Natural Language Processing

Environmental cost of chatbots

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The environmental cost of cloud-based AI

- Like many other AI-based technologies, chatbots are typically offered as “ethereal” cloud services.
- However, training and using chatbots has a concrete and negative impact on the environment.

  energy, water, carbon emissions

- Many individuals find it hard to connect their use of AI with their personal climate goals.

Electricity consumption

Verma and Tan (2024)

Estimated energy consumption of ChatGPT
when generating a 100-word email

single person once	single person once weekly for a year	10% of Sweden's workforce once weekly for a year
0.14 kWh	7.5 kWh	3 900 000 kWh
powering 14 LED light bulbs for one hour	powering a family home for 10 hours	powering 650 family homes for one year

Water consumption

Verma and Tan (2024)

Estimated water consumption of ChatGPT
when generating a 100-word email

single person once	single person once weekly for a year	10% of Sweden's workforce once weekly for a year
519 ml	27 l	14,600,000 l
1 bottle of water	1.4 water jugs (as used in a water cooler)	285 people's water consumption for one year

LLM life cycle analysis

- A complete assessment of the environmental cost of chatbot technology over its full lifecycle is difficult.
- Most data is available on equipment manufacturing, model training, and model deployment.

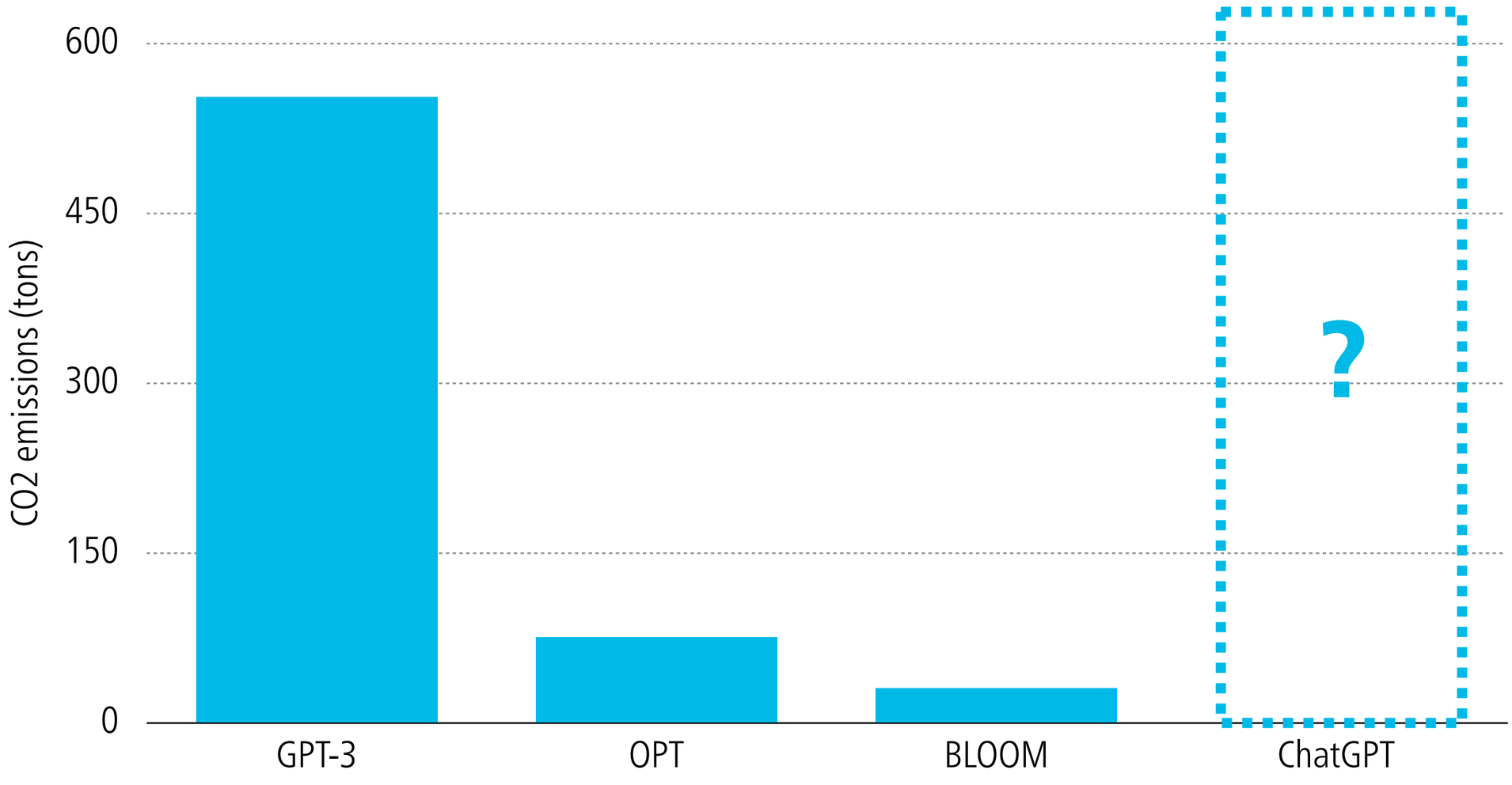
Luccioni et al. (2022)

