Environmental Impact of Artificial Intelligence

Felipe Restrepo

Department of IT, Phoenix Community College

CIS475: Emerging Trends in Information Technology

Professor Brad Olsen

December 14, 2025

Artificial Intelligence has seen exponential growth in the past decade, bringing many positive benefits to the world, and proving to be extremely profitable. However, this rapid advancement also raises important considerations regarding its environmental impact and long-term sustainability.

How Does AI impact the environment

Majority of AI models used by private businesses or open web interfaces like ChatGPT and Google Gemini, run their models on servers within datacenters, these servers configured for AI responses have incredibly powerful processors, that require much larger amounts of energy than the traditional computer to provide quick answers. As a result, the amount of energy needed to power these data centers place a huge demand on local power plants, that often have environmental consequences.

Energy Consumption

As the demand for AI grows, data center energy consumption grows with it. In 2018, the combined U.S. data center consumption was estimated to be 76 TWh accounting for 1.9% of total annual U.S. energy consumption (Shehabi et al., 2024).[15] By 2023, the combined consumption was estimated to be 176 TWh accounting for 4.4% of total U.S. energy consumption.[15] This jump between 1.9% to 4.4% of total U.S. energy consumption presents unprecedented growth unseen in pre-2018 development. It is this exponential growth in energy consumption that creates concern.

Previously before 2016 data center growth throughout the U.S. was still increasing year over year.[15] The difference, however, was that data center growth was much slower, and advancements in infrastructure optimization helped reduce energy consumption at the individual level within a rate that kept the combined energy consumption almost the same as it was in 2014.[15] Failure to maintain this relationship between the two key variables is what has now led to this exponential growth in energy consumption that creates concern. Though data centers such as google claim they are continuously optimizing their datacenters, it is no doubt that the immense demand we see today far surpasses the ability to optimize, creating that concerning jump from 1.9% to 4.4% of total U.S. energy consumption previously mentioned. This number is proof that if demand does not drop to accommodate the rate of optimization, then consequences will follow.

Demand for AI

To provide some references on the actual demand, it's worth looking at one of the most common current day uses of AI, which involves text-based prompts through open web interfaces such as chatgpt.com. The following statistic come from a paper referenced on openai.com published by "OpenAI's Economic Research Team". Here the paper claims that, "By July 2025, 18 billion messages were being sent each week by 700 million users, representing around 10% of the global adult population" (Chatterji et al., 2025).[4] 18 billion messages a week can be averaged to 2.57 billion messages a day (18 / 7 ≈ 2.57). A number that closely matches the daily average estimated by many other sources such as theverge.com,[16] axios.com,[1] and demandsage.com.[18] Additionally, we can use the estimate of 0.34 Wh provided by Sam Altman in one of his blogs[2] to calculate the total combined energy consumption of users on chatgpt.com per day. (0.34 Wh x 2.5 billion = 0.85 billion Wh = 0.85 GWh). A number that closely matches the daily average estimated by Washingto.edu[10] of 1 GWh equivalent to 33,000 U.S. households.

To add to this impact, last year google began replacing that answer box seen at the top of users search results with what is now called an "AI Overview". That answer box used to be referred to as a "Google Snippet" which was the result of Google's search engine algorithms' to choose the source that most directly answered the search query/question. Google would then place this result on top, enlarging and bolding the text that most aligned with the search query. Though these google snippets did also require processing power from a datacenter just like AI prompts, the workload and respective environmental impacts were much smaller. To determine this one could compare Google's statement on energy use for a single search query from 2009 to their statement on Gemini's median text-prompt energy use from August 2025. However, given how much the recent article on Gemini's estimation took into account modern efficiency methods to both processing and infrastructure, it seems only fair that this number be compared to a more recent estimation of how much energy a traditional search query would use if executed on the same ultra-efficient infrastructure google now claims to use. In a paper titled "Estimating the Increase in Emissions caused by AI-augmented Search",[19] Wim Vanderbauwhede dives deep into the calculations of a more appropriate estimate given the increase in processing efficiency over the past decade. He calculates that the, ". . . new estimate for energy consumption and the carbon footprint of a Google search is 0.00004 kWh and 0.02 g CO_2 (using carbon intensity for the US)" (Vanderbauwhede, 2025).[19] Now when you compare that to the recent Gemini text prompt estimation from google of 0.24 Wh[3] (equal to 0.00024 kWh) this shows that AI Overviews dependent on Gemini prompts may consume 6 times more energy than the traditional search query would use. Even with this optimistic estimate (as many other sources estimate much higher consumption numbers for AI prompts) it is clear how this can have a substantial impact on the environment when billions of search queries that did not previously rely on AI processing, are now using Gemini to provide these AI overviews.

