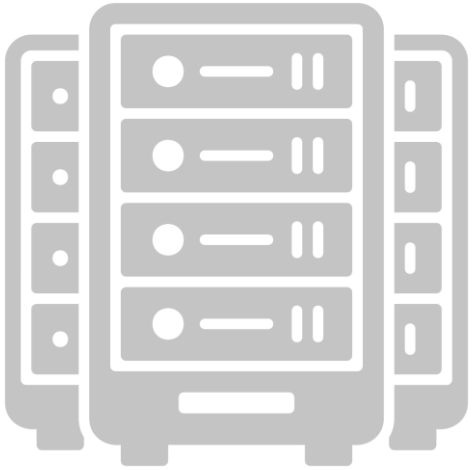


Air Cooling

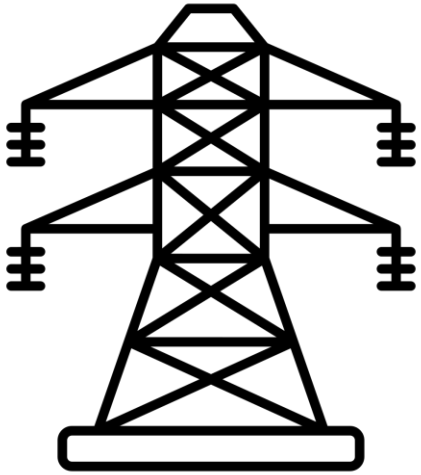


(Herrera et al., 2025)

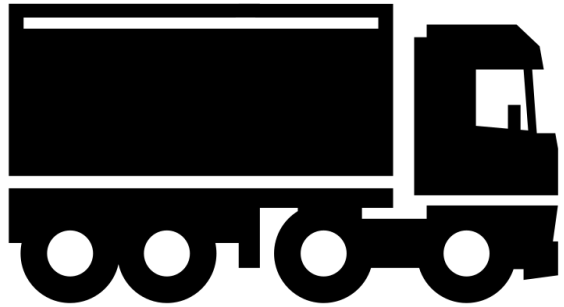
Nationwide, ~75% of the water footprint of data centers is offsite.



Scope 1 /
Direct Water Footprint
[On-site water consumption]



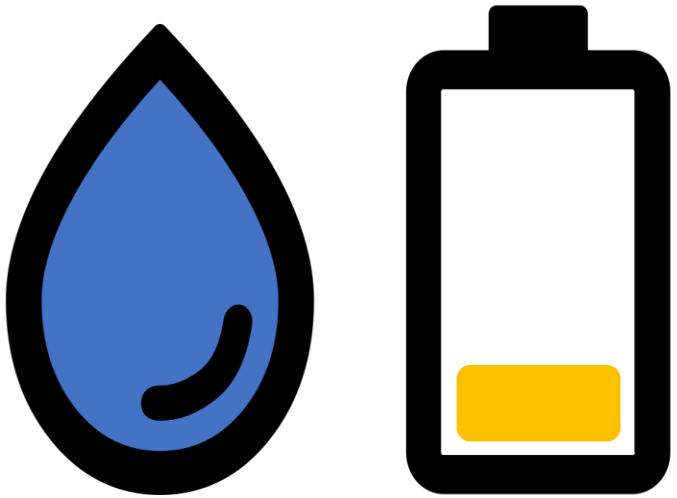
Scope 2 /
Indirect Water Footprint
[Water consumption from energy]



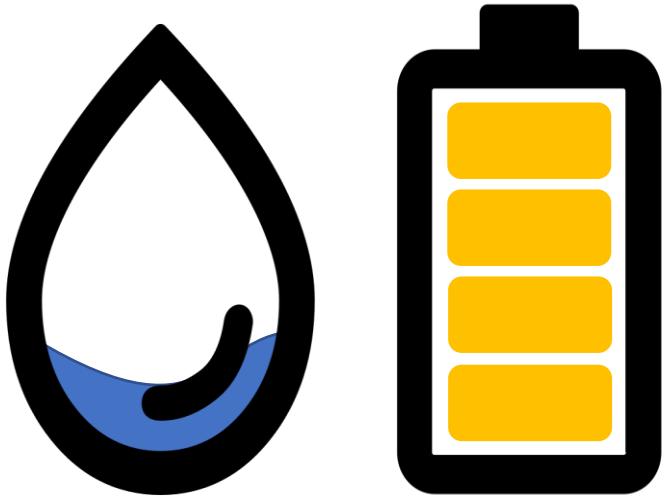
Scope 3 /
Indirect Water Footprint
[Water consumption of supply chain]

Tradeoffs exists between water and energy.