Training the BLOOM model

Number of parameters	176B
Total training time	118 days, 5 hours, 41 minutes
Total GPU time	1,082,990 hours
Total energy used	433,196 kWh
Carbon emissions (incl. PUE)	30 tonnes

Luccioni et al. (2022)

Carbon emissions during training



Luccioni et al. (2022)

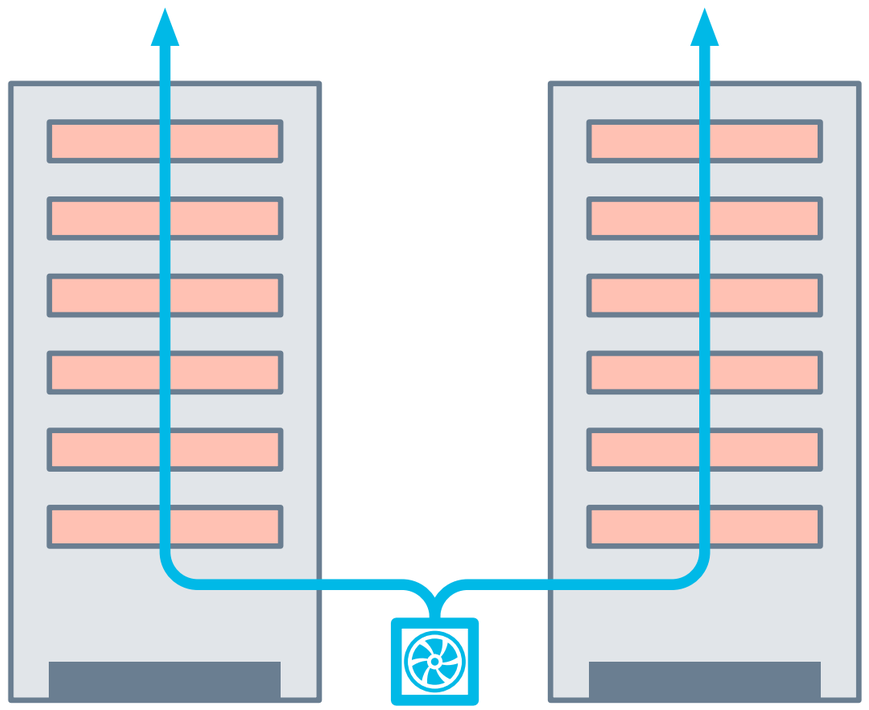
Source: Official Microsoft Blog (2025-09-18)

Top 5 largest data centres worldwide

Name	Location	Size	Power installed
China Telecom – Inner Mongolia	Hohhot, China	994,000 m^2	150 MW
Switch – The Citadel (Tahoe Reno Campus)	Nevada, USA	669,000 m^2	650 MW
Harbin Data Centre (China Mobile)	Harbin, China	660,000 m^2	200 MW
Range International Information Hub	Langfang, China	585,000 m^2	150 MW
Switch – "SuperNAP" (Las Vegas Core Campus)	Nevada, USA	325,000 m^2	495 MW