Another concerning topic is the use of video models and their current accessibility. Models like OpenAI's Sora, and Google's Veo 3 are now open to the public for free at no cost to the individual user. Though the free versions have their limits these models still allow users to create videos of up to 10 seconds with high quality graphics and sound. To put into perspective the implications this has on energy consumption, a 2025 research study on measuring the energy consumption of different AI applications, shows an "average costs of ∼0.002 Wh for text classification, 0.047 Wh for text generation, and 2.9 Wh for image generation." (Luccioni et al., 2025). "By comparison, generating a single short video with WAN2.1–T2V–1.3B consumes nearly ∼90 Wh" (Delavande et al., 2025).[6] This makes video generation roughly 2,000 times more energy demanding than text generation (90 Wh / 0.047 Wh ≈ 1,915), with hundreds of people now using these intensive models everyday making fantasy movie clips, and silly videos of personified cats. This accessibility makes it extremely attractive to users that may have no idea of the respective energy demands of these models.

Water Consumption

In addition to the power draw and carbon emission, there is also another critical environmental issue with the growing development of data centers. As data center expansion exponentially increases along with processing workloads and server density within these data centers, better methods of cooling are required. Often this involves the switch from air cooling to liquid cooling. The issue is that these data centers are tapping into local fresh water sources, and often lose a percentage of the water in evaporation throughout the cooling process. To put some numbers into perspective on how datacenter development in the past few years has impacted water consumption we can look at the direct water consumption from 2014, where data centers consumed 21.2 billion liters of water, with 64% consumed in internal data centers. By 2023, data centers consumed 66 billion liters of water, with 12% consumed by internal data centers and 84% by hyperscale and colocation -- rented/off site -- (Shehabi et al., 2024).[15] To make matters worse the efficiency of some of the new hyperscale data centers is actually going down as measured by the Water Usage Efficiency (WUE) score where 0.00 (WUE) is the optimal score. The report states that, "The shift toward hyperscale and colocation data centers results in an increase in the overall average WUE," Where in 2023 the average WUE was 0.36 L/kWh , and by 2024 the average WUE was 0.45-0.48 L/kWh (Shehabi et al., 2024).[15]

However, even though direct water consumption for cooling remains a concern and generally the focus of most discussions today, the biggest consumption of water lies in the water consumed by powerplants needed to generate the energy used by datacenters. "U.S. data centers consumed approximately 176 TWh in 2023. The total indirect water footprint of U.S. data centers is nearly 800 billion liters, attributed to water consumed indirectly through electricity use, based on the regional electricity grid mix for U.S. data center locations" (Shehabi et al., 2024).[15] This point is further proven by a presentation[17] given by Austin Shelnutt, previous lead engineer and now CEO of Strategic Thermal Labs, who explains why moving away from evaporative cooling within datacenters to drive water consumption down, would do the opposite. He explains that the physical properties of evaporative water cooling make it an uncontested method for large scale data centers. By switching to alternative methods of cooling such as special coolant liquids, closed loop systems, and dry air displacement methods, the costs and energy requirements skyrocket in comparison to evaporative cooling. This places higher energy demand at the power plant consuming a disproportionately larger amount of water compared to the use of evaporative cooling directly on site. (Shelnutt, 2024)[17]

When looking at the full picture of the side effects these data centers have, it starts to become clear how most attempts to remove or mitigate these effects only displace them within other issues. Though science and engineering may continue to bring solutions that allow us to somewhat accommodate the growth in development, the most powerful solution remains in the hands of the everyday consumer. The solution being to **reduce demand**.

Conclusion

In modern times people are starting to use AI tools in place of everyday tools such as search engines, calculators, knowledge libraries etc. Powerful energy intensive video models are incredibly accessible to consumers, allowing thousands of people to create silly videos without a clue of the energy demands they're responsible for. AI is advertised constantly and AI companies continue to push the idea that everything is better with AI in it, further fueling this partially false demand that keeps investment going. This partially false demand has become so profitable that these companies can often afford to bypass legal regulations and shut down environmental concerns that impede development, leading to: displacements of our resources leaving gaps that don't get filled; overallocation causing crises and blackouts; increased utility costs for residential communities; destruction of ecosystems;[11] and increased effects on global warming. For these reasons it is important that we play our part in mitigating the causes that drive these issues, by taking action in our local communities towards regulating data center growth, and most of all by reducing the demand we give them as consumers.

