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The long path towards

GREEN DATA CENTERS

07.10.2025 I Monica Vitali

Data Centers Footprint

01

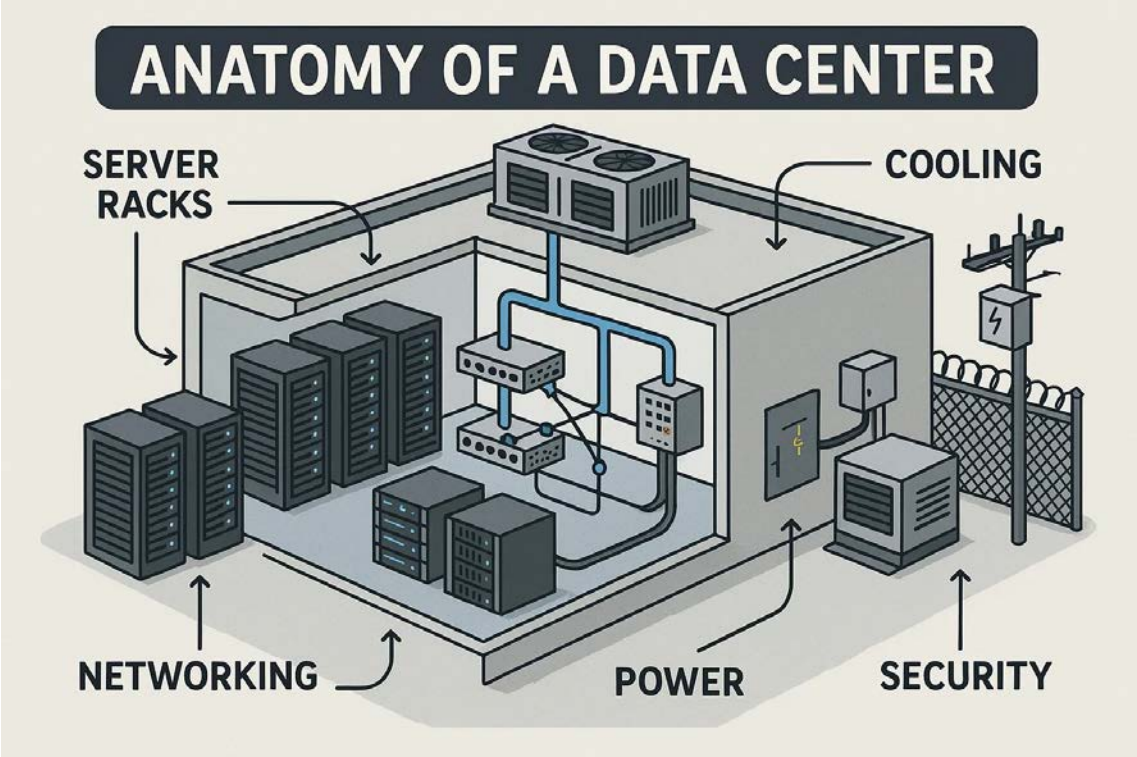
EVERY DAY…

We use information technology to perform a lot of tasks




All these services are hosted in **DATA CENTERS**

WHAT IS A DATA CENTER



https://totalpwr.com/inside-the-anatomy-of-a-modern-data-center/

HOW MUCH IT IMPACTS THE ENVIRONMENT?

