



CESI

Inspired with innovation

Data Center e rinnovabili: il ruolo delle reti elettriche

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December 10, 2025

Data Centers have captured significant attention recently...

THE WALL STREET JOURNAL.

12/2/2025 4:00:00 PM [Share This Episode](#)

China and the U.S. Are in a Race for AI Supremacy



The question everyone in AI is asking: How long before a GPU depreciates?

PUBLISHED FRI, NOV 14 2025•7:00 AM EST | UPDATED FRI, NOV 14 2025•11:19 AM EST

B B C

'I can't drink the water' - life next to a US data centre

10 July 2025



Mitigating the Public Health Impacts of AI Data Centers

by Shaolei Ren and Adam Wierman

November 5, 2025

The cost of compute: A \$7 trillion race to scale data centers

April 28, 2025 | Article

McKinsey & Company

Even at \$200/mo, Altman admits ChatGPT Pro struggles to turn a profit



Texas data center expansion raises blackout risk during extreme winter weather

PUBLISHED SAT, NOV 22 2025•8:10 AM EST



Big Tech's data center boom poses new risk to US grid operators

By Tim McLaughlin

March 20, 2025 2:52 AM GMT+1 · Updated March 20, 2025

FORTUNE

AI will take your job. Get over it

TSMC's 2nm Technology Almost Ready for Mass Production **embedded**

...and shows just how broad the topic really is



~~China and the U.S. Are in a Race for AI Supremacy~~



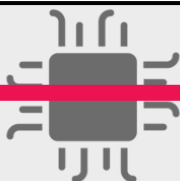
~~'I can't drink the water' - life next to a US data centre~~



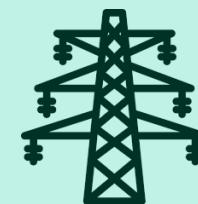
~~AI will take your job. Get over it~~



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~~TSMC's 2nm Technology Almost Ready for Mass Production~~

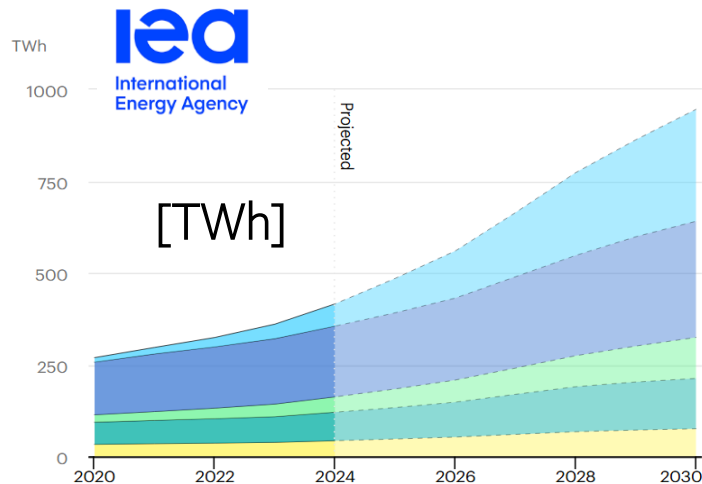
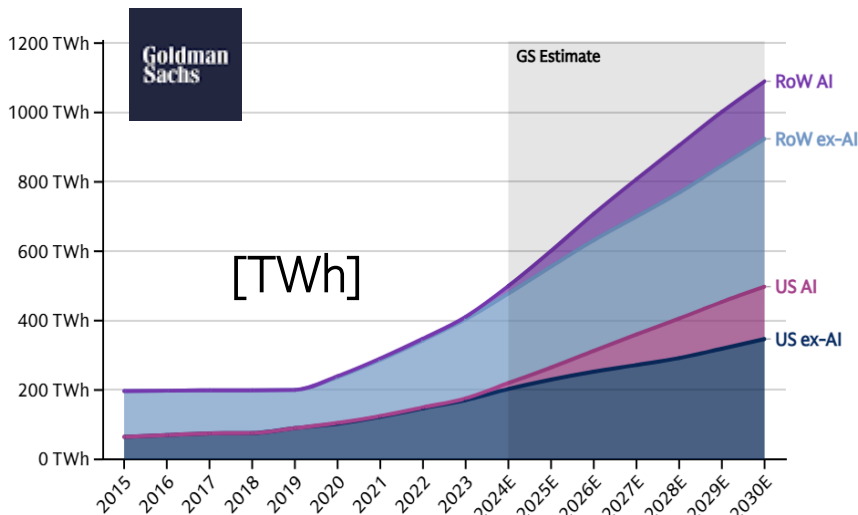


