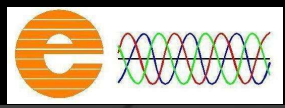
Data Centers And Energy Demand

Jay Babin, E-Flow Thailand

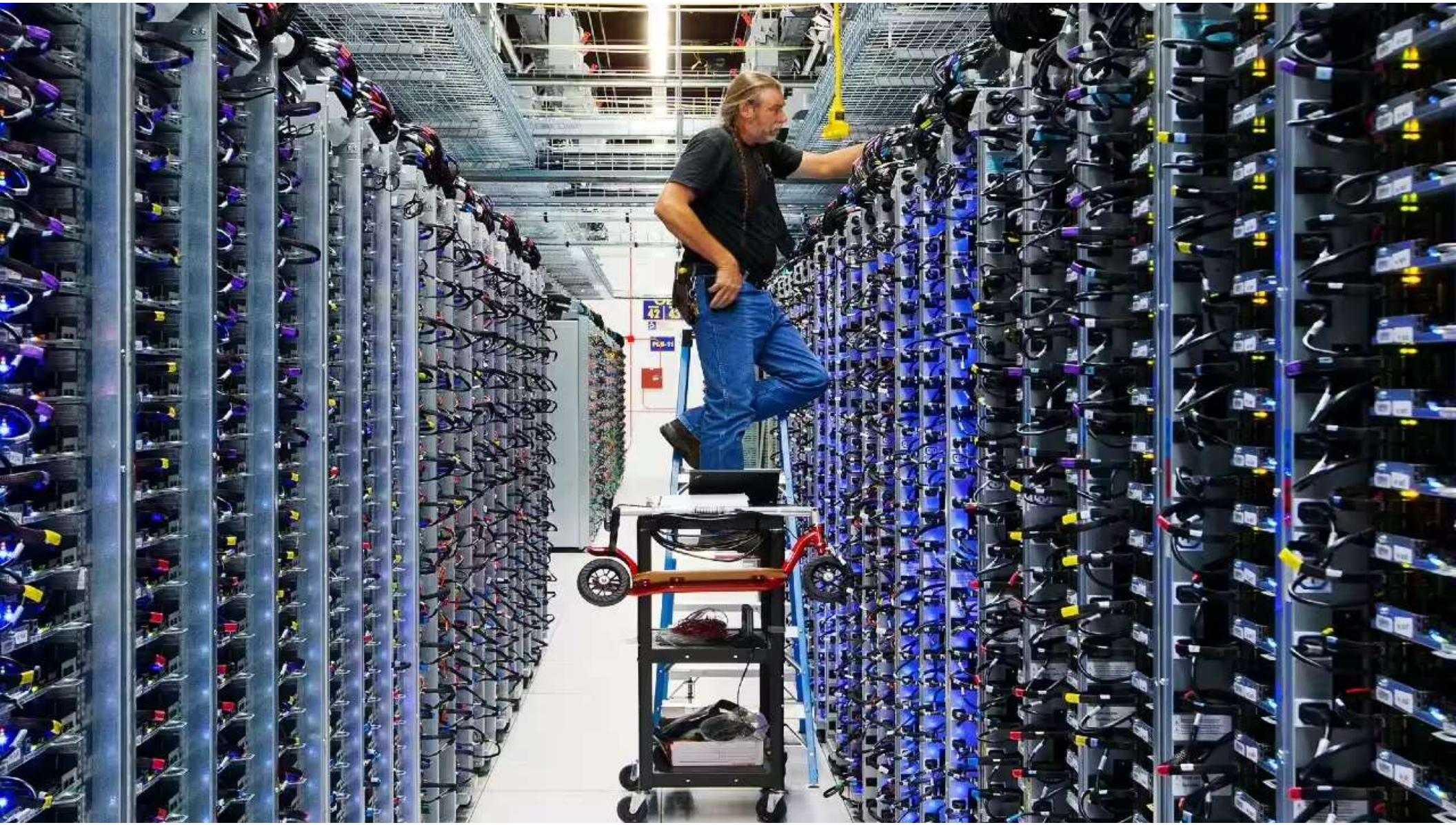


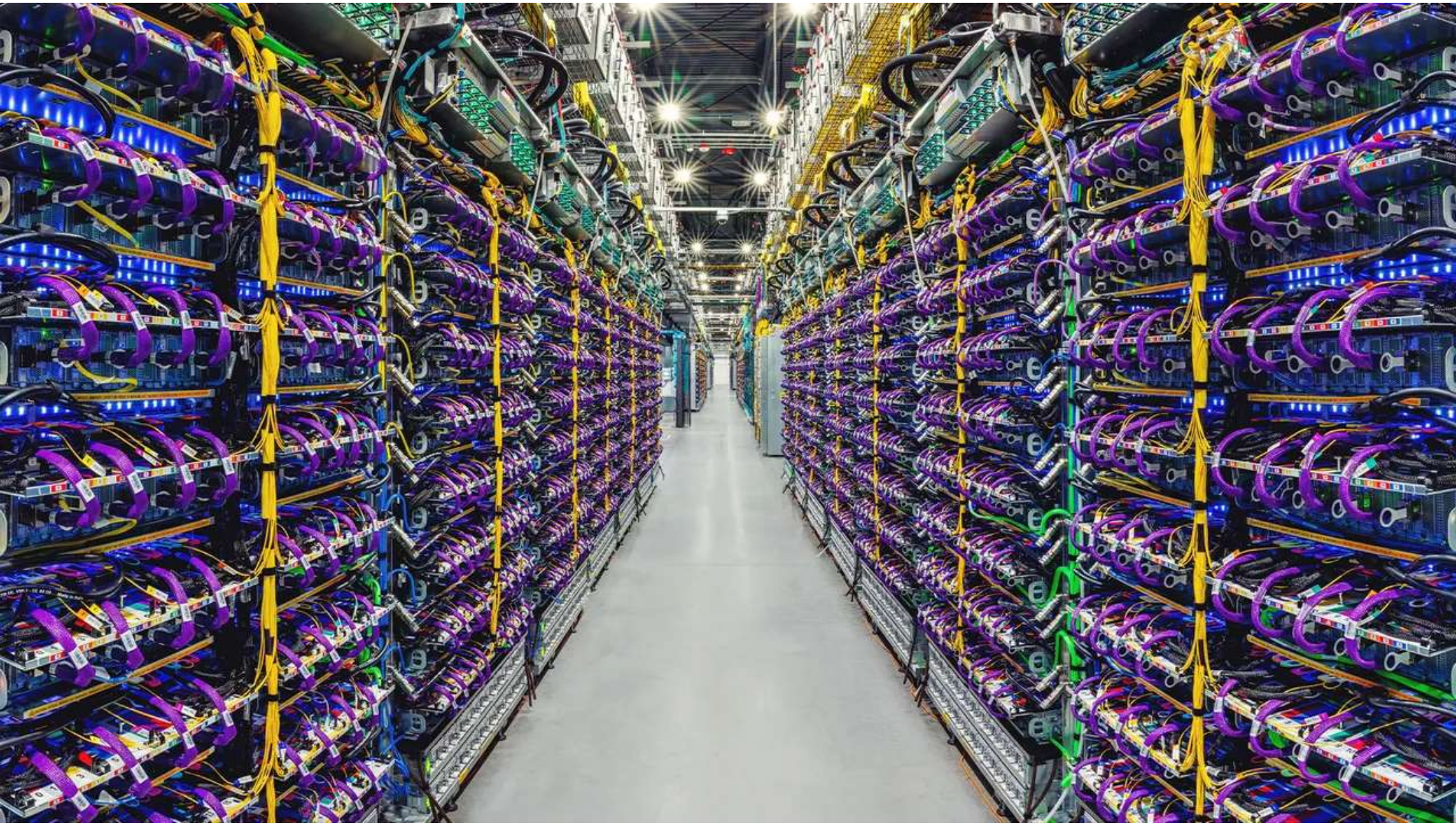
What is a data center?