1 google search

5 min social media

1 mail stored 1 year

1 hour video streaming

1 hour video call

1 GB cloud storage

1 g

10 g

1 kg

10 kg

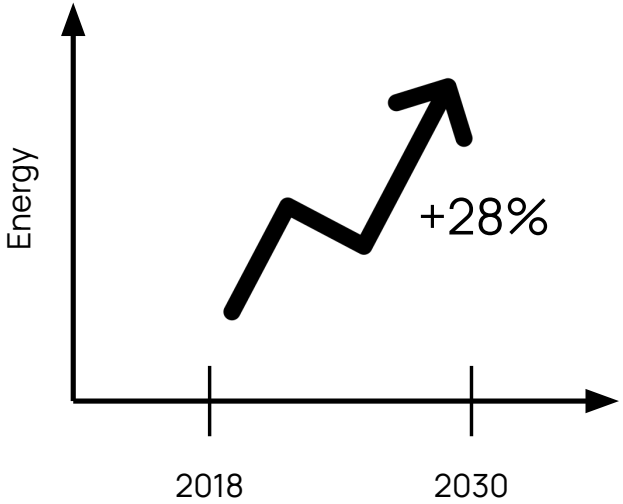
barely moving your car

driving around the block

driving across a small city

driving to a nearby city

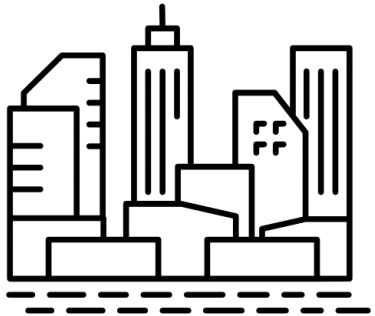
DATA CENTERS ENERGY DEMAND



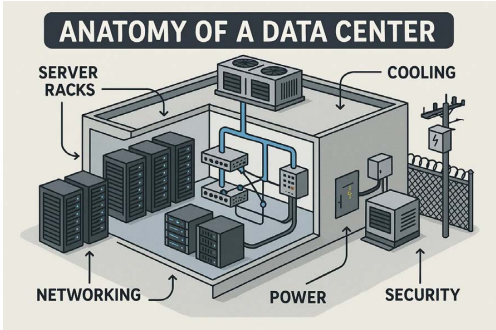
500-200 servers
1-5 MW

tens of thousands of servers
20-100 MW

=

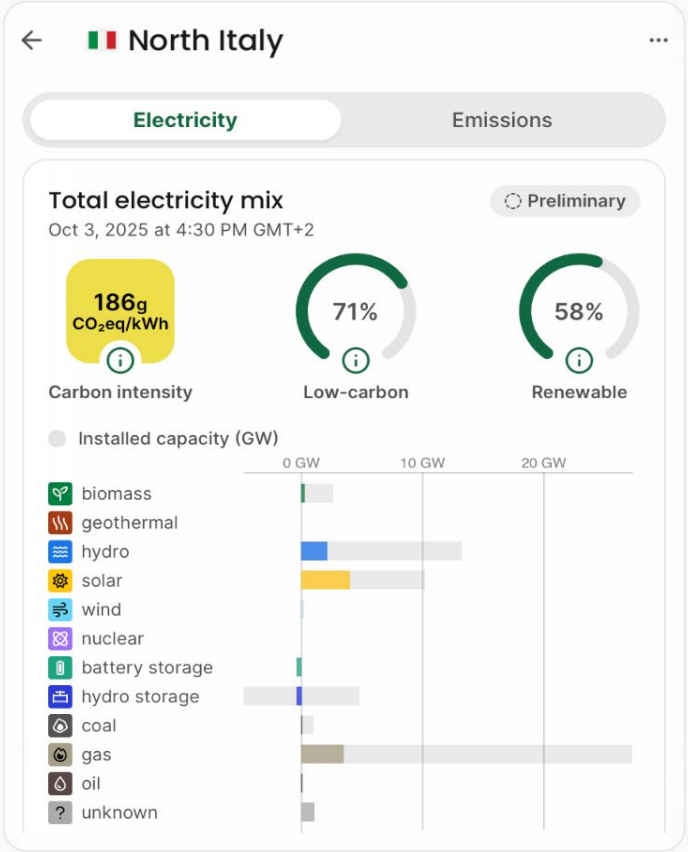


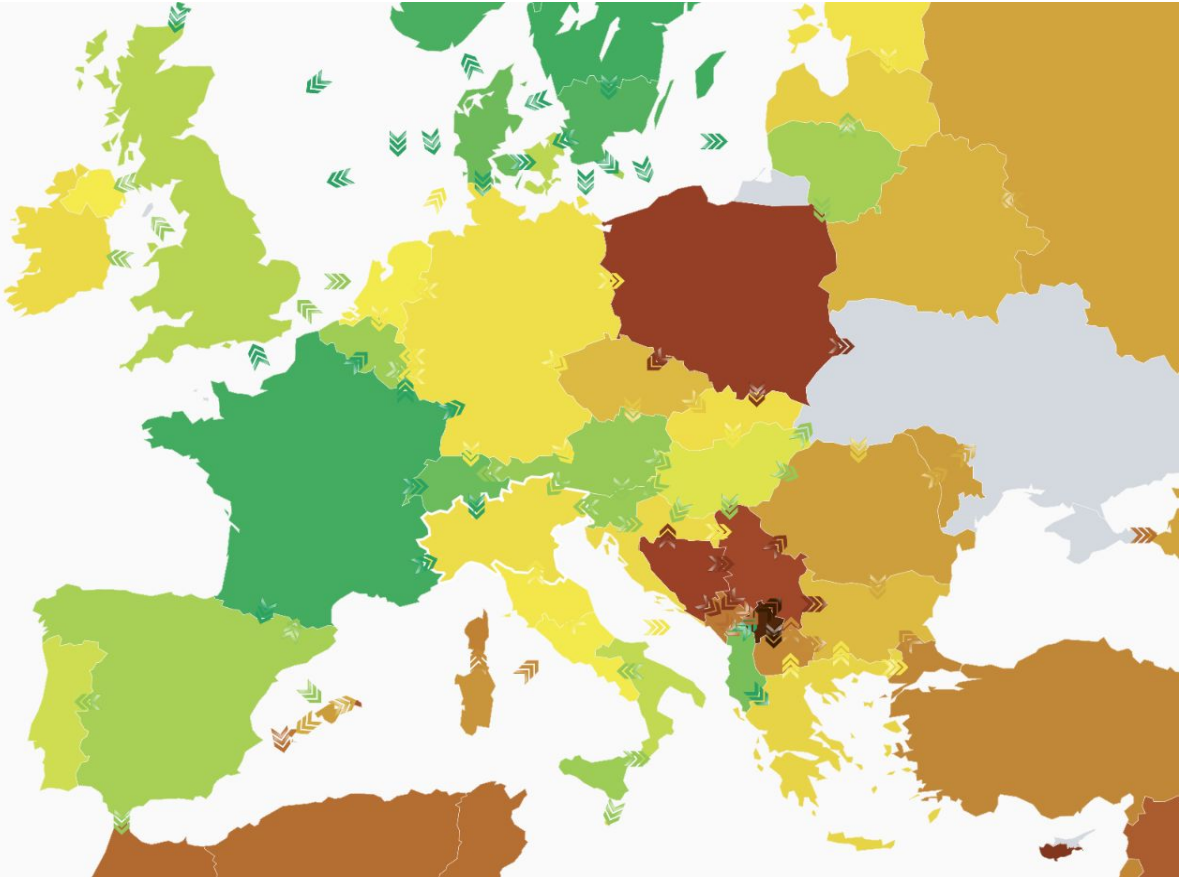
DATA CENTERS ENERGY DEMAND

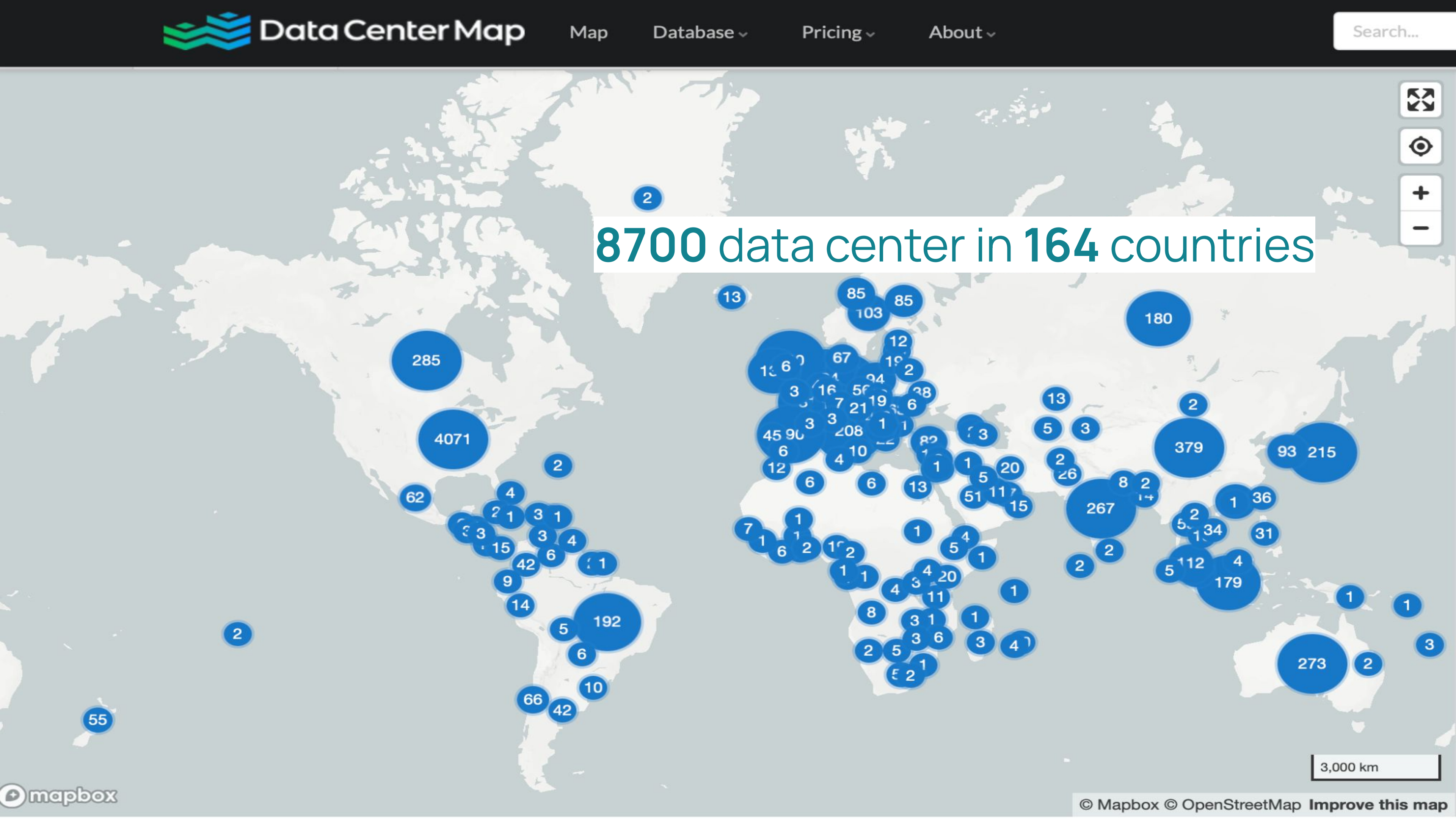


DATA CENTERS CARBON FOOTPRINT

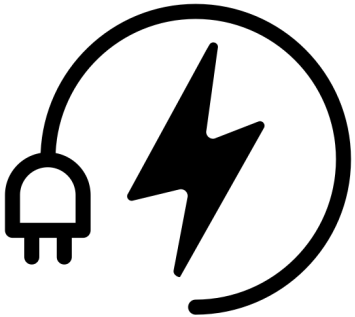