Evaporative Cooling
High WUE, Low PUE



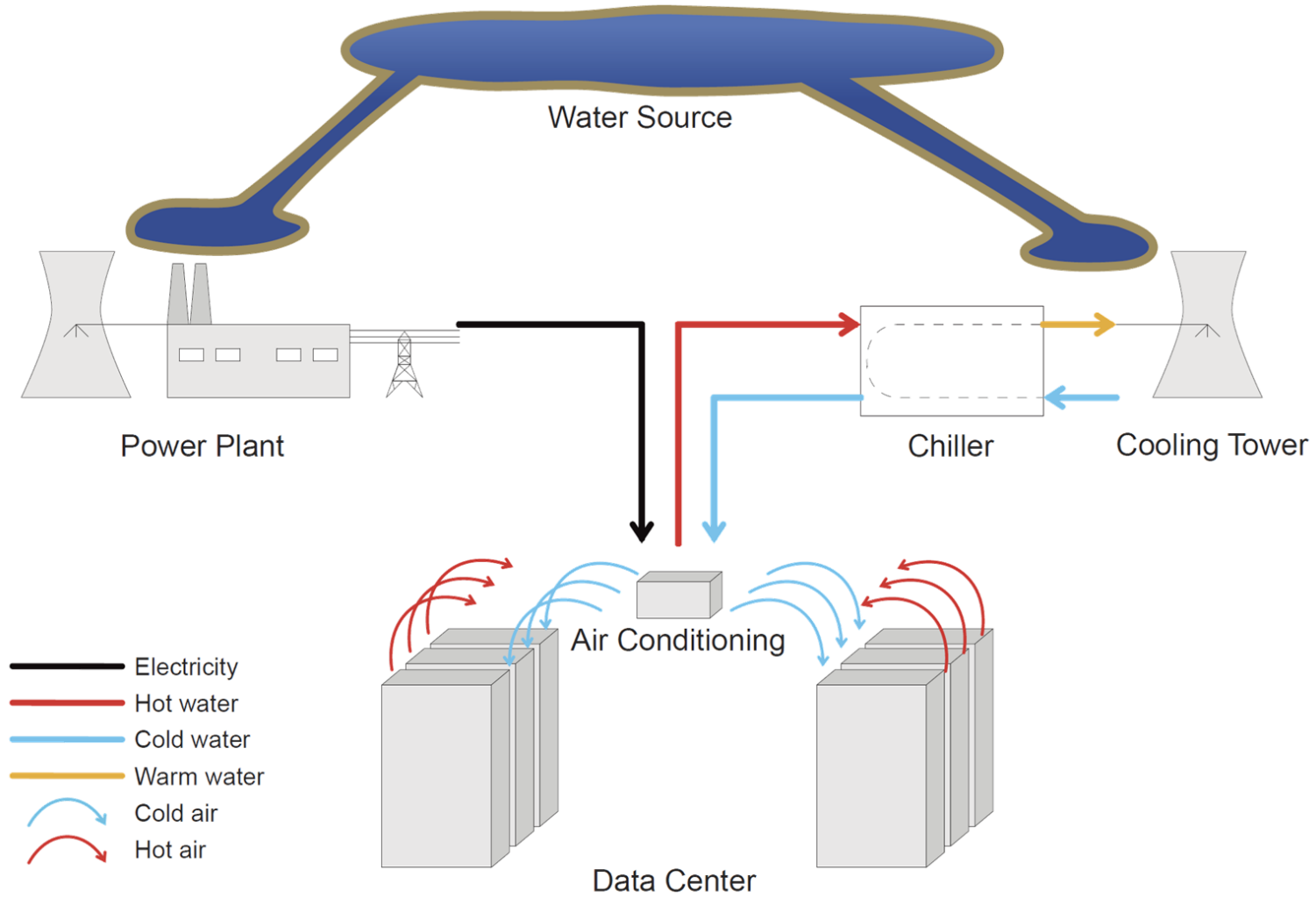
Air Cooling
Low WUE, High PUE



$$Power\ Usage\ Effectiveness\ (PUE) = \frac{Total\ power\ supplied\ to\ the\ data\ center}{Power\ consumed\ by\ the\ IT\ equipment}$$