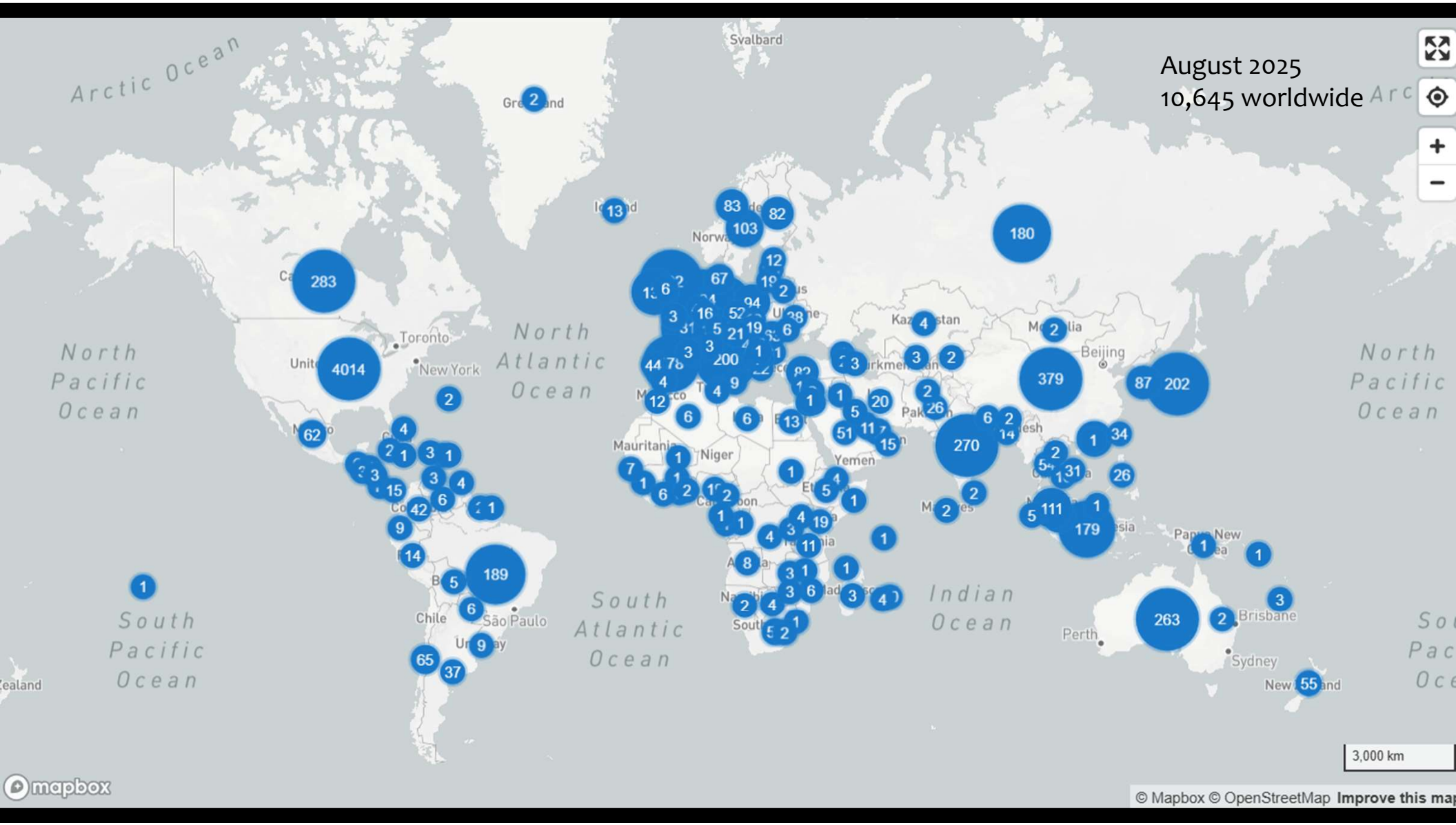
- a large group of networked computer servers typically used by organizations for the remote storage, processing, or distribution of large amounts of data.
- a location where computing and networking equipment is used to collect, process, and store data, as well as to distribute and enable access to resources.

2 types of data centers

- Private-one company builds/owns/operates
- Commercial-The Cloud






August 2025
10,645 worldwide
Arctic Ocean
North Pacific Ocean
North Atlantic Ocean
South Pacific Ocean
South Atlantic Ocean
Indian Ocean
Svalbard
Toronto
New York
Chile
São Paulo
Perth
Sydney
Brisbane
Beijing
Niger
Yemen
Mauritania
283
4014
62
189
65
37
1
2
13
83
82
103
180
379
87
202
270
263
55
3,000 km
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100MW Berlin data center

Around €1 billion to develop the site complete with an on-site substation

China Telecom’s Inner Mongolia Information Park
150 MW, 10.7 million square feet

Yotta NM1 (Panvel, India)