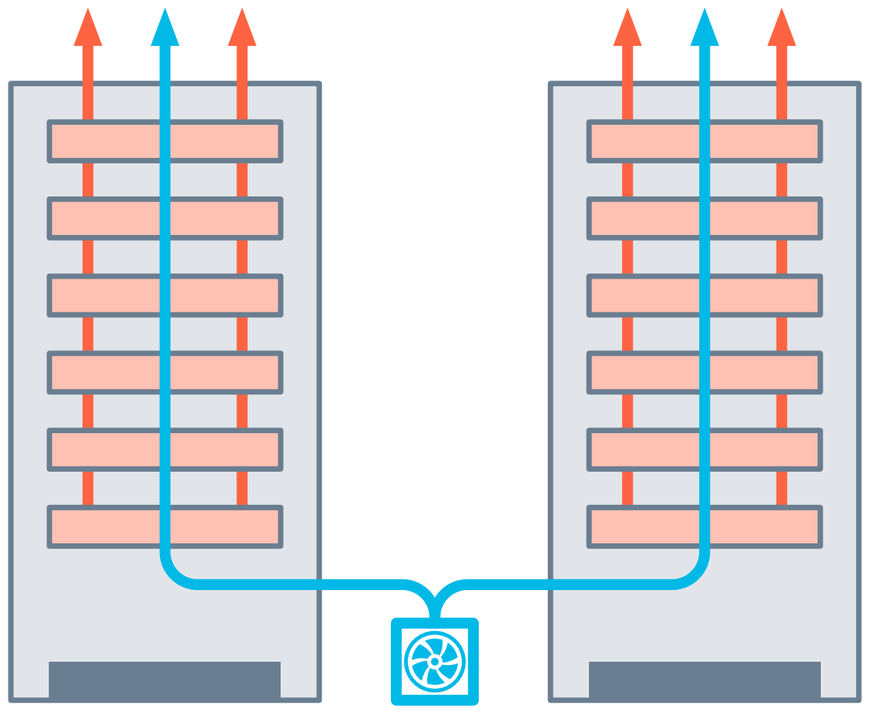
Source: Datum (2025-08-20)

Air cooling



uses fans and air conditioning to move cool air in and hot air out

Air cooling



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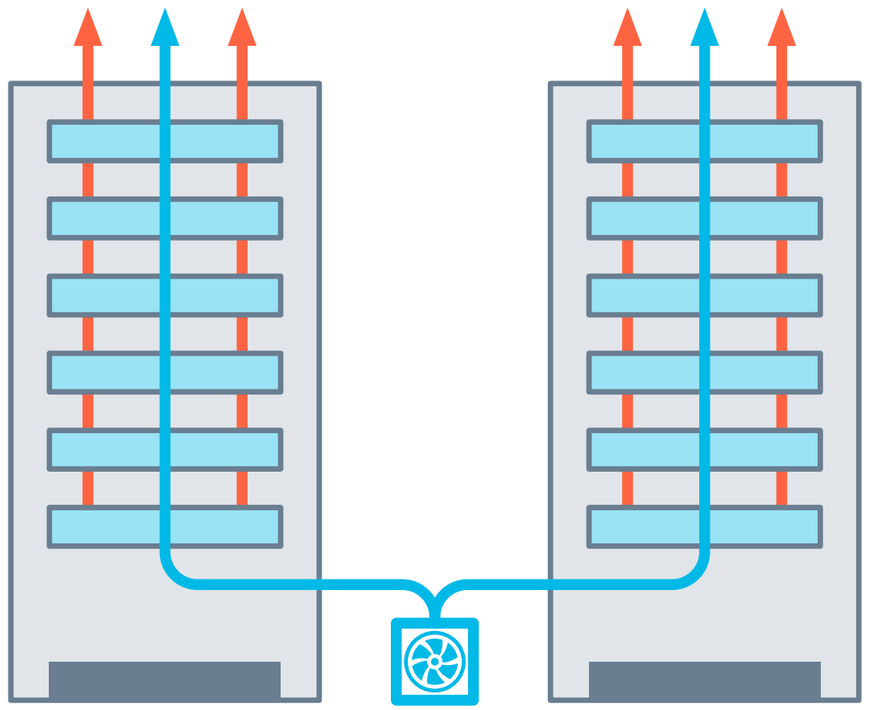