References

[1]Allen, M. (2021, July 21). *Altman plans D.C. push to "democratize" Ai economic benefits*. Axios. https://www.axios.com/2025/07/21/sam-altman-openai-trump-dc-fed

[2]Altman, S. (2025, June 10). *The gentle singularity*. Sam Altman. https://blog.samaltman.com/the-gentle-singularity

[3]Amin Vahdat, A., & Jeff Dean, J. (2025, August 21). *How much energy does Google's AI use? We did the math*. Google Cloud Blog. https://cloud.google.com/blog/products/infrastructure/measuring-the-environmental-impact-of-ai-inference/

[4]Chatterji, A., Cunningham, T., Deming, D., Hitzig, Z., Ong, C., Shan, C., & Wadman, K. (2025, September). *How people use chatgpt*. NBER. http://www.nber.org/papers/w34255

[5]Chow, A. R. (2025, August 13). *Inside Memphis' battle against Elon Musk's Xai Data Center*. Time. https://time.com/7308925/elon-musk-memphis-ai-data-center/

[6]Delavande, J., Pierrard, R., & Luccioni, S. (2025, September 23). *Video killed the energy budget: Characterizing the latency and power regimes of open text-to-video models*. arXiv.org. https://doi.org/10.48550/arXiv.2509.19222

[7]EPRI. (2024, May 28). *Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption*. EPRI. https://www.epri.com/research/products/3002028905

[8]Hölzle, U. (2009, January 11). *Powering a google search*. Official Google Blog. https://googleblog.blogspot.com/2009/01/powering-google-search.html

[9]Luccioni, A. S., Viguier, S., & Ligozat, A.-L. (2022, November 3). *Estimating the carbon footprint of bloom, a 176B parameter language model*. arXiv.org. https://arxiv.org/abs/2211.02001

[10]McQuate, S. (2023, July 27). *Q&A: UW researcher discusses just how much energy CHATGPT uses*. University of Washington. https://www.washington.edu/news/2023/07/27/how-much-energy-does-chatgpt-

use/#:~:text=Overall%2C%20this%20can%20lead%20to,for%20these%20types%20of%20computation.

[11]Miller, C., Brooke, N., & Harlan, W. (2025, November 13). *Petition Seeks Endangered Species Protection for Imperiled Alabama Fish Proposed Data Center Would Destroy Remaining Habitat, Pollute Rural Community*. Black Warrior Riverkeeper. https://blackwarriorriver.org/birmingham-darter-petition/

[12]Offutt, M. C., & Zhu, L. (2025, August 26). *Data Centers and their energy consumption: Frequently asked questions*. congress.gov. https://www.congress.gov/crs-product/R48646

[13]OpenAI. (2025, September 15). *How people are using CHATGPT*. OpenAI. https://openai.com/index/how-people-are-using-chatgpt/

[14]Petersen, M. (2024, August 12). *Power-hungry AI data centers are raising electric bills and blackout risk*. Los Angeles Times. https://www.latimes.com/environment/story/2024-08-12/california-data-centers-could-derail-clean-energy-goals

[15]Shehabi, A., Newkirk, A., Smith, S., Hubbard, A., Lei, N., Siddik, M., et al. (2024). *2024 United States Data Center Energy Usage Report*. Lawrence Shehabi et al., 2024 National Laboratory. Retrieved from https://doi.org/10.71468/P1WC7Q

[16]Roth, E. (2025, July 21). *OpenAI says chatgpt users send over 2.5 billion prompts every day*. The Verge. https://www.theverge.com/news/710867/openai-chatgpt-daily-prompts-2-billion

[17]Shelnutt, A. (2024, December 4). *Ending the War on Water for Data Center Cooling*. YouTube. https://youtu.be/0YlB5-j1wD0?si=UyM938YdFZnkkcQS

[18]Singh, S. (2025, December 3). *CHATGPT users stats (December 2025) - growth & usage data*. DemandSage. https://www.demandsage.com/chatgpt-statistics/

[19]Vanderbauwhede, W. (2025, January 6). *Estimating the increase in emissions caused by AI-augmented search*. arXiv.org. https://doi.org/10.48550/arXiv.2407.16894