BUSINESS INSIDER

AI's next bottleneck
isn't just chips —
it's America's
power grid,
Goldman Sachs says

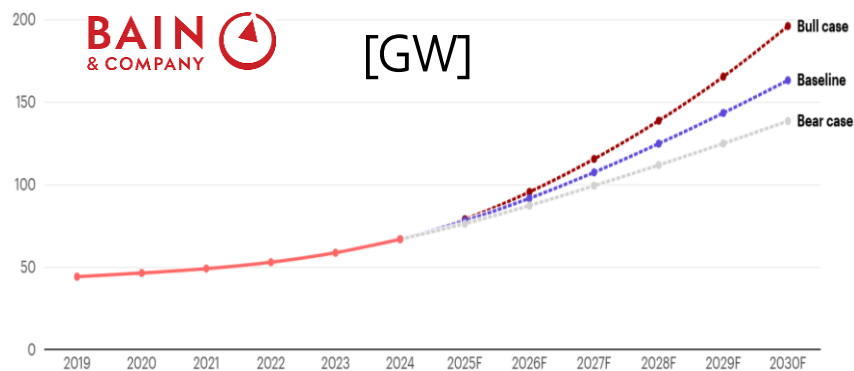


Global Data Center energy & capacity estimates 2025-2030⁽¹⁾

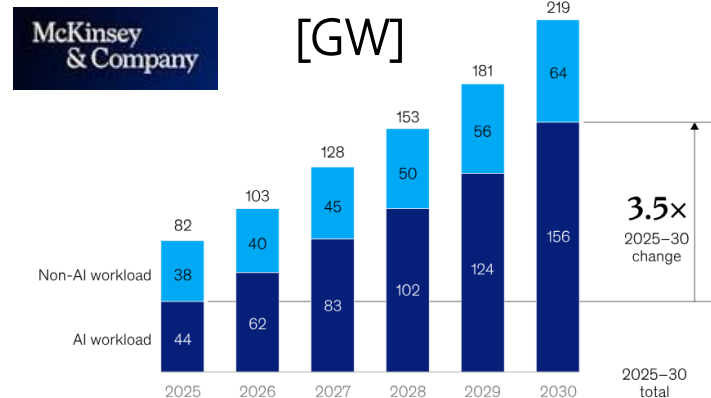


~1.000 TWh
Data Center
Energy Consumption
(2X vs 2025)

Global data center capacity forecast (gigawatts)