https://www.electricitymaps.com/



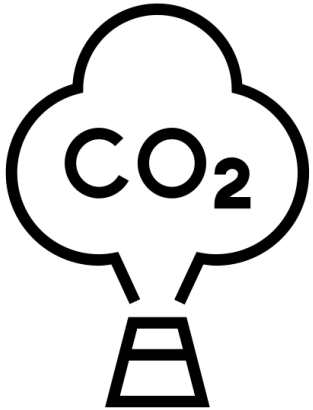



Data Center Map
Map
Database
Pricing
About
Search...
8700 data center in 164 countries
3,000 km
mapbox
© Mapbox © OpenStreetMap Improve this map

GLOBAL IMPACT



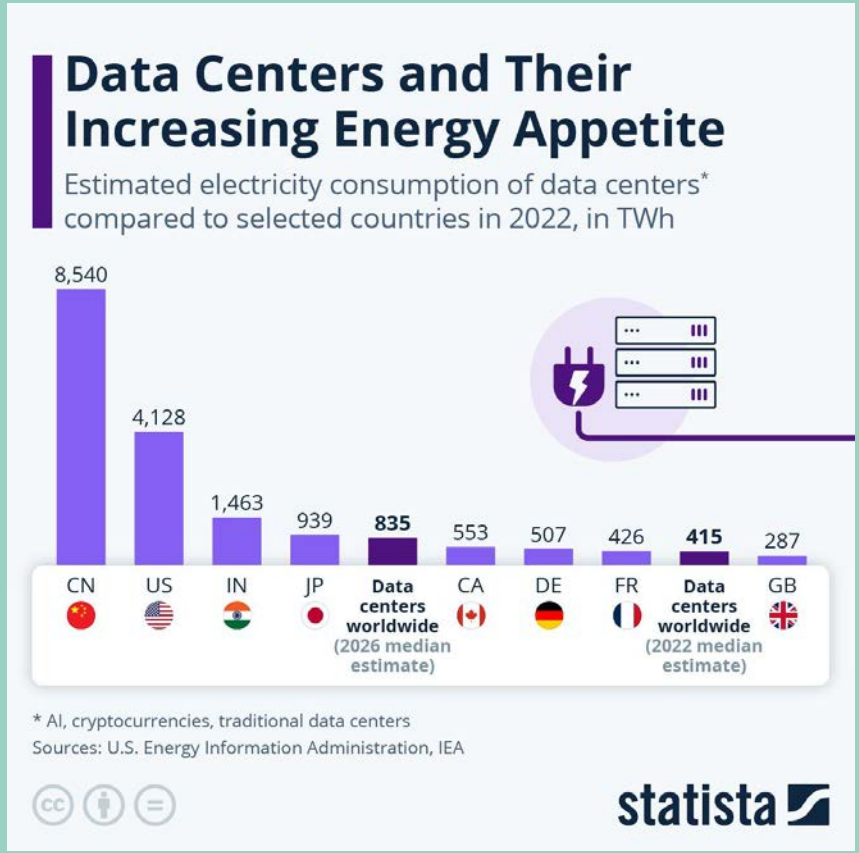
2% of global energy



4% of global emissions

Millions of tons per year

GLOBAL IMPACT



Greening the Cloud

02

METRICS

METRICS

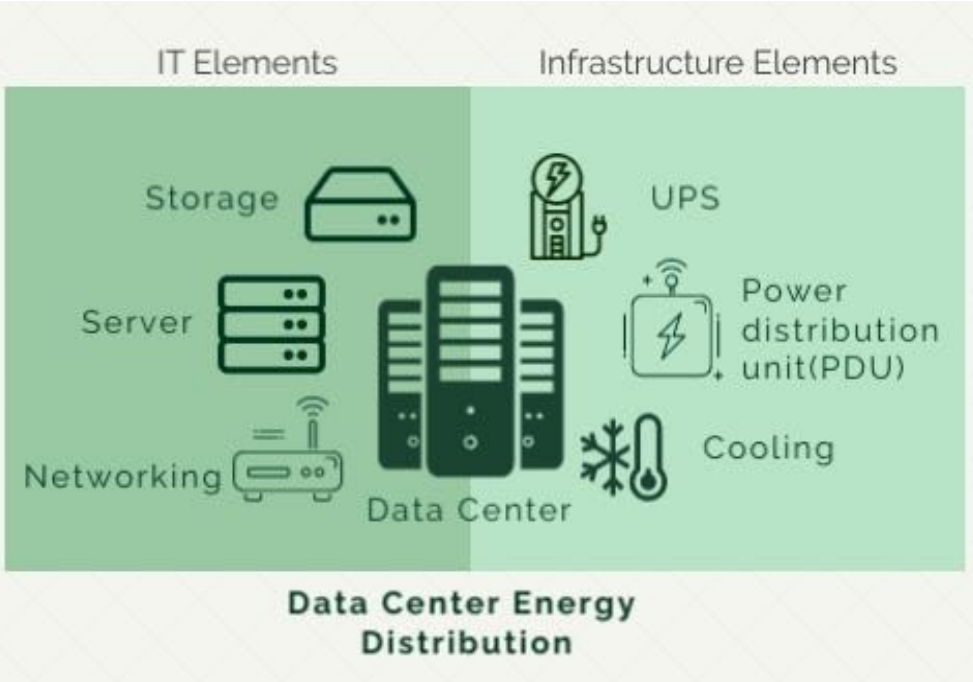
According to GreenGrid,

"PUE is the total power sourced by the data center divided by the power sourced by the IT load."

Mathematically,

$$PUE = \frac{\text{Total power consumed by the facility}}{\text{Power consumed by the IT equipment}}$$

