Artificial Intelligence and Data Centers

The term artificial intelligence (AI) describes systems or tools capable of executing tasks that are usually associated with human intelligence, such as decision making, learning, and problem-solving across different environments.[1] AI's foundational research was conducted by Marvin Minsky, John McCarthy, and Alan Turing.[1] AI models have been able to assert some level of intelligence since 1966.[1,2,3,4] AI is not a single tool or model, but rather a collection of tools with unique performance and emission profiles.

Terms Associated with Artificial Intelligence

- **Machine learning (ML)** is a subfield of AI where the system can create models based on data (i.e., learn).[1]
- **Deep learning** is used to describe a family of ML models that typically take the form of biologically inspired neural networks.[1]
- **Generative AI (GenAI)** models can create new data such as text, images, and videos, building on data that they have been trained on.[5]
- **Large language models (LLMs)** can comprehend and generate natural language to accomplish diverse tasks such as text classification, sentiment analysis, and conversation.[6]
- **Agentic AI** builds on GenAI techniques to accomplish a specified goal with limited supervision.[7]

AI innovation has accelerated rapidly, with global AI patents surging 8.2% from 2023 to 2024 and increasing more than 33-fold since 2010.[8] Estimates of water, energy, and GHG impacts are sensitive to chip architecture,[9] model type,[10,11] prompt length,[10,12] output data length,[10,12] data center cooling,[13] time of day,[10] and electricity mix.[10] Most companies do not directly report impacts from model training or utilization.[10] AI has potential to help solve difficult sustainability challenges, but with the recent introduction of GenAI, energy demands and GHG consequences of training and running AI models have grown dramatically, creating a sustainability trade-off.[14,15,16]

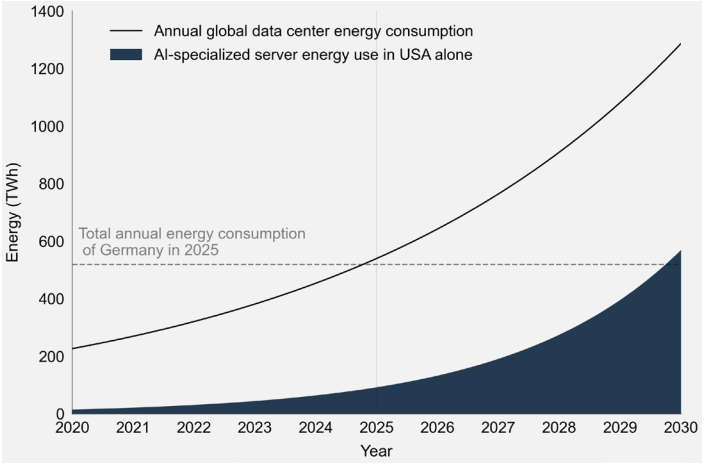
Patterns of Use

- In 2025, 31% of Americans reported interacting with AI multiple times a day and 15% engaged with AI once a day.[17] In 2024, only 17% of Americans believed that AI would have a positive effect on the country, while nearly half were unsure or thought that the effect would be equally positive and negative.[18] These feelings were consistent regardless of political affiliation.[19]
- At least 17% of U.S. companies use AI for general business functions.[20]
- AI is having a significant impact on healthcare by enhancing diagnostics, patient interaction, drug development, and medical reasoning.[21,22] Studies have shown that AI can match or surpass human experts in image-based diagnoses.[21] In 2022, researchers had modeled just 0.1% of known proteins critical to drug development, when a model predicted structures for over 200 million proteins, accelerating the discovery by a factor of 45,000.[23]

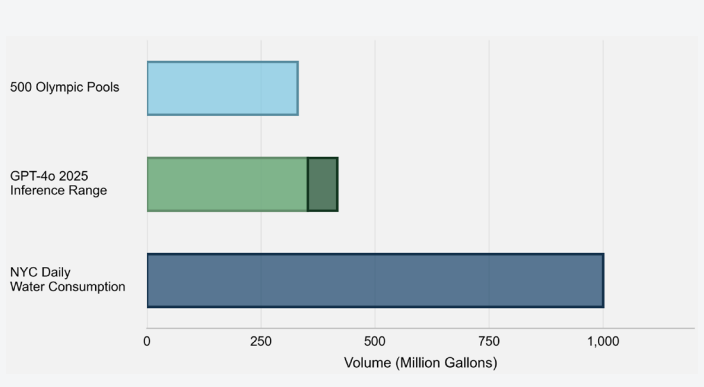
Data Centers

- U.S. data centers produced 1-5 Mt CO_2e over 12 months between 2023 and 2024, equivalent to 2.18% of U.S. total emissions. U.S. data centers emit 48% more CO_2e per unit of electricity than the U.S. average. This is due in part to their location in areas with high carbon intensities.[24]
- Research suggests that over half of recent data center load growth may be attributed to AI (specifically ML).[25] However, AI's energy use currently represents only a small portion of technology sector demand and an estimated 0.01% of global annual GHG emissions in 2024.[15] By 2028, global AI energy consumption could equal 22% of U.S. household use.[26]
- The U.S. hosts 10x more data centers than any other country.[8]
- At the local and regional level, AI data centers can cause major transmission,[27,28] electricity price,[10,27,29] land use,[28,30] water use,[31] pollution,[30,32] and grid reliability[27] concerns.
- Since 2022, two-thirds of U.S. data center construction has been in water-stressed regions.[30]
- Energy use occurs during training as well as utilization. Training new models requires high energy use, but this can be eclipsed by demand for inference—the process of generating responses—at high deployment scale.[33]
- Training ML models is orders of magnitude more energy- and carbon-intensive than each inference.[33] Research indicates that although a training run can require the equivalent energy of hundreds of millions of inferences,[33] this one-time training impact can be eclipsed by the ongoing inference impact from widespread deployment of ML models.[10,33]