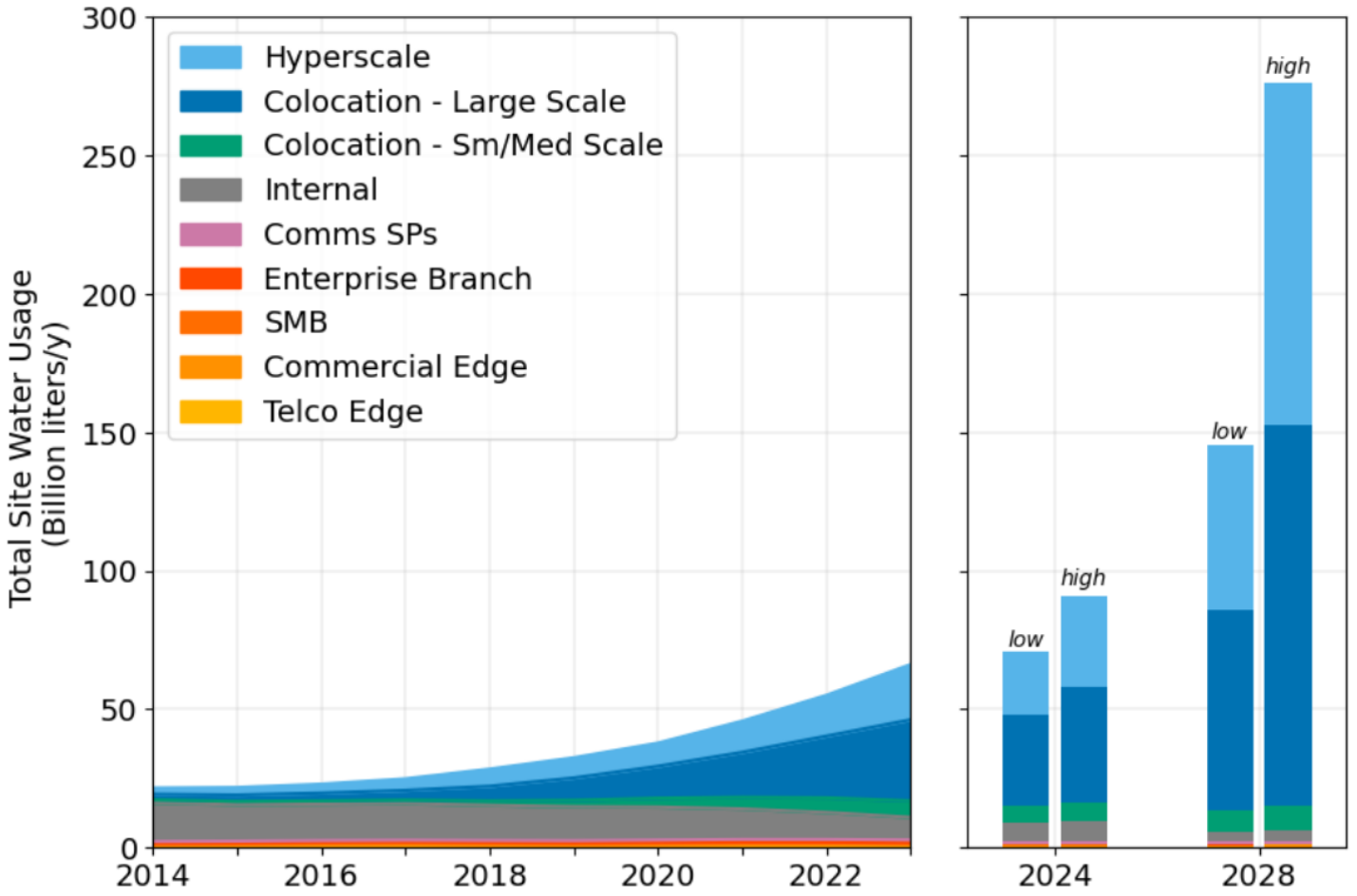
$$Water\ Usage\ Effectiveness\ (WUE_{SITE}) = \frac{Data\ center\ water\ consumption}{IT\ equipment\ energy\ consumption}$$

However, assessing tradeoffs in water use is not straightforward.