250 MW

Utah Data Center (Utah, USA)
150,000 m^2, 65 MW, operated by NSA

Due to massive power surges during construction, the facility opened after a year's delay

Thailand data center situation

Reuters 17 March 2025

- Thailand has approved 90.9-billion-baht ($2.7 billion) worth of investments in data centers and cloud services,
- China's Beijing Haoyang Cloud&Data Technology- 300 MW
- Thai GSA Data Center O_2 -35 MW
- Singapore based Empyrion Digital
- TikTok announced plans, to set up a data hosting services valued at 126.8 billion baht, in Thailand.
- Google said it would invest $1 billion in Thailand,
- Amazon Web Services announcing a $5 billion investment over 15 years.
- Microsoft has also announced it will open its first regional data center in Thailand.

Energy Use in USA

Total U.S. data center energy use 2014-2028

This table shows estimated annual energy use in U.S. data centers from 2014 to 2028, measured in terawatt-hours and gigawatts, as well as the percentage of total annual electricity consumption in the U.S.

	Data center annual energy use	Percent of total annual U.S. electricity consumption
2014	60 TWh	<1.5%
2018	76 TWh	1.9%
2023	176 TWh	4.4%
2028	74-132 GW	6.7%-12%

26 Feb 2025
www.techtarget.com

Data Centers Energy Demands-USA

- There were 5,426 data centers nationally as of March 2025, and the number is skyrocketing. Collectively, these centers consumed about 17 gigawatts (GW) of power in 2022 (for context, a large nuclear power plant generates about 1 GW)
- Data centers' projected electricity demand in 2030 is set to increase to up to 130 GW (1,050 TWh), which would represent close to 12% of total U.S. annual demand.
- the Electric Power Research Institute (EPRI) estimates that data centers could consume up to 9% of U.S. electricity generation annually by 2030, up from 4.4% of total electricity demand in 2023.
- Forecasts from the U.S. Department of Energy indicate that data centers will consume as much as 580 TWh annually in 2028, translating to about 123 GW and representing up to 12% of total U.S. electricity consumption.