Share of AI in Data Center Energy Consumption[34,35,36]



Estimated 2025 Water Consumption for GPT-4o Inference[37,38,39]

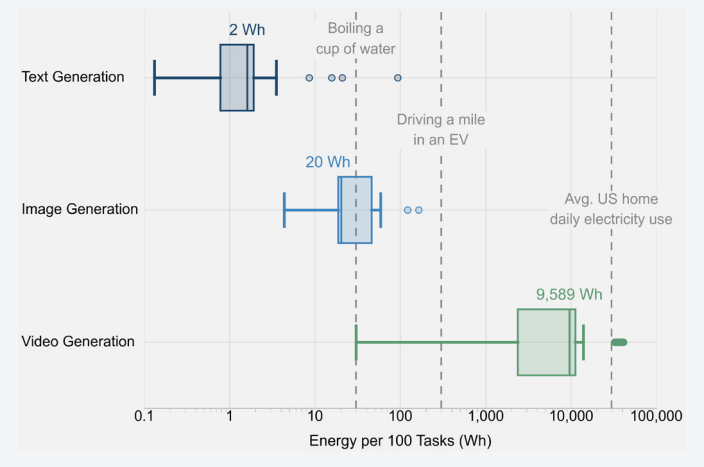


- Generative AI requires substantial computing power, using significantly more energy than task-specific software—up to 33 times more per task, particularly in areas like text classification (e.g., email spam filtering) and question answering (domain-specific chatbots).[33] For example, each ChatGPT request is estimated to use 2.9 Wh of electricity, ten times the 0.3 Wh used for a standard Google search.[40]
- The energy consumed by a given ML model depends on the model size, which is represented by the number of parameters that are fitted during the training process.[10] There can be trillions of parameters for the most complex models.[8,10]
- AI's environmental impact may be geographically disproportionate. Google's data center in Finland operated on 97% low-carbon energy in 2022, but its data centers in Asia used 4–18% low-carbon energy.[46]
- Data centers employ 25 to 150 people per facility.[30]

AI-Driven Sustainability

- By processing large datasets, such as weather and energy use patterns, AI can forecast wind energy production and energy demand with high accuracy.[47,48] The IEA estimates that widely implemented AI could bring annual savings of $110B by 2035 through grid balancing, lowering operating costs, and predicting power plant maintenance.[23]
- ML can also improve energy use estimation for large communities and was, for example, used to evaluate the energy use of New York City's 1.1 million buildings and create a building efficiency ranking.[49,50,51] AI-enabled HVAC and building energy management systems have led to electricity savings of up to 10% in communities in Sweden and India.[23,52,53] The IEA predicts that, by 2035, AI solutions could save more than 100 TWh/year in non-residential buildings and between 30-40 TWh/year in residential buildings.[23]
- In agriculture, AI can be used for smart irrigation control (optimization of water usage), crop disease detection, and automation of afforestation.[25,51]
- AI can improve wildfire and drought predictions.[54,55]

Energy Use of LLMs (Wh/100 Inferences)[40,41,42,43,44,45]



Sustainable AI Practices

- Sustainable AI is the design and utilization of AI systems that prioritize minimizing lifecycle environmental impacts. Methods include choosing the smallest model that meets the requirements and tuning rather than training a new model.[26]
- Some experts argue that the term "sustainable AI" has been overused and that an application of AI cannot be considered fully "sustainable" if the model is not running on renewable energy.[16]
- Switching from diesel backup generators to battery energy storage systems can reduce pollution.[30]
- Lagging regulatory oversight of AI has enabled unrestrained AI implementation without adequate environmental or societal accountability. In some cases, perceived benefits of AI might be used to justify limited regulation or delay more sustainable alternatives.[14]
- There are many applications of AI that can be impactful, but there are also areas where it is either ineffective or even counterproductive.[14] AI is widely used to accelerate fossil fuel exploration and extraction, and some models consume substantial energy during training and operation, contributing to emissions.[51]
- Advancements in both commercial and open-source AI models have introduced techniques to enhance energy efficiency while reducing computational and memory demands without sacrificing performance.[25] However, these increases in efficiency do not necessarily reduce total AI energy use due to rebound effects and the Jevons paradox (efficiency increases reduce costs, which in turn leads to increased use).[14,15]
- While tools for measurement of AI model energy use have been developed and are readily available,[41] sharing of these energy data remains one of the biggest bottlenecks for accurate estimation and prediction of AI effects on sustainability.[10,14]

Cite as: Center for Sustainable Systems, University of Michigan. 2026. "Artificial Intelligence Factsheet." Pub. No. CSS25-22. July 2026
Sources for this factsheet are here, help with units and abbreviations is here.