[20]Yañez-Barnuevo, M. (2025, June 25). *Data Centers and water consumption*. Environmental and Energy Study Institute (EESI). https://www.eesi.org/articles/view/data-centers-and-water-consumption

Endnotes

[1] Allen, M. (2021, July 21). Altman plans D.C. push to "democratize" Ai economic benefits. Axios. https://www.axios.com/2025/07/21/sam-altman-openai-trump-dc-fed
[2] Altman, S. (2025, June 10). The gentle singularity. Sam Altman. https://blog.samaltman.com/the-gentle-singularity
[3] Amin Vahdat, A., & Jeff Dean, J. (2025, August 21). How much energy does Google's AI use? We did the math. Google Cloud Blog. https://cloud.google.com/blog/products/infrastructure/measuring-the-environmental-impact-of-ai-inference/
[4] Chatterji, A., Cunningham, T., Deming, D., Hitzig, Z., Ong, C., Shan, C., & Wadman, K. (2025, September). How people use chatgpt. NBER. http://www.nber.org/papers/w34255
[5] Chow, A. R. (2025, August 13). Inside Memphis' battle against Elon Musk's Xai Data Center. Time. https://time.com/7308925/elon-musk-memphis-ai-data-center/
[6] Delavande, J., Pierrard, R., & Luccioni, S. (2025, September 23). Video killed the energy budget: Characterizing the latency and power regimes of open text-to-video models. arXiv.org. https://doi.org/10.48550/arXiv.2509.19222
[7] EPRI. (2024, May 28). Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption. EPRI. https://www.epri.com/research/products/3002028905
[8] Hölzle, U. (2009, January 11). Powering a google search. Official Google Blog. https://googleblog.blogspot.com/2009/01/powering-google-search.html
[9] Luccioni, A. S., Viguier, S., & Ligozat, A.-L. (2022, November 3). Estimating the carbon footprint of bloom, a 176B parameter language model. arXiv.org. https://arxiv.org/abs/2211.02001
[10] McQuate, S. (2023, July 27). Q&A: UW researcher discusses just how much energy CHATGPT uses. University of Washington. https://www.washington.edu/news/2023/07/27/how-much-energy-does-chatgpt-use/#:~:text=Overall%2C%20this%20can%20lead%20to,for%20these%20types%20of%20computation
[11] Miller, C., Brooke, N., & Harlan, W. (2025, November 13). Petition Seeks Endangered Species Protection for Imperiled Alabama Fish Proposed Data Center Would Destroy Remaining Habitat, Pollute Rural Community. Black Warrior Riverkeeper. https://blackwarriorriver.org/birmingham-darter-petition/
[12] Offutt, M. C., & Zhu, L. (2025, August 26). Data Centers and their energy consumption: Frequently asked questions. congress.gov. https://www.congress.gov/crs-product/R48646
[13] OpenAI. (2025, September 15). How people are using CHATGPT. OpenAI. https://openai.com/index/how-people-are-using-chatgpt/
[14] Petersen, M. (2024, August 12). Power-hungry AI data centers are raising electric bills and blackout risk. Los Angeles Times. https://www.latimes.com/environment/story/2024-08-12/california-data-centers-could-derail-clean-energy-goals
[15] Shehabi, A., Newkirk, A., Smith, S., Hubbard, A., Lei, N., Siddik, M., et al. (2024). 2024 United States Data Center Energy Usage Report. Lawrence Shehabi et al., 2024 National Laboratory. Retrieved from https://doi.org/10.71468/P1WC7Q
[16] Roth, E. (2025, July 21). OpenAI says chatgpt users send over 2.5 billion prompts every day. The Verge. https://www.theverge.com/news/710867/openai-chatgpt-daily-prompts-2-billion
[17] Shelnutt, A. (2024, December 4). Ending the War on Water for Data Center Cooling. YouTube. https://youtu.be/0YlB5-j1wD0?si=UyM938YdFZnkkcQS
[18] Singh, S. (2025, December 3). CHATGPT users stats (December 2025) - growth & usage data. DemandSage. https://www.demandsage.com/chatgpt-statistics/
[19] Vanderbauwhede, W. (2025, January 6). Estimating the increase in emissions caused by AI-augmented search. arXiv.org. https://doi.org/10.48550/arXiv.2407.16894
[20] Yañez-Barnuevo, M. (2025, June 25). Data Centers and water consumption. Environmental and Energy Study Institute (EESI). https://www.eesi.org/articles/view/data-centers-and-water-consumption