Estimated global data center capacity demand, 'continued momentum' scenario,



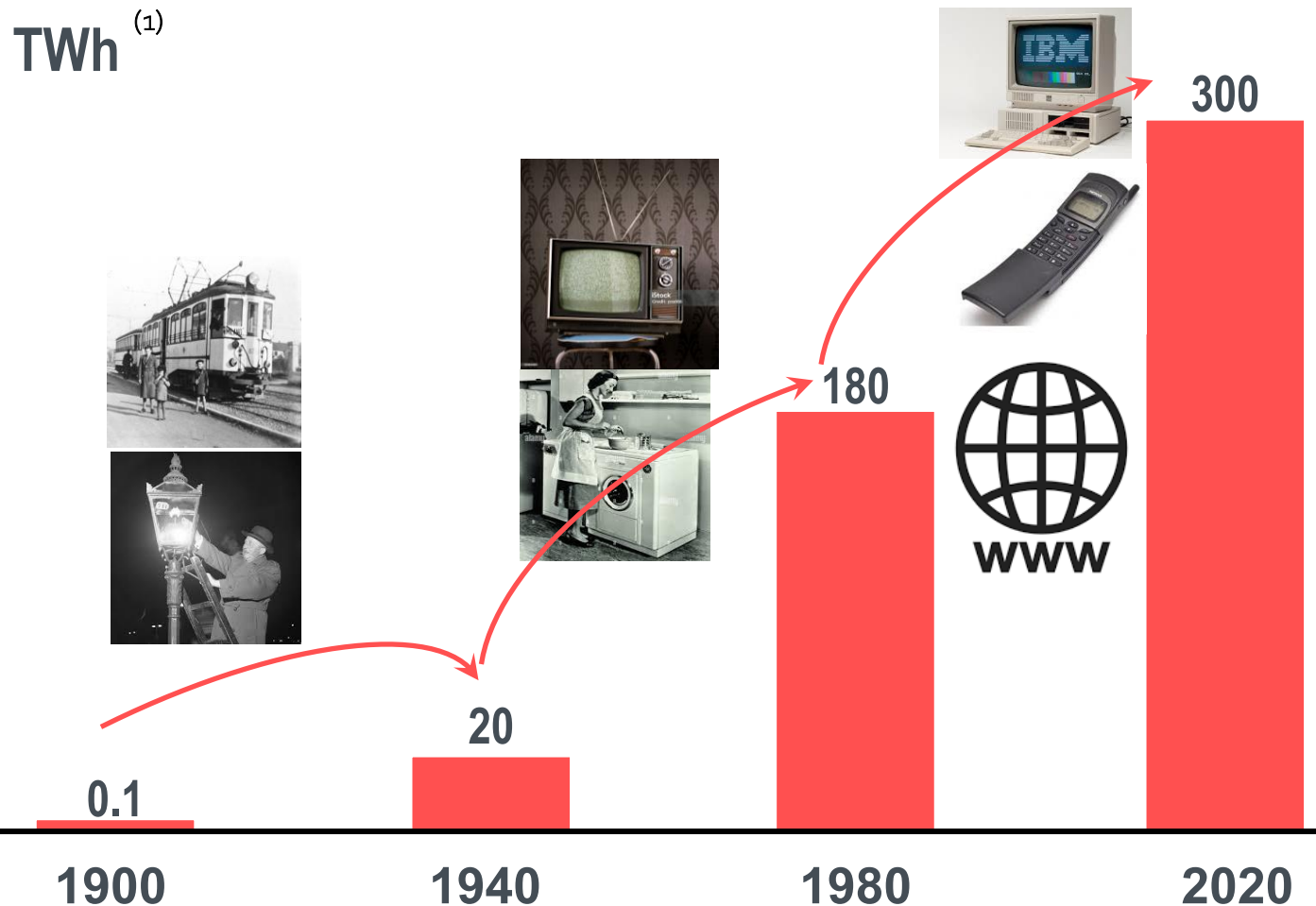
~200 GW
Data Center
Power Capacity



63+ GW
Connection requests
(as of 10/2025)

(1) Sources: Goldman Sachs, IEA, Bain & Company, McKinsey & Company, Terna, CESI elaboration

But not the first time we had to deal with increasing electrical load...



But why
penetration of
Data Centers
will pose so many
unprecedented
challenges to the
power system?

(1) Sources: ISTAT, Wikipedia, Terna, Treccani, CESI elaboration

#1

**Energy
Density**

#2

**Heat/Power
Ratio**

#3

**Reliability
Index**

Energy density and overall size can be significant

#1

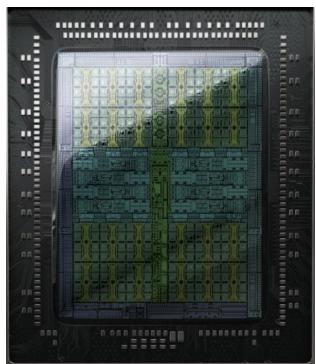
Energy
Density

#2

??