Environmental and Energy Study Institute, April 2025

Data Centers Need Own Power Supply,

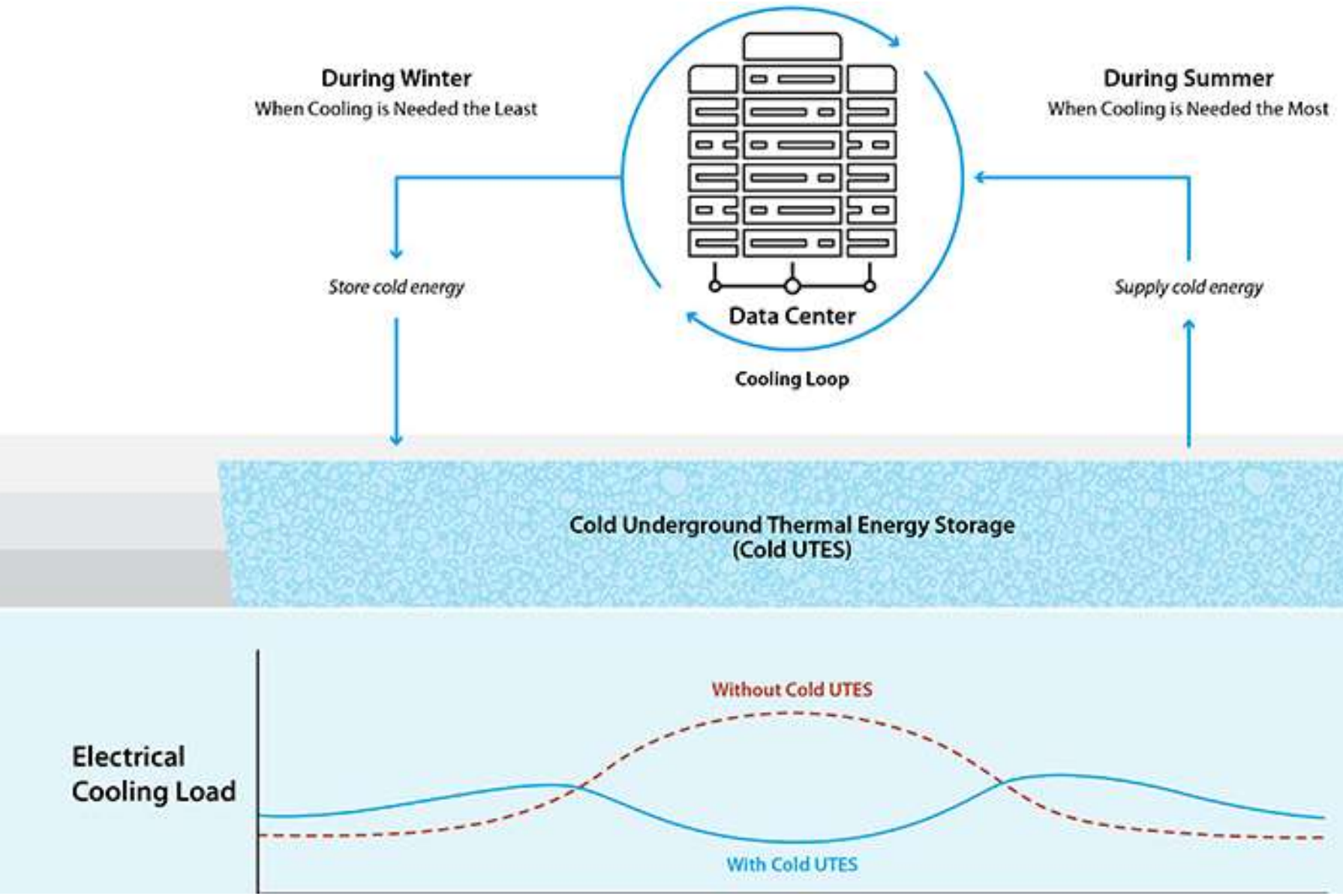
US Grid Watchdog Says

- the grid operated by PJM Interconnection LLC, stretching across 13 states from Virginia to Illinois, has no spare supply for new data centers and suggested developers build their own power plants
- Watchdog Monitoring Analytics LLC said it "recommends that large data centers be required to bring their own generation."
- The grid is home to the highest concentration of data centers whose soaring power demand has strained aging infrastructure, driven up costs for consumers and become a political flashpoint.
- "The current supply of capacity in PJM is not adequate to meet the demand from large data center loads and will not be adequate in the foreseeable future,"

Bloomberg, 15 Aug. 2025

Where does the energy go?

- As much as 40% of data center total annual energy consumption is related to the cooling systems, which can also use a great deal of water.
- Data centers typically cool computing equipment by blowing cold air over the components using a water-cooled fan coil or by directly cooling the computing equipment with cool water
- Cold Underground Thermal Energy Storage (Cold UTES) project offer a unique opportunity to reduce data center cooling loads while building more resilient infrastructure that creates a stable source of cooling—in turn reducing the need to build power plants to serve data center cooling loads


During Winter
When Cooling is Needed the Least
During Summer
When Cooling is Needed the Most
Store cold energy
Supply cold energy
Data Center
Cooling Loop
Cold Underground Thermal Energy Storage
(Cold UTES)
Electrical
Cooling Load
Without Cold UTES
With Cold UTES

Global energy demand 2015-2021

This table shows energy demand in data centers worldwide from 2015-2021, by type and in terawatt-hours.

Year	Traditional Data Centers	Cloud (Non-Hyperscale) Data Centers	Hyperscale Data Centers
2015	97.62	61.97	31.11
2016	83.72	70.33	41.21
2017	70.11	75.14	49.78
2018	60.55	76.27	60.87
2019	50.42	71.7	69.72
2020*	41	72.9	76.23
2021*	32.61	71.62	86.58

FUTURE ENERGY DEMAND USA

- An analysis of **U.S. data center energy** consumption in McKinsey & Company's Global Energy Perspective 2023 report shows