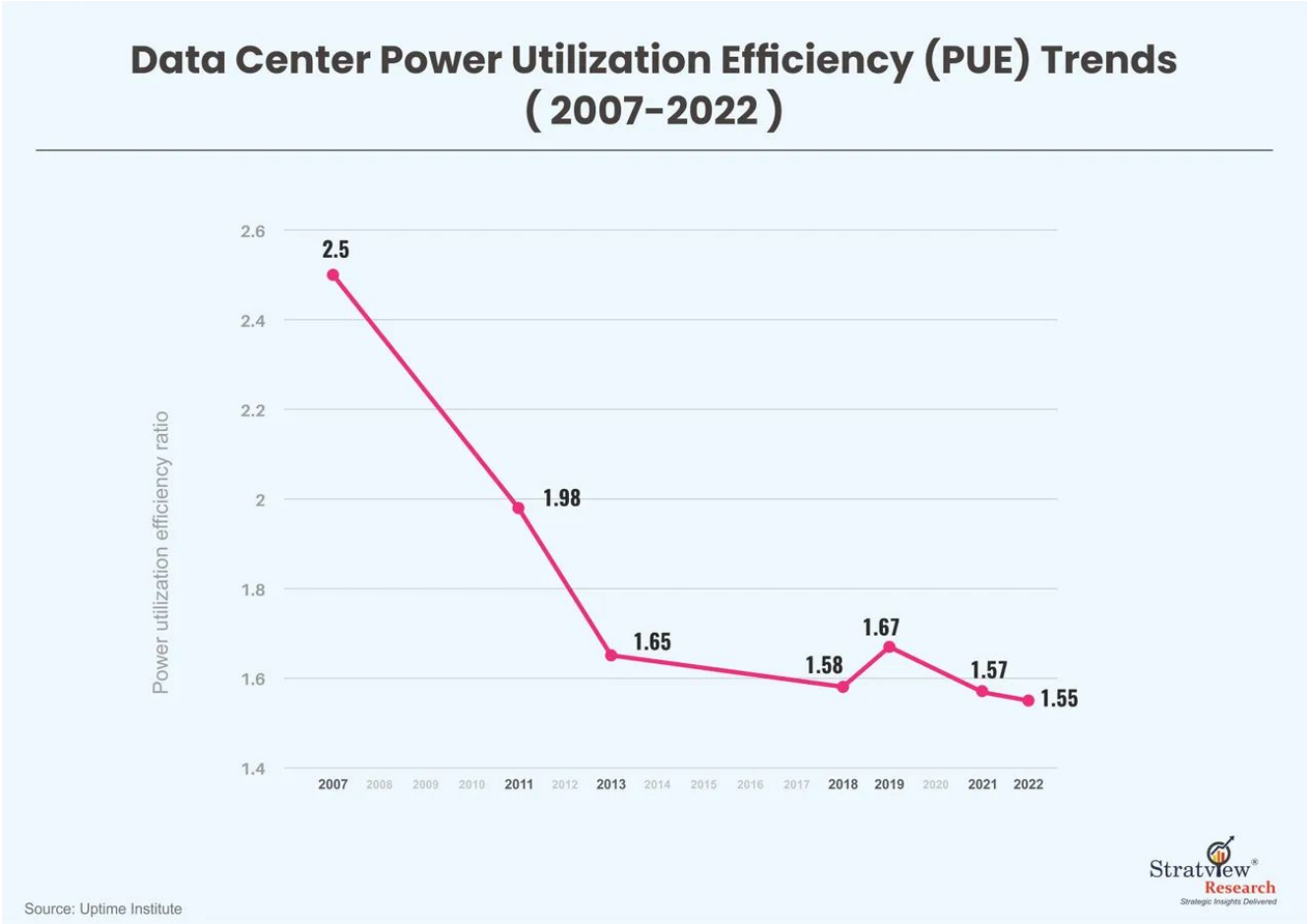
The efficiency is higher as PUE is closer to 1.0



Data Center Energy Distribution

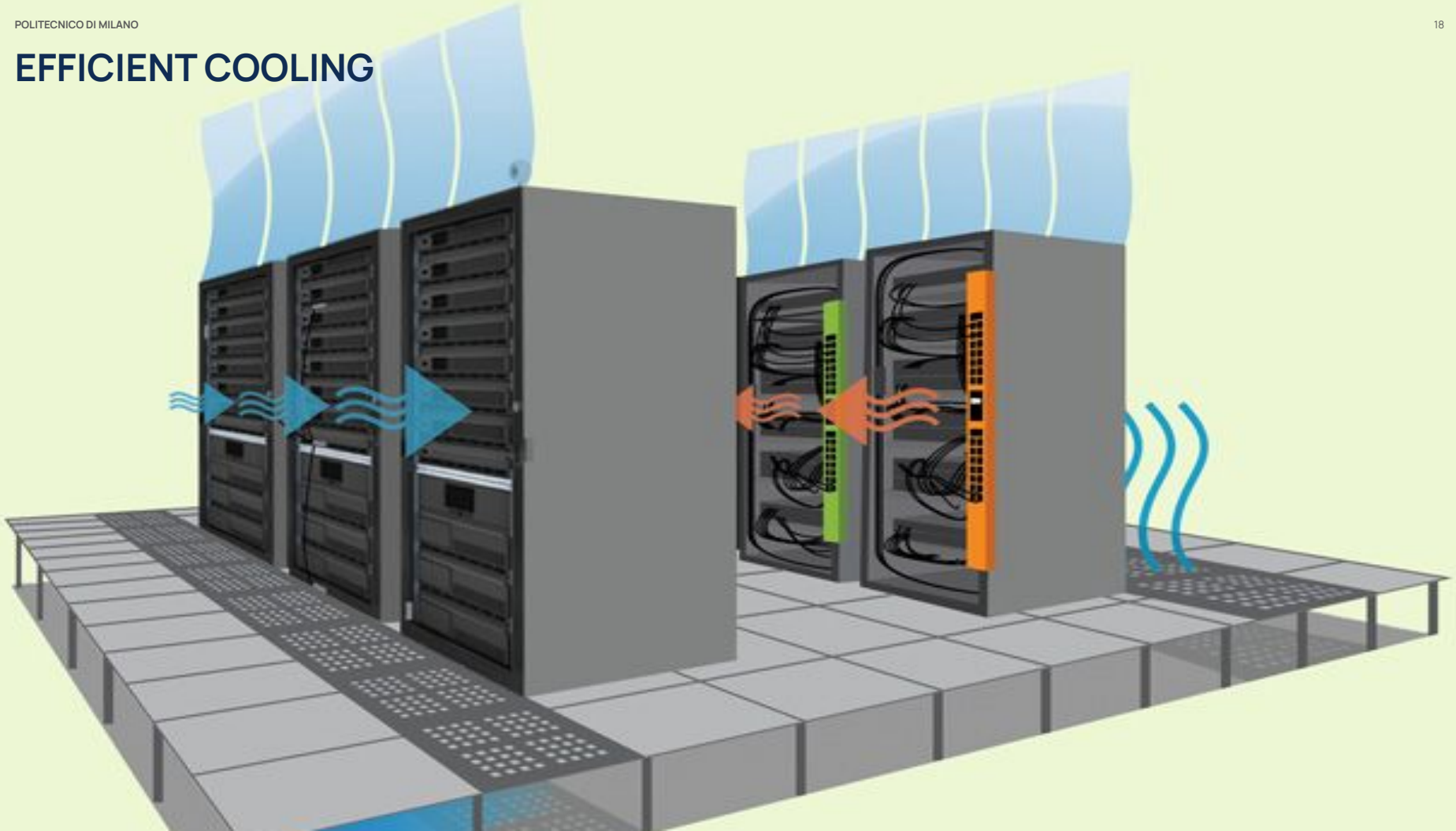
https://medium.com/@vsnehamichelle/power-usage-effectiveness-pue-in-data-centers-b1a21fb97255

METRICS


Data Center Power Utilization Efficiency (PUE) Trends
(2007-2022)
Power utilization efficiency ratio
2.6
2.4
2.2
2
1.8
1.6
1.4
2.5
1.98
1.65
1.58
1.67
1.57
1.55
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Source: Uptime Institute
Stratview Research
Strategic Insights Delivered

EFFECTIVE DC PLACEMENT

EFFICIENT COOLING



EFFICIENT HARDWARE

RENEWABLE ENERGY SOURCES

2024 Year in Review

As we reflect on 2024, we are proud of our achievements. We have worked hard to reduce our environmental footprint, drive improvements throughout our value chain, create a safer, more inclusive place for people to work, and provide skills development opportunities, empowering our people to grow. These actions are accelerating our journey toward a more sustainable business at AWS.