#3

???



Blackwell GPU

1 GPU
~600 W



72 GPUs⁽¹⁾
~100+ kW



50.000+ GPUs
40-60 MW



Stargate Project

0.5-1+ M GPUs
1+ GW

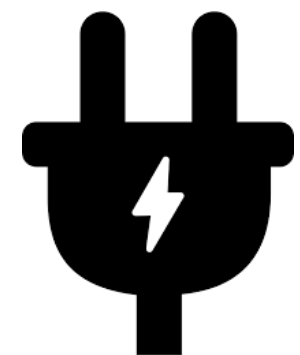
Issues

- Baseload generation (Nuclear? RES+Storage?)
- Optimal connection to very HV grid

(1) Source: NVIDIA, includes 72 GPU NVIDIA RTX PRO 6000 Blackwell and 36 CPUs

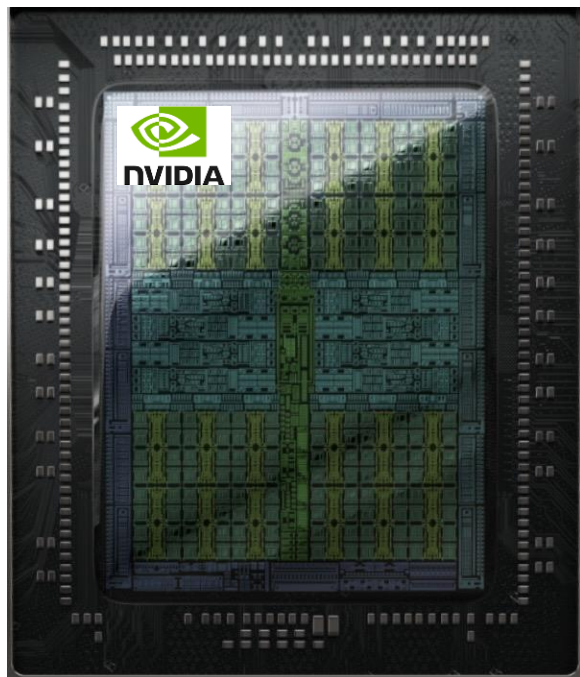
Over 99% of power is converted into heat

#1	#2	#3
Energy Density	Heat/Power Ratio	???



~600 W⁽¹⁾

Power from electrical grid



<1%

To display results on screen



~594 W

Heat generated



70-80 °C

GPU Operating temperature

Issues

- Air cooling vs liquid cooling
- Water availability
- Heat recovery systems

(1) Source: NVIDIA

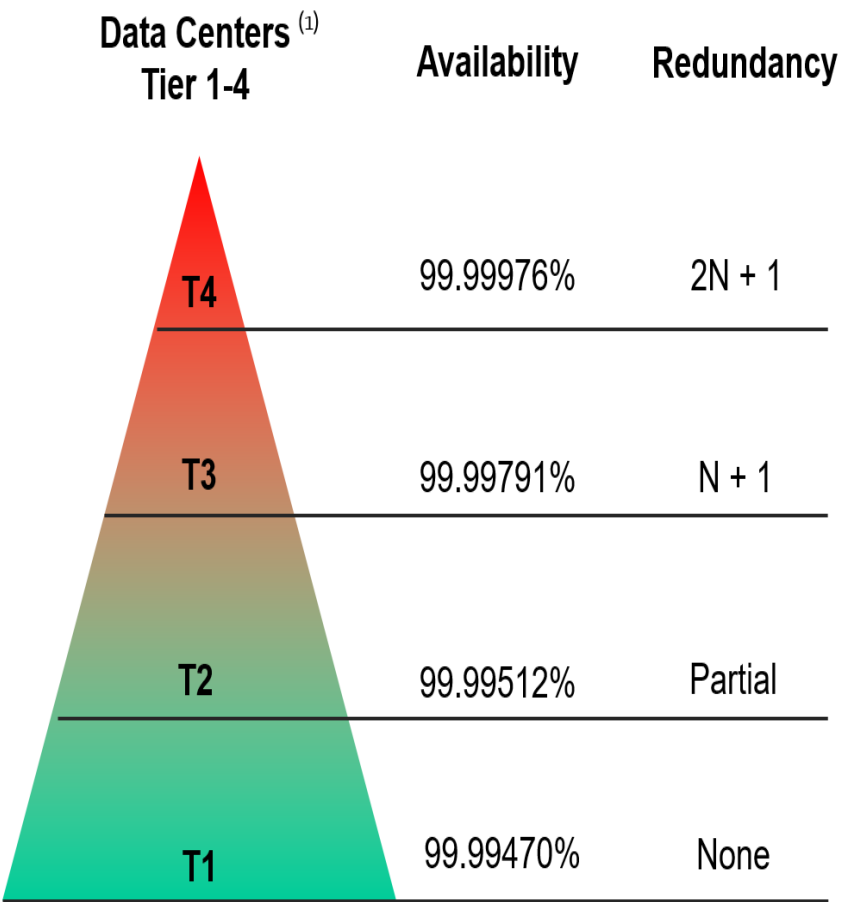
Data Centers reliability assessment can be very challenging