Year	Consumption (TWh)	% Total
2023	147	3.7
2027	371	8.0
2030	606	11.7

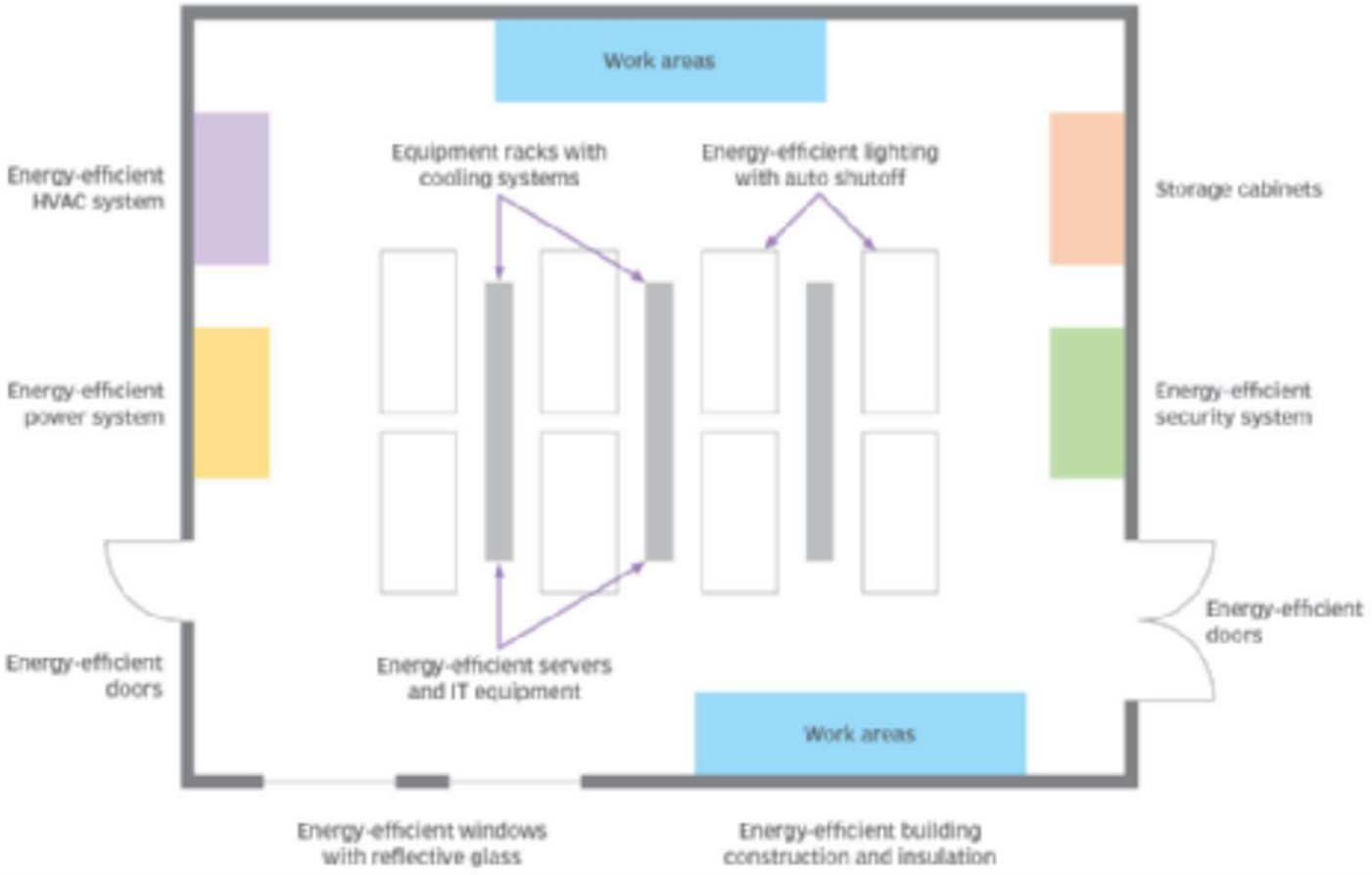
- the report estimates that AI could see data centers accounting for 2,500 to 4,500 TWh by 2050 for 5% to 9% of total **global** electricity demand.

Energy Control/Efficiency

- Energy efficient equipment
- Use renewable energy
- Efficient data storage and server power measures
- Eco-friendly data center buildings
- Data center site selection
- Infrastructure energy efficiency
- HVAC management
- Monitoring tools and lifecycle assessments
- Flexible operational strategies

Data center energy-efficiency activities

Data centers are implementing a variety of energy-efficient ideas and technologies to help them manage power consumption.



Too Much?