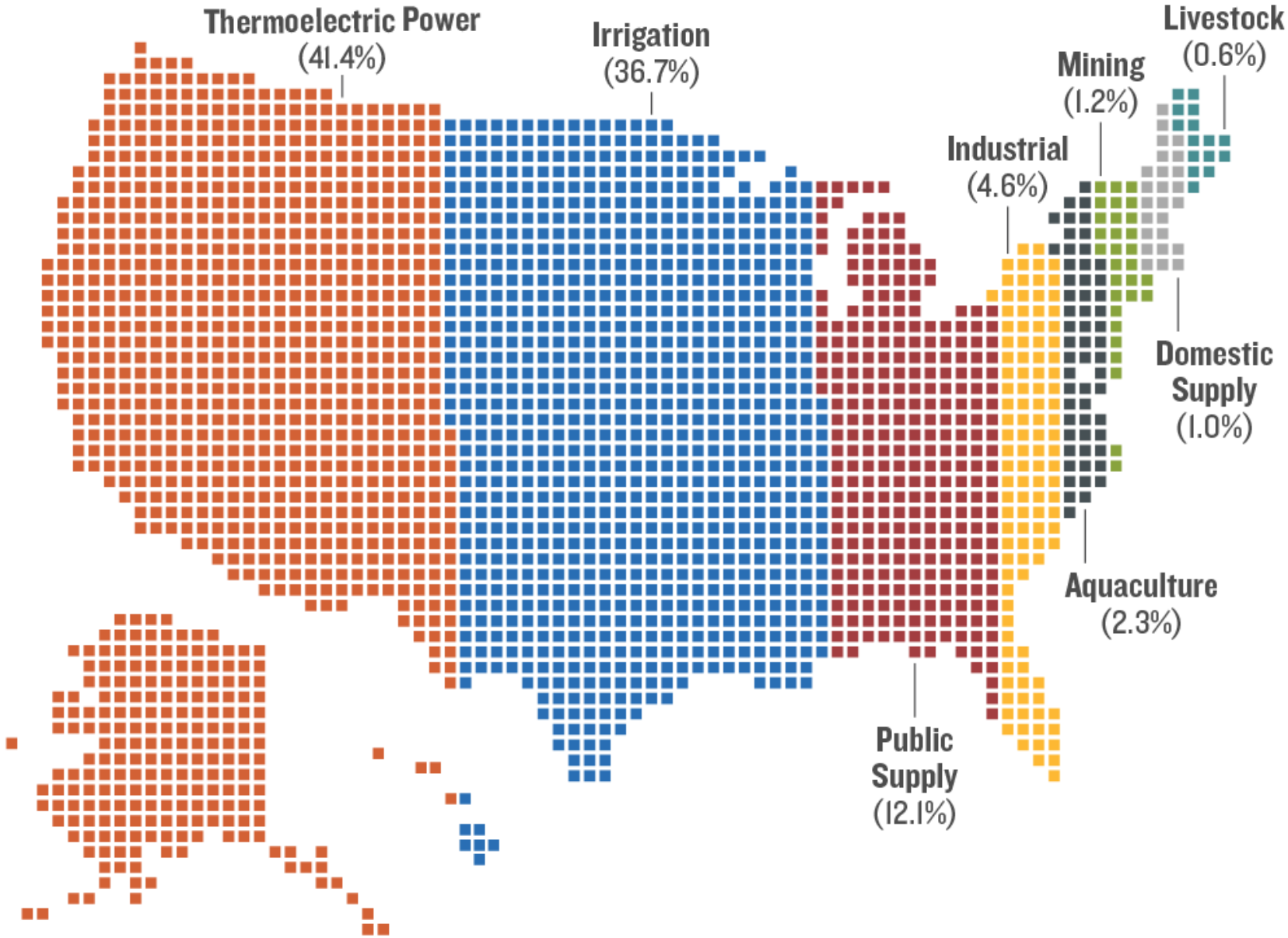
(Zuccon et al., 2023)

On-site water consumption is expected in increase significantly.



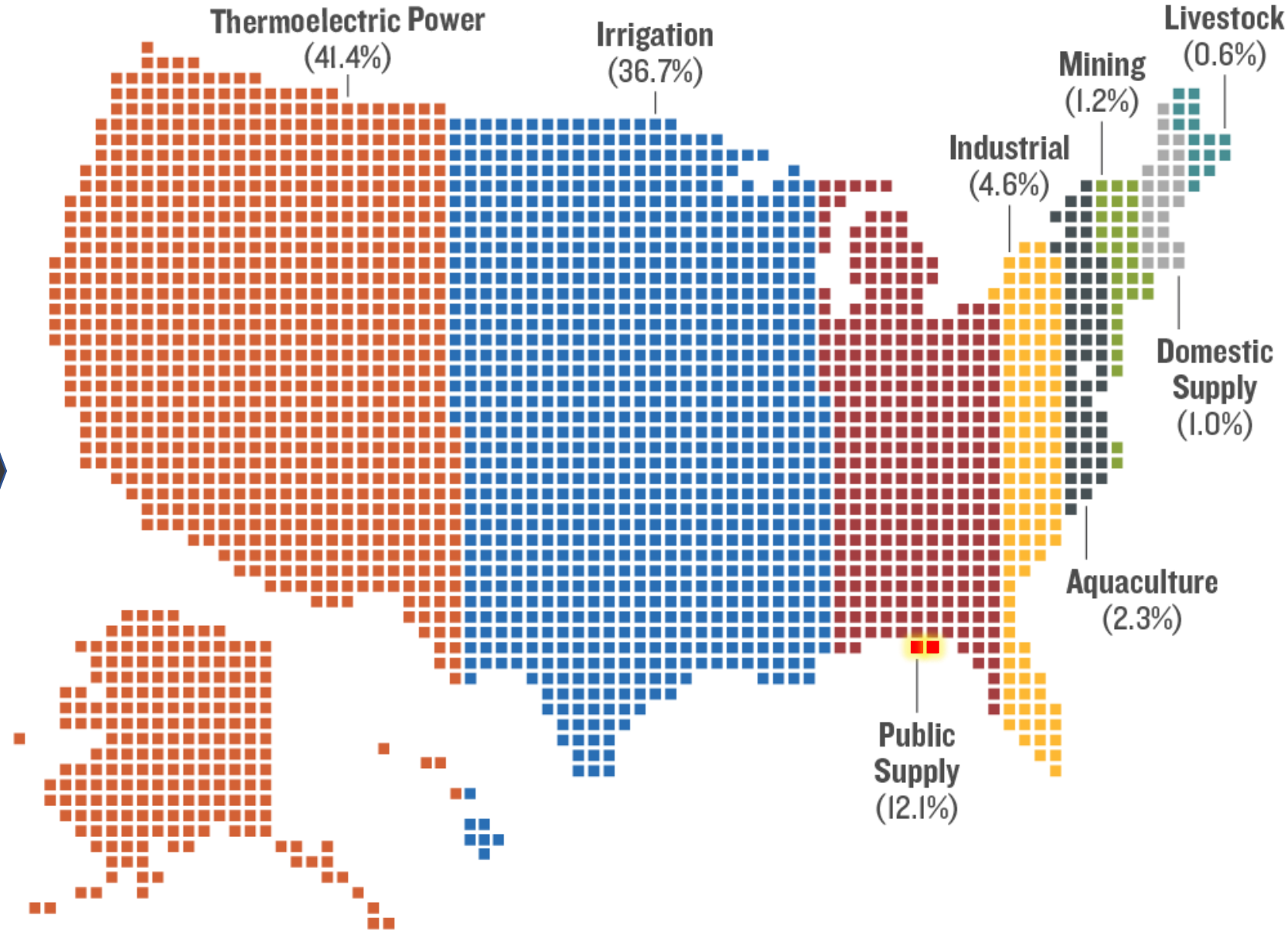
(Shehabi et al., 2024)