The AWS AI & ML Scholarship program helps students learn AI skills through expert training and mentorship.

100%

Of electricity consumed by Amazon was matched with renewable energy sources in 2024, for the second consecutive year

Since 2020, Amazon has been the world's largest corporate purchaser of renewable energy annually

1.15

Global Power Usage Effectiveness (PUE) for AWS data centers, compared to the industry average of 1.25

12K $MTCO_2e$

Reduction from customer adoption of Graviton chips

38

Data centers constructed with lower-carbon concrete, in addition to 36 data centers in 2023

36

Data centers with lower-carbon steel in 2024, in addition to 31 in 2023

Nearly **$2M**

In AWS credits provided to 41 customers affected by eight natural disasters

71K $MTCO_2e$

Reduction from Amazon's own adoption of Graviton chips

Goal

Distribute up to $60 million in AWS cloud computing credits to support global health by the end of 2024

$60M

In cloud computing credits awarded to 403 global customers since 2021

82K

Students provided access to science, technology, engineering, and math (STEM) education through 93 AWS Think Big Spaces, which allow for hands-on exploration

0.15

L/kWh water use effectiveness (WUE) for Amazon's data centers, a 17% improvement from 2023

Goal

AWS will be water positive by 2030, returning more water to communities than it uses in its direct operations

53%

Of the way toward meeting its water positive goal

4.3B

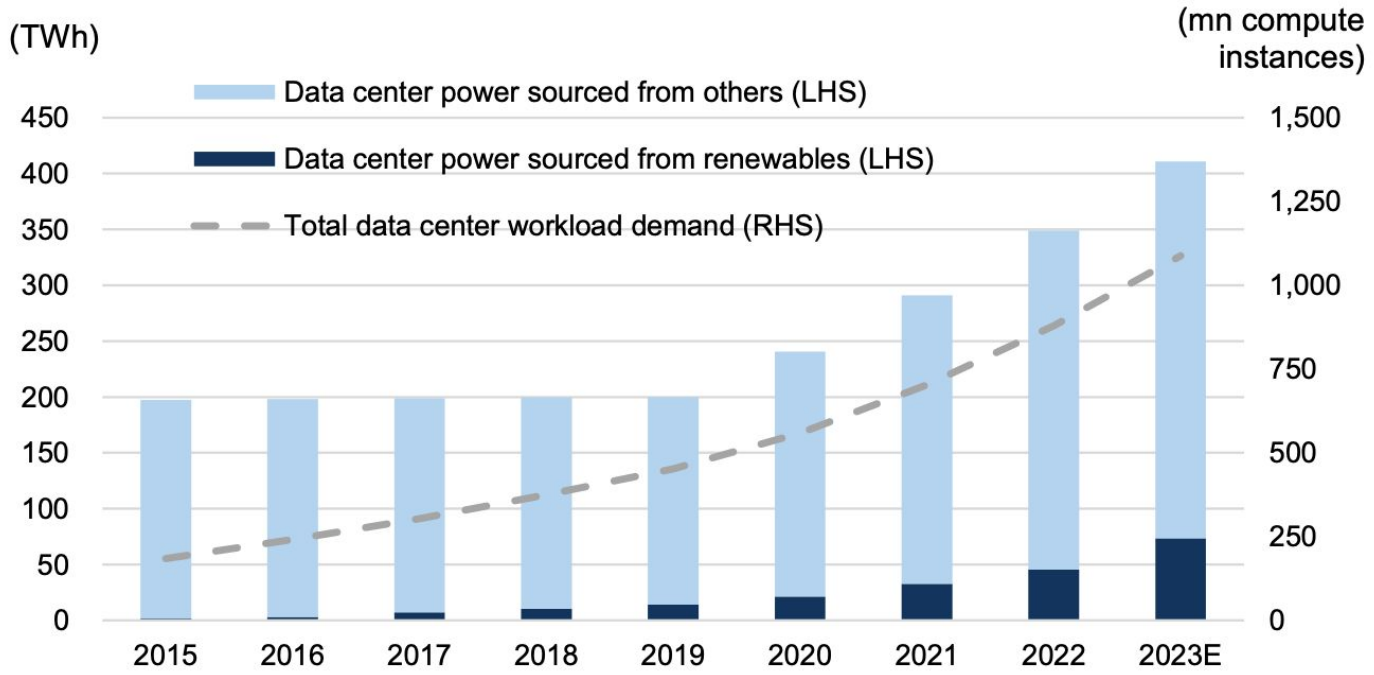
Liters of water returned to communities from active replenishment projects, with more than 7 billion liters of total annual contracted replenishment volume for future years

https://sustainability.aboutamazon.com/products-services/aws-cloud

AI: the elephant in the room

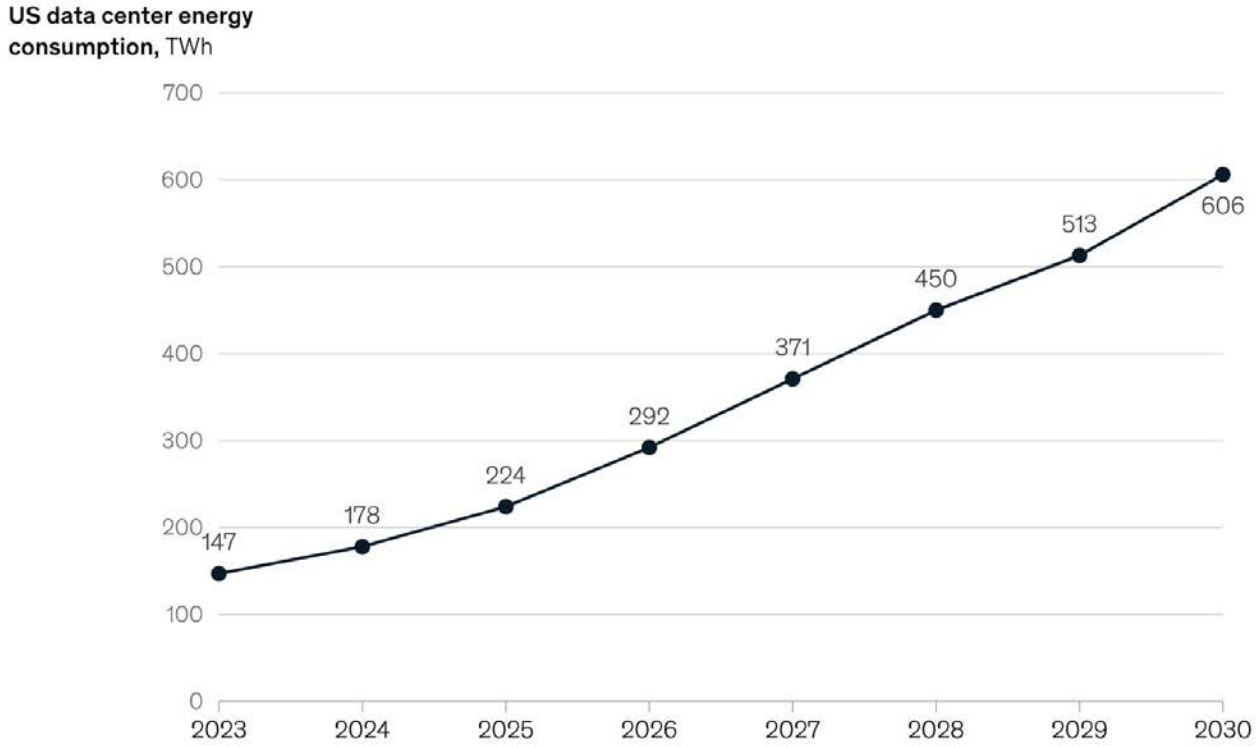
03

DC Energy Demand Trends



AI, data centers and the coming US power demand surge. Goldman Sachs (2024)