- Data center capital expenditures surged 53% year-over-year to $134 billion in the first quarter of 2025 alone.
- Meta is reportedly exploring a $200 billion investment in data centers,
- Microsoft has committed $80 billion for 2025.
- OpenAI, SoftBank, and Oracle have announced the $500 billion Stargate initiative. McKinsey projects that data centers will require $6.7 trillion worldwide by 2030.
- The average server utilization rate hovers between 12%-18% of capacity,
- An estimated 10 million servers sit completely idle, representing $30 billion in wasted capital. Even active servers rarely exceed 50% utilization
- the majority of our existing compute infrastructure is essentially burning energy while doing nothing productive

Fortune, 11 April 2025

Energy Consumption World-wide

Ranking	Location	Consumption (TWh/year)	Per capita (MWh per annum)
	World	29,664	3.67
1	China	9,443	6.64
2	United States	4,272	12.44
3	India	1,956	1.36
23	Thailand	224	3.13
3* (2030)	Data Centers (2030)	2,967	2.72
		Production (TWh/yr)	
Largest Nuclear PP, Kori, South Korea (7,489 MW)		65.6	
Need 45 of the largest nuclear power plants for data centers in 2030			

Countries 2023 Data

Fortune, 11 April 2025

The Future

- The Environmental Reckoning Data center energy consumption is projected to triple by 2030, reaching 2,967 TWh annually. Goldman Sachs estimates that data center power demand will grow 160% by 2030.
- While tech giants are purchasing entire nuclear power plants to fuel their data centers, cities across the country are hitting hard limits on energy capacity for new facilities

Fortune, 11 April 2025

Power Limitation

- Google wanted to build another data center in Dublin, Ireland, but has been denied
- The council reportedly wrote that Google did not provide enough detail on “how the proposal will impact the power supply once operational”
- It said that “the existing insufficient capacity in the electrical network and the lack of significant on-site renewable energy to power the data center” were reasons for refusal

Data Centers will be expensive to run

- 2,967 twh/year
- @3.99 Bt/kwh
- 1.18383E+14 Baht yearly electric bill
- 3.69948E+12 USD
- Thailand GDP 526.4 Billion USD
- Electric bill is 7.03 times Thailand's GDP

Data centers and the Environment

- The 176 terawatt-hours (TWh) consumed by U.S. data centers in 2023 represented 4.4% of total U.S. electricity consumption and emitted about 105 million metric tons of carbon emissions

Data Centers Inherent (lack of) Security

- Google sounds alarm after massive data breach leaves 2.5B users exposed. A cybercriminal group known as the ShinyHunters hacked a database in June 2025 of their accounts
- Facebook was breached August 2019 but did not notify over 530 million until April 2021. The data included phone numbers, full names, locations, some email addresses, and other details from user profiles.
- In November 2019, an attack hit Alibaba's Chinese shopping website Taobao, impacting more than 1.1 billion user's data
- in 2021, LinkedIn also fell victim to a data scraping breach. Affecting 700 million LinkedIn profile. The data, including email addresses, phone numbers, geolocation records, genders, and other social media details, was posted on a dark web forum in June of 2021.

Bloomberg, 15 Aug. 2025

Data Centers Inherent (lack of) Security Thailand

- TrueMove H Data Breach
- Saraburi Hospital Ransomware Attack
- 3BB and MONO Customer Data Breach
- Bangkok Airways Ransomware Attack
- Bhumirajanagarindra Kidney Institute Patient Data Theft
- CP Freshmart Customer Data Theft
- Central Restaurant Group Cyber Attack
- TCAS Student Data Leak - Over 23,000 students' personal data from the 2021 admissions process was sold on the dark web.
- 9near Hacker Incident - Hacker 9near sold personal data of 55 million Thai citizens, including sensitive identification details.

Summary

- Thousands of data centers now
- Thousands more coming
- Severely under used (max 12-18%)
- Data centers rank #3 worldwide for countries in terms of energy consumption
- Need 45 of the worlds biggest nuclear reactors in 2030 to power all the data centers
- Going to be a huge electric bill
- Multi-millions of tons of CO_2 will be emitted

Data Centers, QR Codes and other things that I don’t understand

- If 40% of op-ex is for cooling, why build data centers in the tropics?
  - $2.7 billion worth of investments in data centers and cloud services in Thailand
- Why don’t Google, Meta and Yahoo build a huge facility in the subarctic
  - Canada, Sweden, Norway
- Krispy Kreme doesn’t take cash
  - QR code-based payment system
- 7 / 11 is now officially an inconvenience store
  - QR code frustration, among other things