How does America use its water?



Source: Dieter et al. (2018) Estimated Use of Water in the United States in 2015. USGS Circular 1441.

Data center water withdrawals represent <0.2% of total



Source: Dieter et al. (2018) Estimated Use of Water in the United States in 2015. USGS Circular 1441.

Key takeaways

- Majority of data center water usage happens off-site (electricity generation).
- Expansion of hyperscale data centers with water-intensive cooling is expected to increase on-site water usage.
- Still, a data centers' direct water usage makes up small percentage of national water withdrawals.
- However, data centers can strain local water sources and infrastructure.

Data centers come in different sizes.

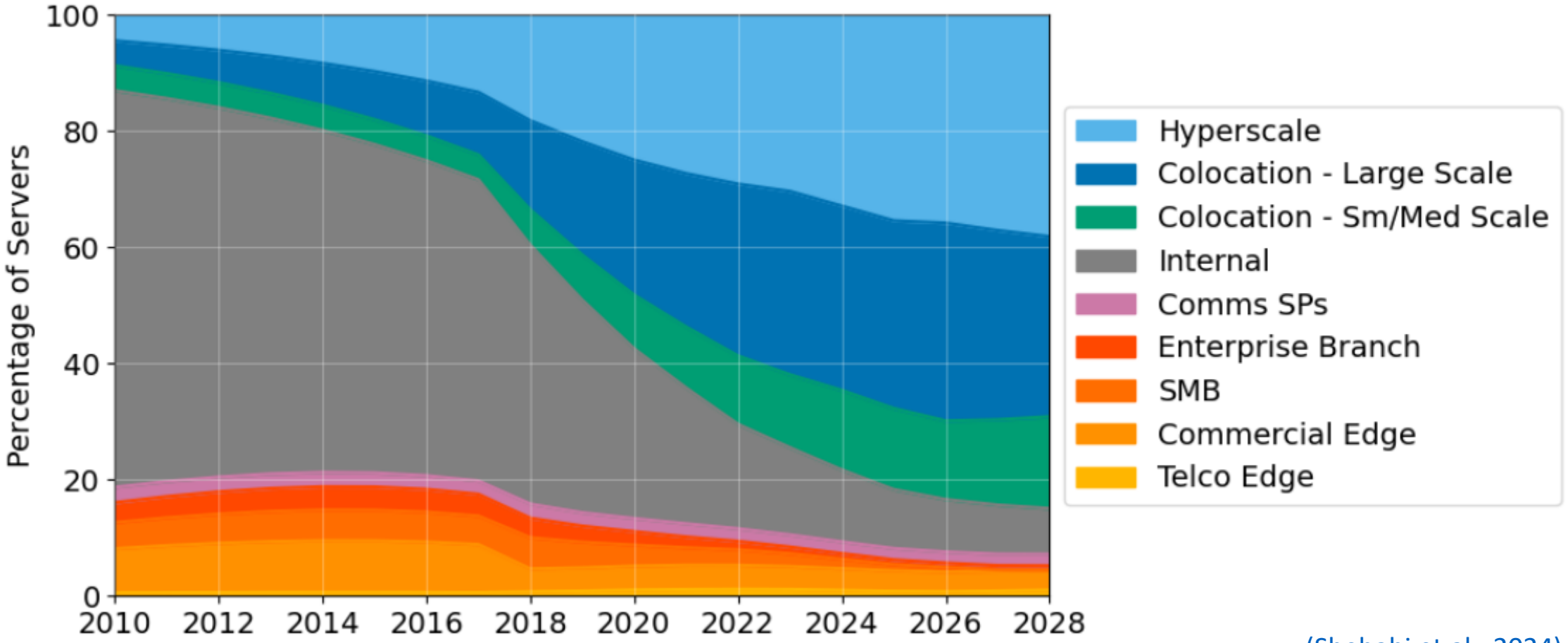
Enterprise/Onsite/Internal

Colocation

Edge

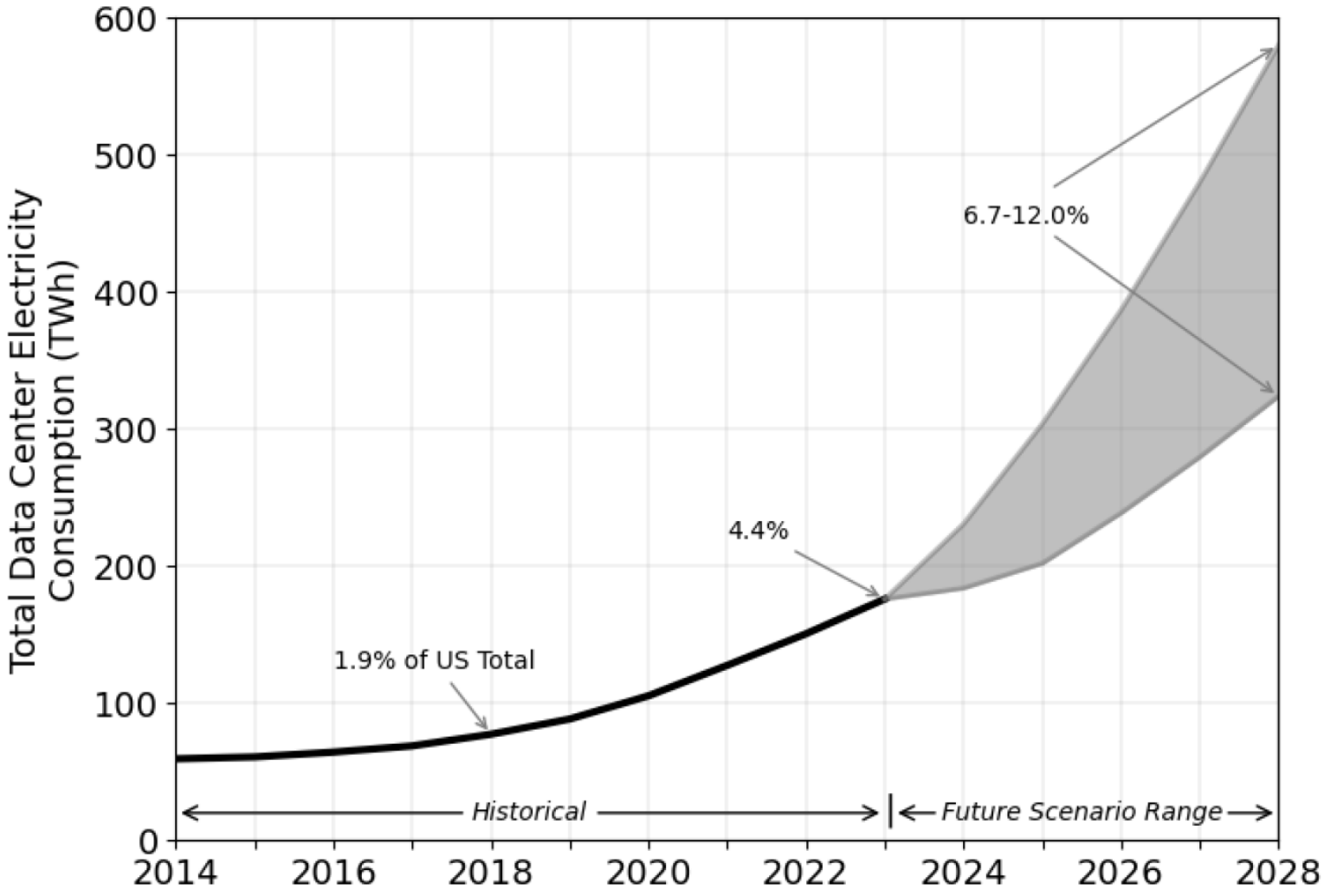
Hyperscale

Data centers are getting larger.



(Shehabi et al., 2024)

Data center electricity consumption is expected to significantly increase by 2028.



(Shehabi et al., 2024)

Improvements in operational efficiency and a shift to hyperscale data centers is expected to improve power usage effectiveness (PUE).