DC Energy Demand Trends



https://www.mckinsey.com/industries/private-capital/our-insights/scaling-bigger-faster-cheaper-data-centers-with-smarter-designs

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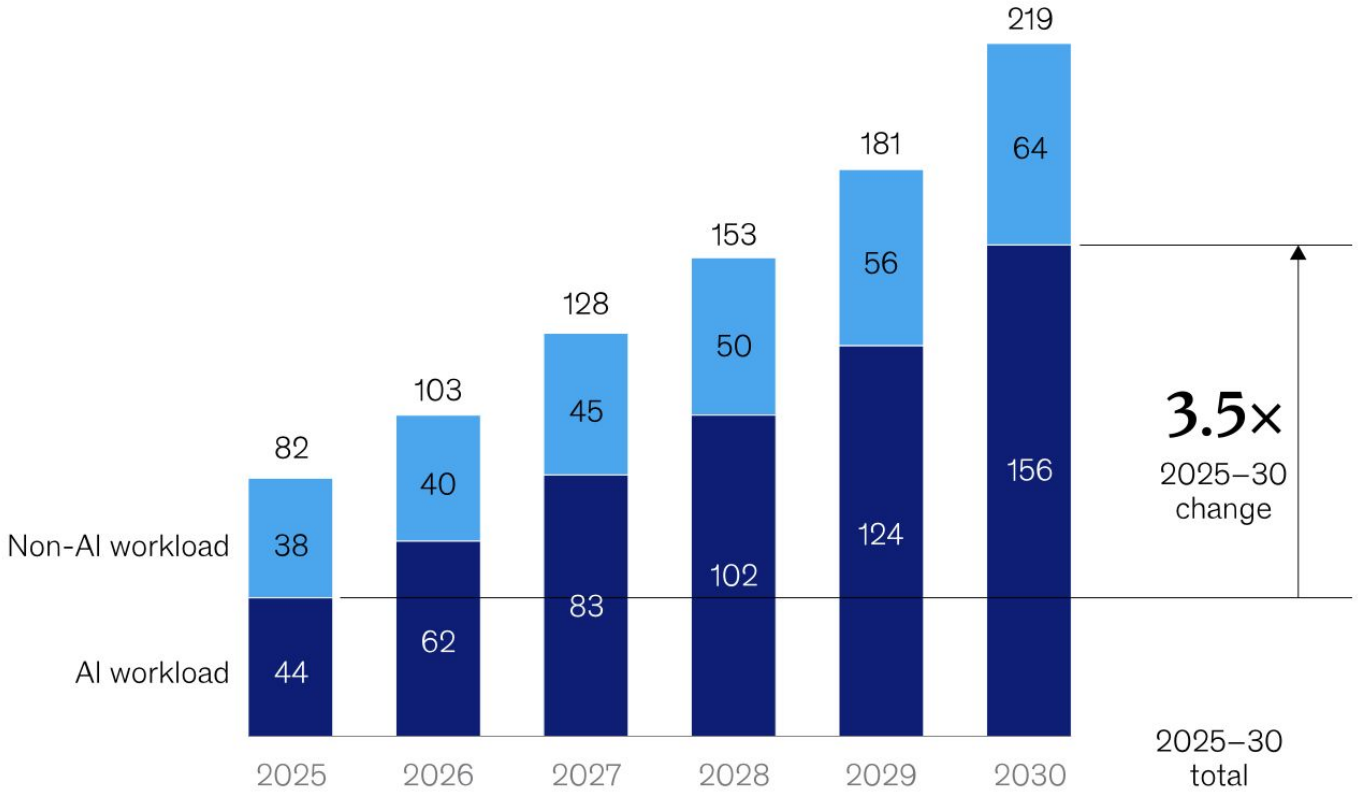