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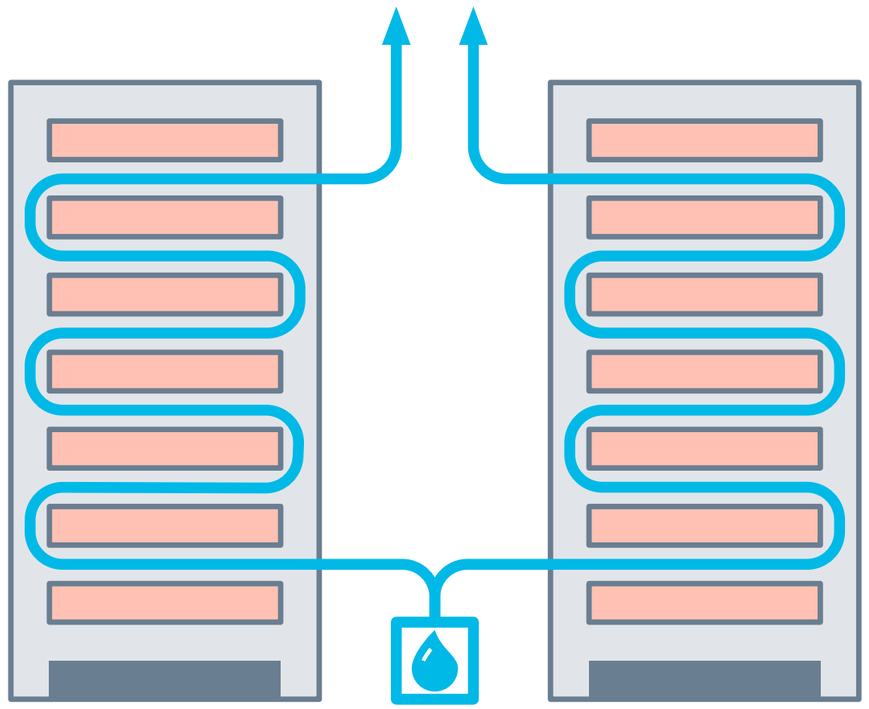
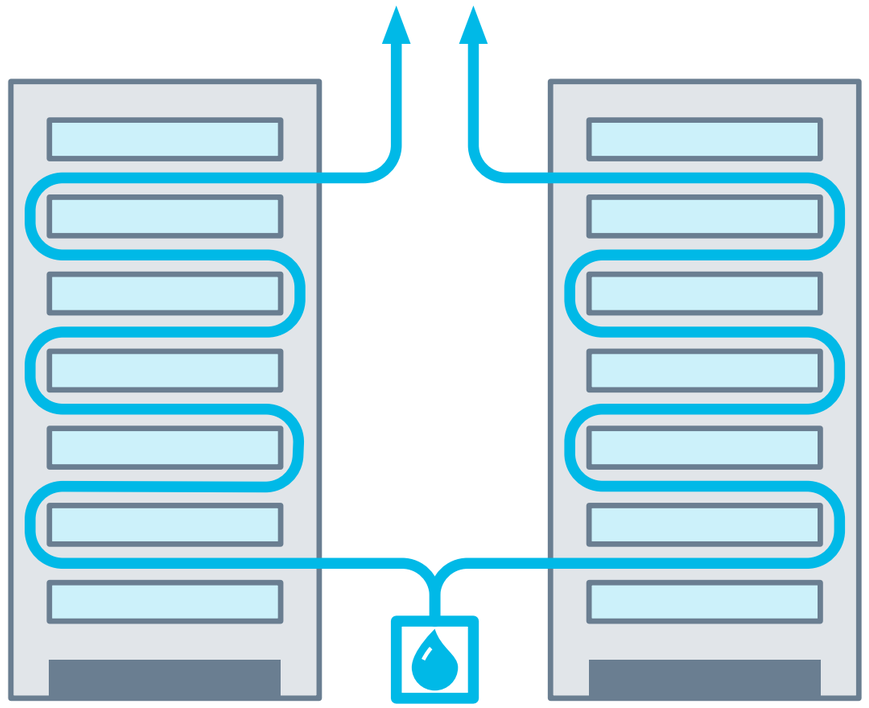
Liquid cooling



uses liquid to absorb the heat from the servers and carry it away

Liquid cooling



uses liquid to absorb the heat from the servers and carry it away

Key performance indicators

- **Power Usage Effectiveness (PUE)**

  is the ratio of the energy used by the data centre to the energy delivered to the computing equipment

  ISO standard

- **Water Usage Effectiveness (WUE)**

  is the ratio of the data centre's water consumption (m^3) to the energy delived to the computing equipment (MWh)

Resource effectiveness of European data centres

Country	Power installed	Total energy consumption	Total water consumption	PUE (Power)	WUE (Water)
Sweden	350.7 MW	1.1 TWh	43,465 m^3	1.14	0.04
Finland	313.4 MW	1.4 TWh	7,591 m^3	1.16	0.01
Germany	2.6 GW	5.4 TWh	5,870,093 m^3	1.40	1.43

EC Public Dashboard – 2024 Data

Summary

- Cloud-based technology is abstract for most users but has a concrete and negative impact on the environment.
- For chatbots in particular, training and deployment requires substantial amounts of electrical energy and water.
- There is currently no comprehensive reporting on resource consumption and environmental consequences.

Interventions

- **Technical interventions** that make AI models less resource-intensive, such as quantisation or distillation
- **Behavioural interventions** such as users choosing task-specific models or tools not powered by AI where possible
- **Organisational interventions** such as opting for compute solutions powered by renewable energy
- **Policy interventions** such as enforcing transparency regarding the environmental cost of the technology

[Google] has claimed that it's been carbon neutral in its operations since 2007. […] But in its latest report, the company states: "Starting in 2023, we're no longer maintaining operational carbon neutrality."

Rathi (2024)