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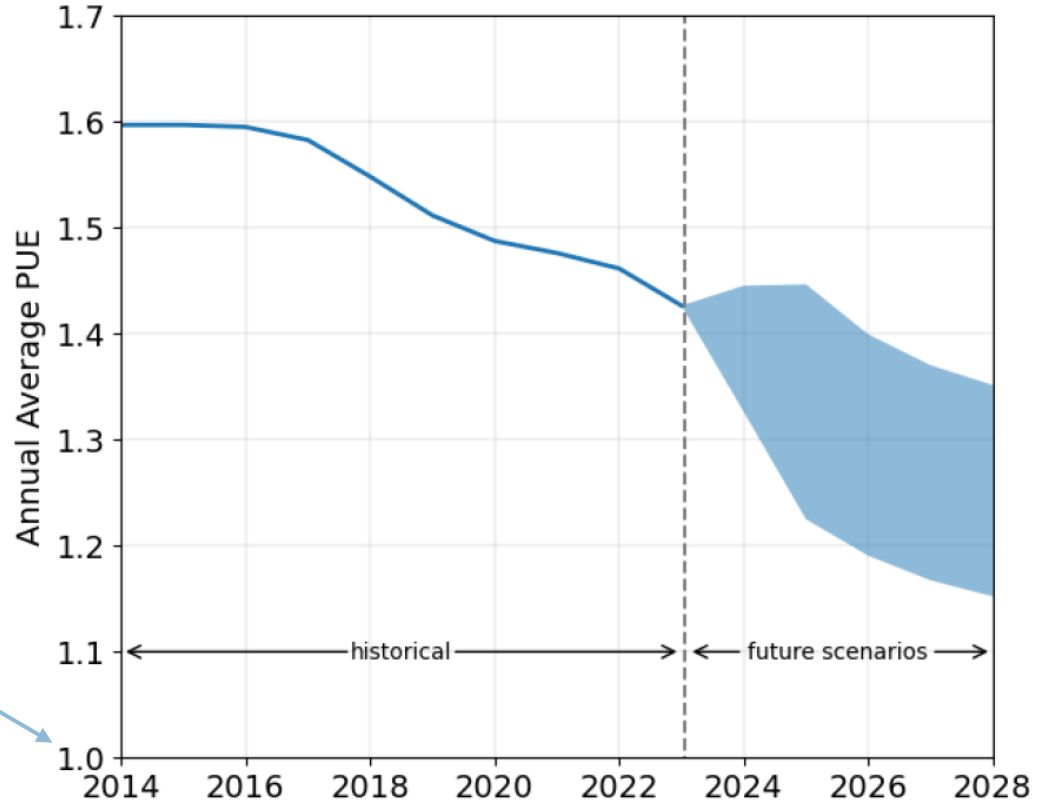


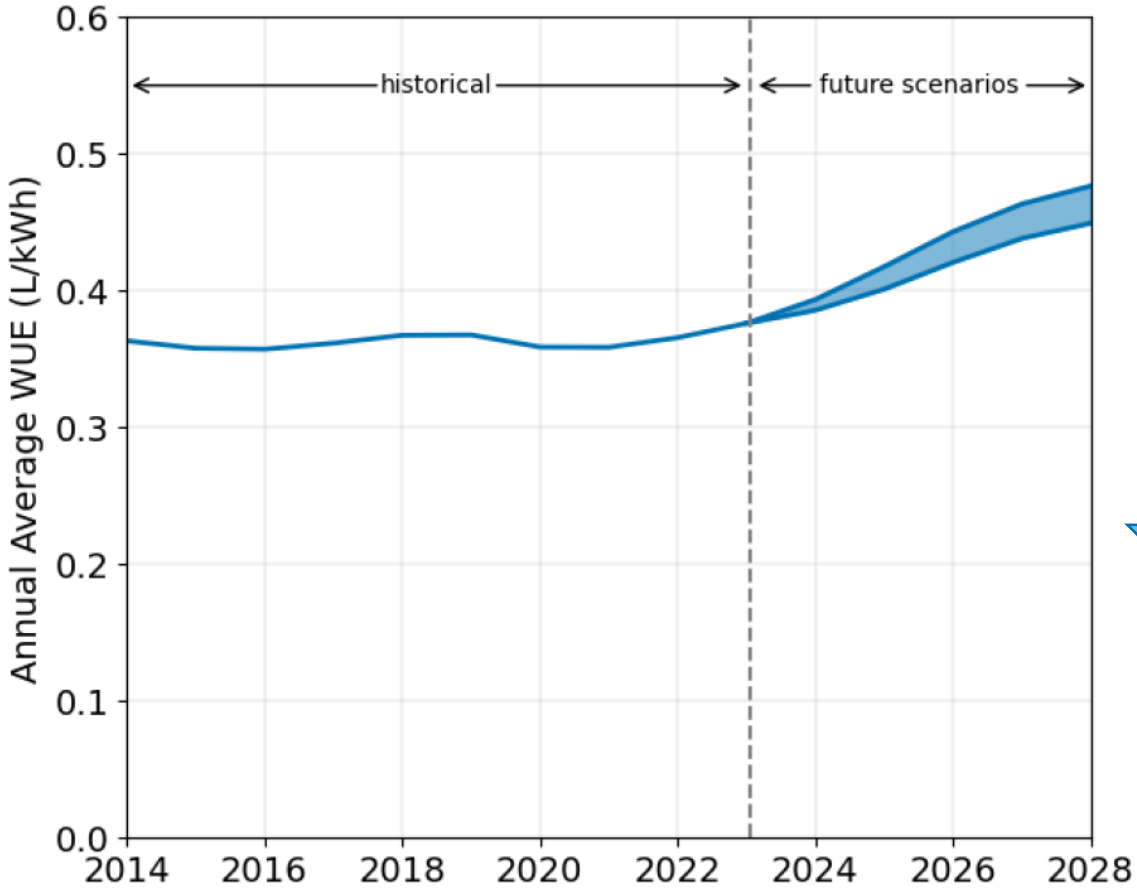
Ideal Case: All power used for IT equipment