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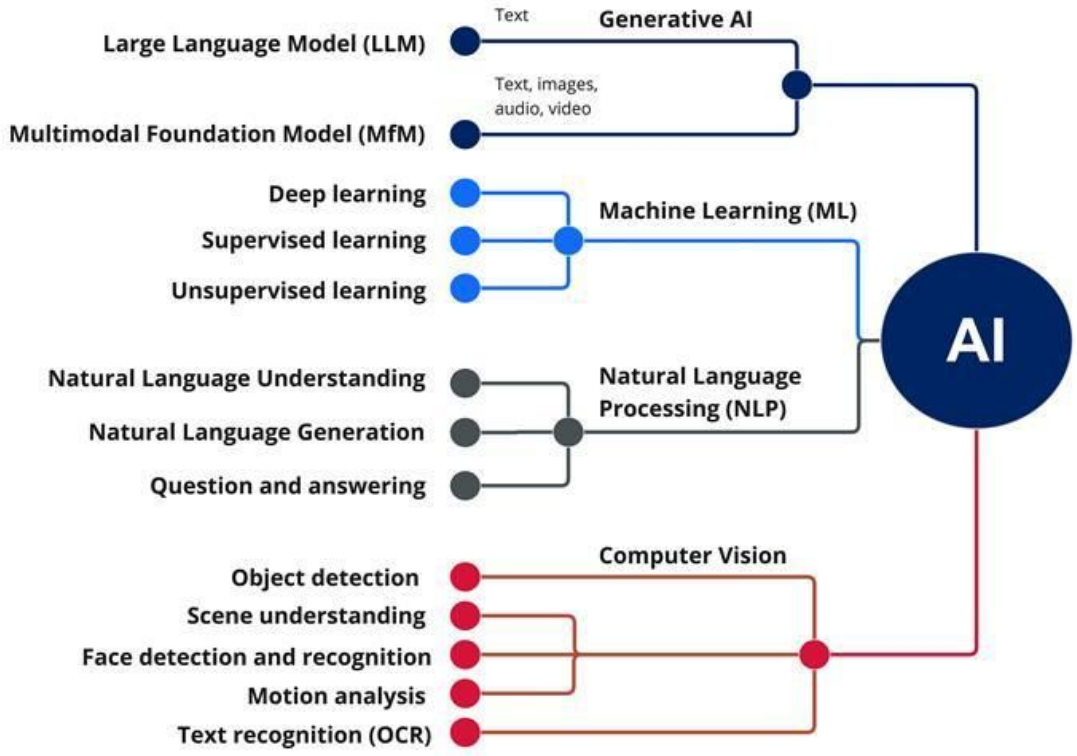
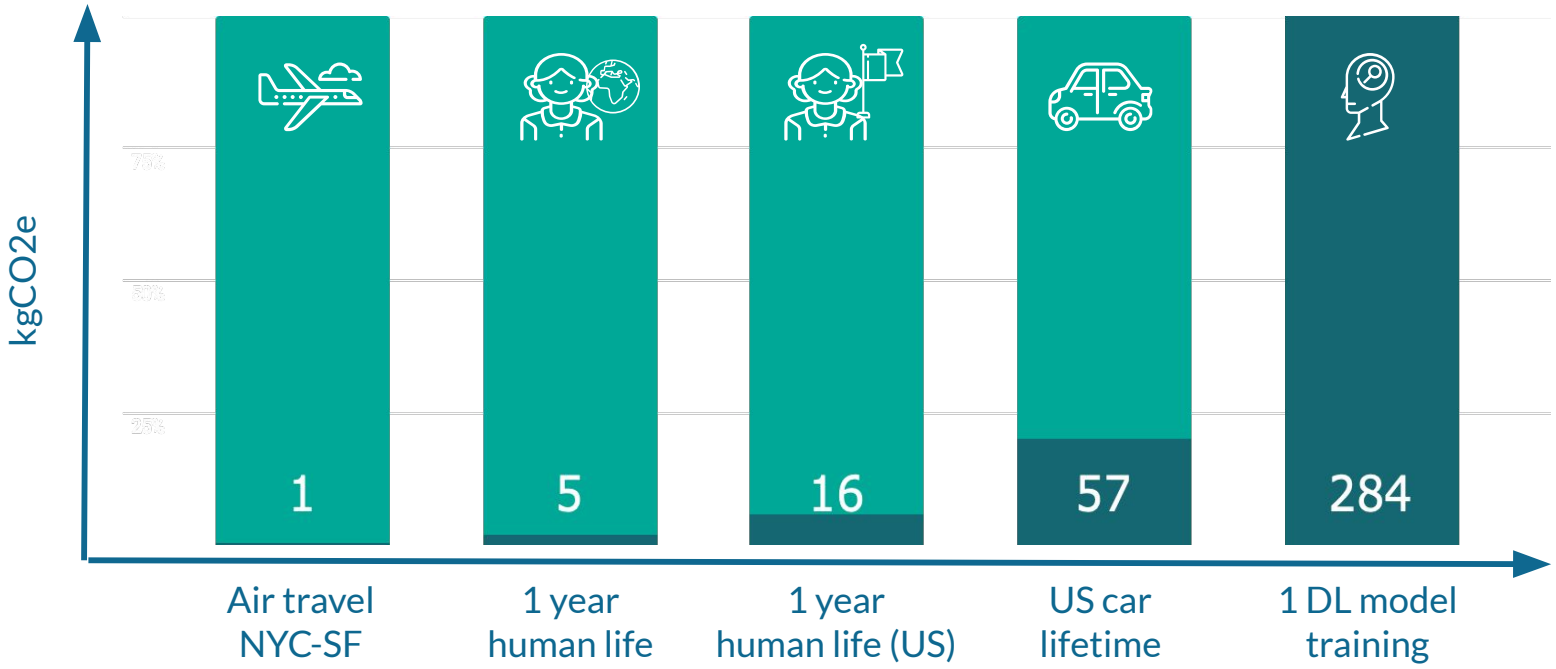
ARTIFICIAL INTELLIGENCE



Impact depends on:

- Model complexity
- Model dimension (parameters)
- Training data volume

AI FOOTPRINT



TRADITIONAL AI vs GENERATIVE AI

1 DL training

284 kgCO2e

20 days

1 GPT-3 training

610k kgCO2e

120 years

TRADITIONAL vs GENERATIVE AI

GPT-4 usage

1 day

1 conversation

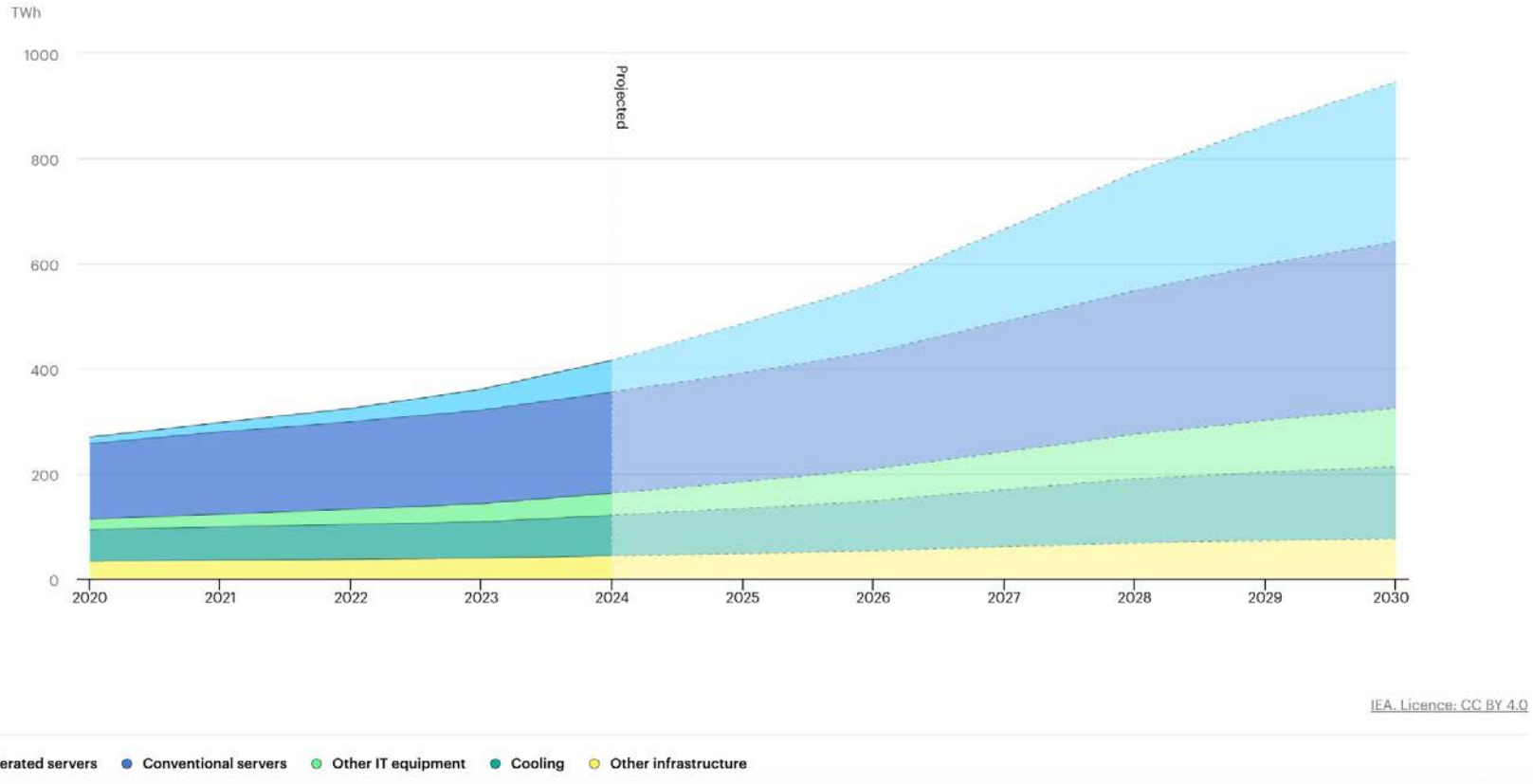
180'000 US households

50 cl water

1 X  = 10 X 

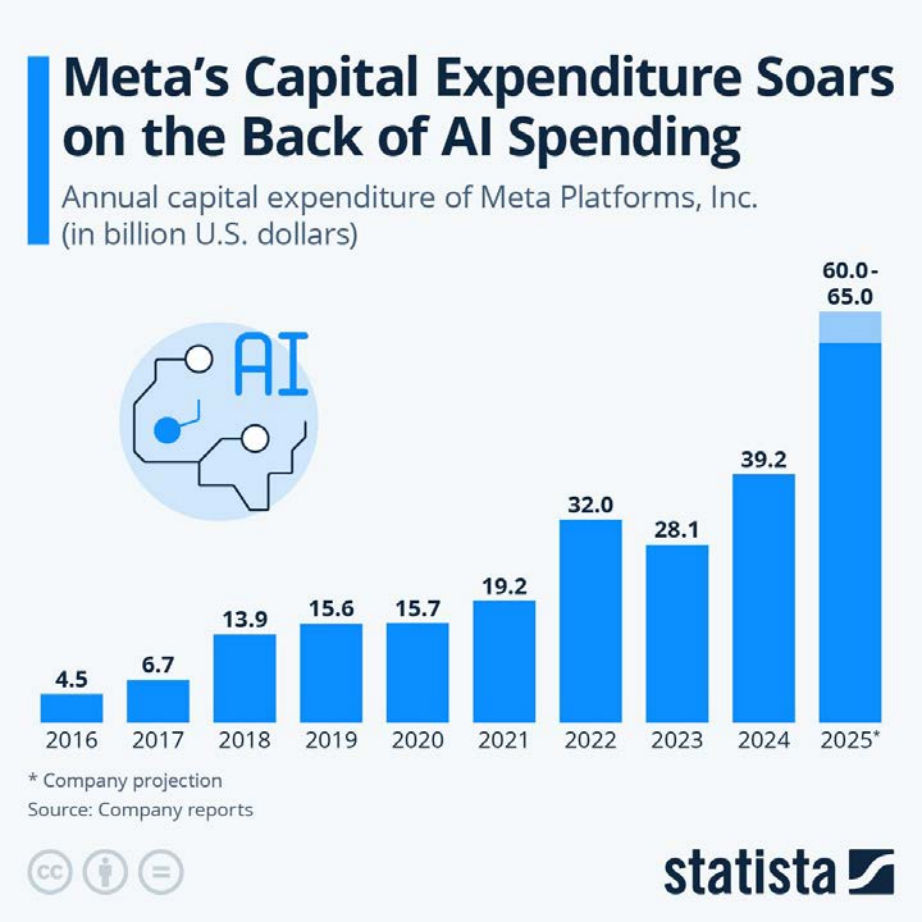
https://www.forbes.com/sites/cindygordon/2024/03/12/chatgpt-and-generative-ai-innovations-are-creating-sustainability-havoc/#

The RISE of AI

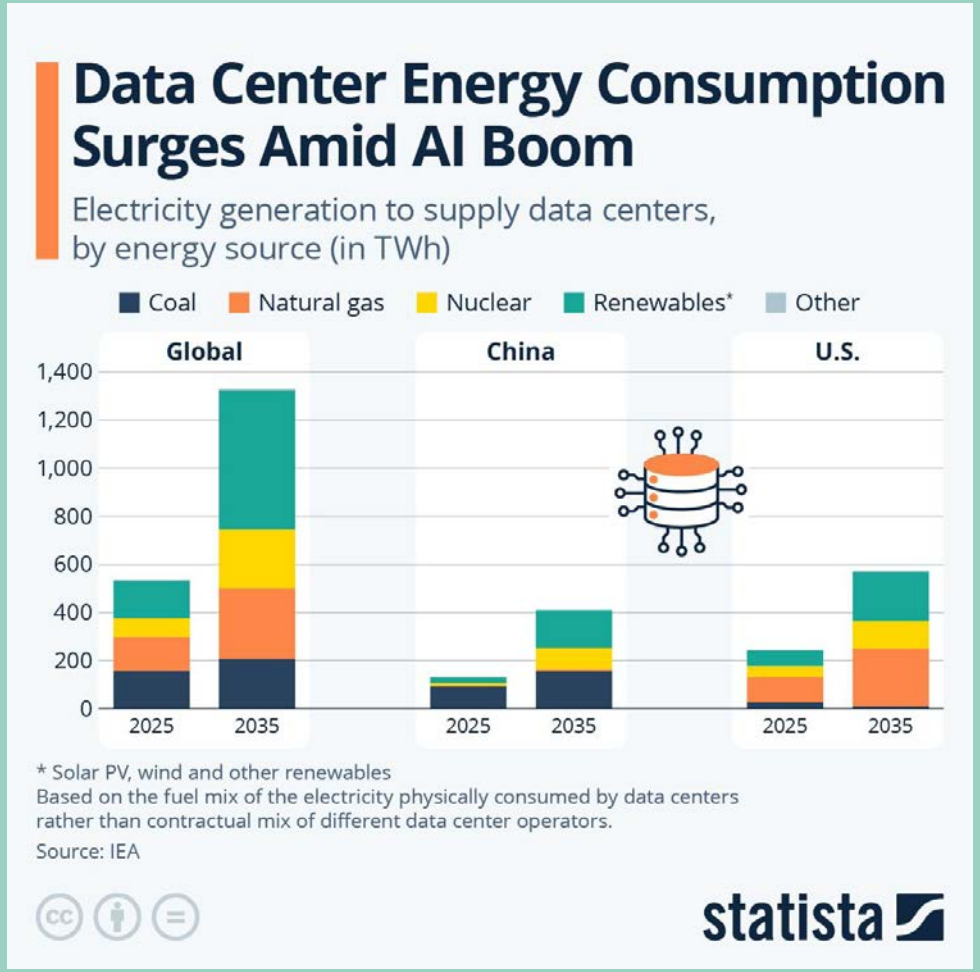


https://www.iea.org/reports/energy-and-ai/energy-demand-from-ai

The RISE of AI



The RISE of AI



Future Challenges

04

REGULATIONS

Guidelines for energy transparency of AI development, training & deployment.
Technical documentation must report:

- Energy & resource consumption during training.
- Expected energy use during deployment (inference).

Measurement & logging should be enabled at each stage.
Providers of General-Purpose AI models must disclose known or estimated training energy use.
Data must be verifiable, comparable, and comprehensible (harmonized methods to follow).

CLOUD PROVIDERS

Cloud providers will play a central role in enabling transparent, standardized, and auditable energy monitoring for AI training and inference by:

- Providing monitoring tools for training, fine-tuning, and inference energy use
- Offering real-time / near real-time dashboards or APIs with electricity (kWh), compute, and emissions data.
- Making data exportable for inclusion in AI Act technical documentation.

EXPLOITING USER AWARENESS

Empowering users with detailed information about the impact of using AI tools

Immediate feedback drives awareness
Allow users to see energy use or emissions **as they interact**

Promotes responsible behavior
Real-time indicators can nudge users to **opt for lower-impact options**.

Enables informed choices
Users can **compare alternatives** and choose more efficient paths.

Closes the loop between consumption and action
Transparency turns passive usage into **active, conscious engagement**.

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