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AI's Environmental Footprint: From Risk to Responsible Innovation

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INTRODUCTION

Generative AI's rapid expansion drives rising electricity and water use, as well as carbon emissions.

Training and running AI models use significant computational resources and cooling water.

Sources:
https://news.mit.edu/2025/explained-generative-ai-environmental-impact-0117

https://www.technologyreview.com/2025/05/20/1116327/ai-energy-usage-climate-footprint-big-tech/

Data Centers and Electricity Demand

AI drives increasing data center electricity use, projected to reach 12% of U.S. total by 2028.

Many data centers still rely heavily on fossil fuels, raising emissions concerns. Renewable adoption is growing but uneven across regions.

Community resistance is growing (water, noise, grid strain) – e.g. McCalla, Alabama.

Sources:

https://www.weforum.org/stories/2025/06/how-ai-use-impacts-the-environment/

https://news.mit.edu/2025/explained-generative-ai-environmental-impact-0117

https://unherd.com/2025/08/the-small-town-alabamians-resisting-a-data-centre/

Carbon Footprint of AI Models

According to various sources, the CO2 emissions of a single query to ChatGPT ranges from 2.5 to 5 grams.

Industry estimates suggest that each generative AI query uses 4-5 times more energy than a standard search engine query.

At scale, millions of queries accumulate to a vast carbon footprint, though efficiencies are being noted with more recent large language models.

Sources:
https://www.arbor.eco/blog/ai-environmental-impact
https://arstechnica.com/ai/2025/08/google-says-it-dropped-the-energy-cost-of-ai-queries-by-33x-in-one-year/
https://smartly.ai/blog/the-carbon-footprint-of-chatgpt-how-much-co2-does-a-query-generate
https://services.google.com/fh/files/misc/measuring_the_environmental_impact_of_delivering_ai_at_google_scale.pdf

Traditional Data Center AI vs Edge Computing

Edge computing moves AI tasks closer to users via local devices.

Edge reduces data center load but increases overall grid demand (in the aggregate) as well as e-waste concerns.

Hardware upgrade cycles accelerate consumer waste generation which must be addressed in a responsible manner.

Source:

https://www.cdotrends.com/story/4207/choking-ais-toxic-e-waste-legacy

Electronic Waste from AI Hardware

AI hardware demand intensifies global electronic waste growth.

AI-related e-waste expected to increase by fivefold by 2030.

Challenges include recycling scarcity and toxicity from rare earth metals.

Focus on sustainable hardware design and circular economy principles.

Source:

https://www.datacenterknowledge.com/green-materials/ticking-time-bomb-ai-data-centers-and-the-looming-e-waste-crisis
https://www.cnet.com/tech/mobile/google-lg-lenovo-modular-phones/

The Policy Landscape: Holding AI Accountable for its Footprint

California AB 222 (2025) – mandates energy use reporting by data centers.

Growing calls for corporate and developer transparency on AI's energy and water usage; the Brookings Institution and others have highlighted major current gaps in public reporting.

Sources:

https://legiscan.com/CA/text/AB222/

https://www.brookings.edu/articles/as-energy-demands-for-ai-increase-so-should-company-transparency/