(Shehabi et al., 2024)

However, these same trends are expected to increase water usage effectiveness (WUE) at the data center.

$$Water\ Usage\ Effectiveness\ (WUE_{SITE}) = \frac{Data\ center\ water\ consumption}{IT\ equipment\ energy\ consumption}$$

(The Green Grid, 2011)

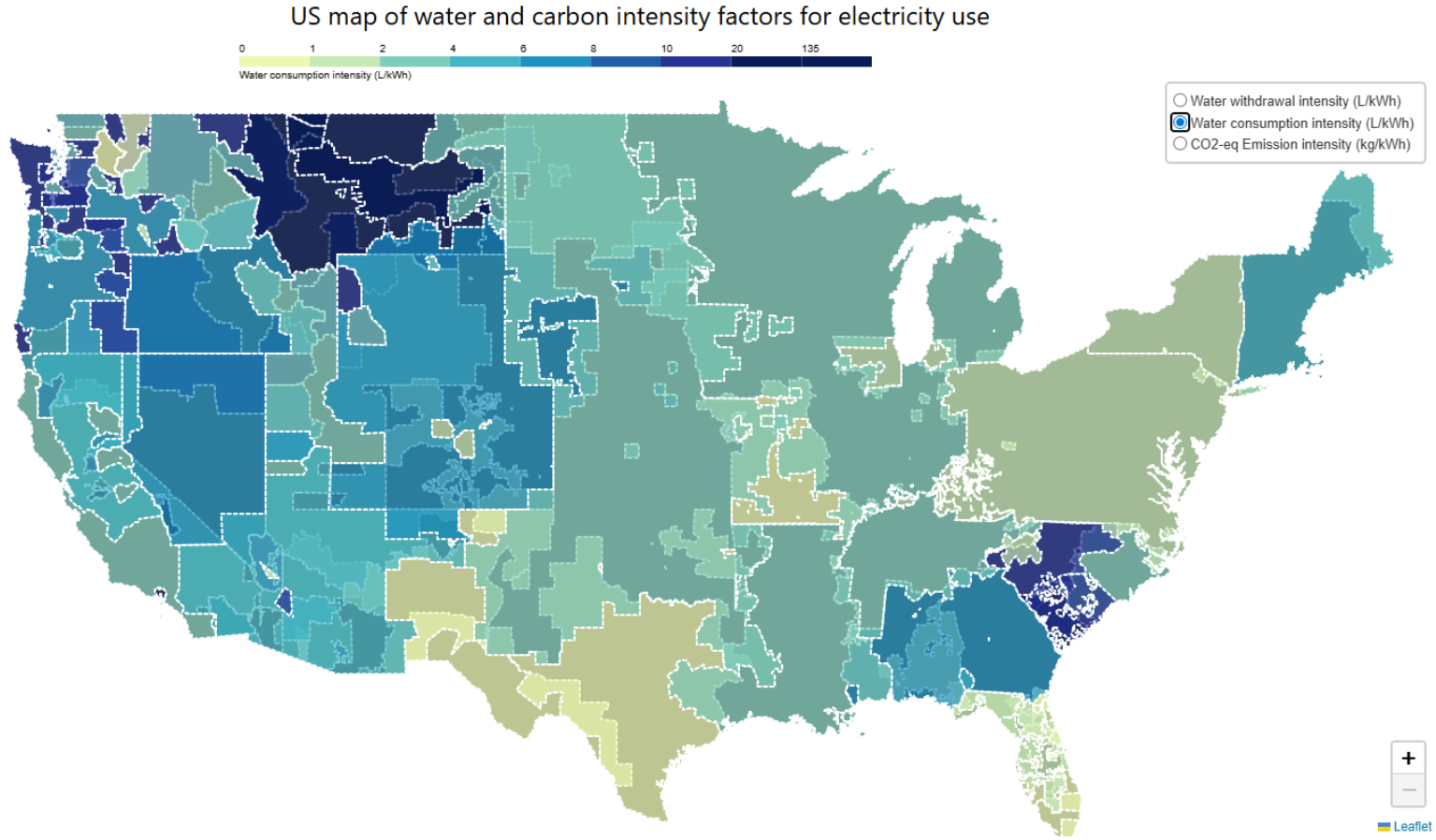


Lower is better

(Shehabi et al., 2024)

$Water\ Usage\ Effectiveness\ (WUE_{SOURCE})$

Find the water and carbon intensity of electricity use for any time/location.



waterimpacttool.lbl.gov

[(Siddik et al., 2024)]