#1	#2	#3
Energy Density	Heat/Power Ratio	Reliability Index

Issue

- Will a Data Center built in a specific location meet a specific reliability index?

40+ risk factors to consider!



1. Human Error

- Incorrect switching operations affecting one or two feeders.
- Multiple human-error events during plant reconfiguration.
- Control room evacuation due to toxic cloud or fire affecting operator actions.
- Gunshots damaging insulators on HV lines.
- Jet-water streams accidentally directed onto overhead lines.
- Terrorist attacks on transmission line pylons or substations.
- Aircraft impact due to pilot error or misnavigation on lines or substations.

2. Mechanical & Electrical Failures

- Internal transformer failures.
- Transformer explosion or fire, including domino-effect propagation.
- Failure of one supply line during maintenance of the other.
- Failure of busbars (including structural collapse or common-mode failure).
- Failure of RTN lines (mechanical or electrical faults).
- Failure of the second line while the first is out of service.
- Failure of the second busbar while the first is out of service.
- Failure of switching devices or protection systems.
- Untimely operation of the bus differential protection.

3. External Events (Natural Hazards)

- Tornado hitting:
 - The electrical station (categories F0-F5).
 - The power plant.
 - The RTN lines feeding the plant.
- Severe wind or mechanical stress on lines.
- Lightning striking two RTN lines (long outage >3 min).
- Lightning striking two RTN lines (momentary outage <3 min).
- Seismic:
 - Earthquake at the design-basis level.
 - Earthquake exceeding design-basis level (beyond-design-basis events).
- Other Environmental Hazards:
 - Fire in adjacent facilities requiring control-room evacuation.
 - Toxic cloud requiring evacuation.
 - Heavy-vehicle impact on substation structures.

4. External Events (Man-Made)

- Terrorist attack on substation equipment.
- Terrorist attack on transmission line pylons.
- Aircraft impact on:
 - RTN line busbars.
 - RTN lines feeding the island mode.
 - RTN lines feeding the non-island mode.
- Accidental impact of heavy machinery or trucks inside substation perimeter.

5. Grid / System-Level Failures

- Complete blackout of the RTN grid (general system blackout).
- Failure of two RTN lines supplying the plant (common-mode).
- Failure of natural gas supply feeding the combined-cycle units, causing loss of generation.
- Failure of successful islanding transition by the dedicated generator when external RTN lines are lost.

6. Maintenance-Related Risks

- Planned maintenance causing temporary single-line operation and increasing vulnerability to coincident faults.
- Forced outage of one line combined with random failure of the second line

(1) Source: IEEE - Review of Data Centers Energy Consumption and Reliability Modelling, CESI

Reliability study: 40+ risk factors included

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(1) Source:CESI

Thank you for your attention!



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