# AI & Energy Use:
# Context, Scale, and Justice

*Updated with current research — May 2025*

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## The Bottom Line

AI uses energy — but it is not one of the world's biggest energy consumers. What makes AI energy use worth watching is not its current scale, but **how fast it's growing, where it shows up, and who bears the costs.**

### How Big Is the AI Energy Footprint, Really?

Data centers — which host all cloud computing, streaming, email, and AI — currently account for about 1.5% of global electricity consumption (roughly 415 TWh in 2024, per the IEA). AI is a subset of that. To put that in perspective:

> 🍔 **The Cheeseburger Comparison:** A single quarter-pound cheeseburger requires roughly 7–20 megajoules of energy to produce (including growing feed, processing, and refrigeration) — that's approximately 2,000–5,500 watt-hours. A typical AI prompt uses about 0.3 watt-hours (Epoch AI, 2025). That means one cheeseburger contains the embedded energy of roughly **7,000–18,000 AI prompts.** *The podcast stat of '1,000 prompts' was actually quite conservative.*

- One AI text prompt (e.g., ChatGPT, Claude): **~0.3 watt-hours** — equivalent to running a 10-watt LED bulb for 2 minutes (Epoch AI, Feb 2025; OpenAI CEO Sam Altman, Apr 2025)
- One hour of Netflix streaming: **~77–240 watt-hours** — equivalent to 250–800 AI text prompts (IEA, 2020 analysis)
- One Google search (circa 2009): **~0.3 watt-hours** — similar to a modern AI query, per Google's own disclosure
- One quarter-pound cheeseburger (lifecycle energy): **~2,000–5,500 watt-hours** — equal to 7,000–18,000 AI prompts
- Global data centers (including AI): **~1.5% of global electricity in 2024** (IEA), projected to reach ~3% by 2030 — with AI growing to ~35–50% of that share

**A note on estimates:** Energy per AI query has dropped significantly as models become more efficient. Early 2023 estimates pegged ChatGPT at ~3 Wh per query (10× a Google search). By

2025, Epoch AI's analysis and OpenAI's CEO both put typical queries at ~0.3 Wh — a 10× improvement. Longer or image-heavy prompts use more; simple text exchanges use less.

## Where AI Fits in the Global Energy Picture

If global electricity use were divided by sector:

| Sector | Approx. Share | Notes |
|---|---|---|
| 🏭 Heavy industry (steel, cement, chemicals) | **~38% of final energy** | Largest single driver of global energy demand |
| 🏠 Buildings (residential + commercial) | **~30–35% of final energy** | Heating, cooling, lighting, appliances |
| 🚗 Transportation | **~25–30% of final energy** | Mostly oil-based; electrification underway |
| 🖥️ All data centers (cloud, streaming, AI, email) | **~1.5% of electricity (~415 TWh, 2024)** | AI is a growing subset of this; not a separate category |
| 🧠 AI specifically | **Subset of data centers; ~0.1–0.2% of global electricity** | Fast-growing but currently small in absolute terms |

*Sources: IEA World Energy Outlook 2024; IEA Energy and AI Report 2025; Epoch AI (2025)*

## Why AI Energy Use Still Deserves Scrutiny

### 1. Growth Trajectory Matters

The IEA's 2025 Energy and AI report projects data center electricity demand will roughly double by 2030 (to ~945 TWh), with AI growing from ~5–15% of data center load today to ~35–50% by 2030. That's a significant trajectory — even if today's totals are modest.

### 2. Energy Source Matters More Than Energy Amount

Two identical AI queries can have radically different climate footprints. A prompt processed in Iceland (geothermal) vs. West Virginia (coal) may differ by 50× in carbon emissions while consuming the same electricity. Grid mix is the variable that matters most.

### 3. Energy Burdens Are Unevenly Distributed

Data centers are often sited where electricity is cheap, regulation is lighter, and communities have less political leverage — leading to grid strain, local electricity price increases, and pollution concentrated in already overburdened communities. This is a governance issue, not an inherent AI problem.

### 4. AI Gets Attention Because It's New, Not Because It's Worst

We scrutinize AI energy intensely while largely normalizing:

- Private aviation: A single transatlantic private jet flight uses ~70,000–100,000 kWh — equivalent to 230,000–330,000 AI text prompts
- Crypto mining: Bitcoin mining used ~120–140 TWh in 2024 — roughly 30% of all global data center electricity
- Inefficient buildings: Residential and commercial buildings consume ~30–35% of all final energy globally
- Industrial agriculture: Food systems account for roughly 30% of global greenhouse gas emissions

***AI didn't create the energy crisis. It walked into one already in progress.***

## The Counterintuitive Part: AI as an Energy Solution

AI is also being deployed to reduce energy consumption system-wide, including:

- Grid optimization: Google's DeepMind reduced data center cooling energy by 40% using AI — now applied to other industrial systems
- Renewable forecasting: AI dramatically improves wind and solar generation forecasts, enabling better grid integration
- Industrial efficiency: AI-driven process optimization reduces energy waste in steel, cement, and chemical manufacturing
- Climate science: AI accelerates climate modeling that would otherwise take years of supercomputer time
- Building efficiency: AI-managed HVAC systems routinely cut energy use by 15–30% in commercial buildings

*AI can increase energy demand locally while reducing it system-wide — if governed responsibly. The critical variable is not whether AI exists, but who controls it, where it's powered, and toward what ends.*

# Annotated Source List

## ⚡ Per-Query Energy & Comparisons

### 1. Epoch AI — How Much Energy Does ChatGPT Use?

*Epoch AI, February 2025* — https://epoch.ai/gradient-updates/how-much-energy-does-chatgpt-use

**Why it matters:** The most rigorous 2025 analysis of per-query energy. Finds ~0.3 Wh per typical GPT-4o query — 10× less than the widely-cited 2023 estimate. Explains exactly why earlier figures were inflated. Ideal for audiences who've seen alarming headlines.

### 2. IEA — Energy and AI (2025 Report)

*International Energy Agency, 2025* — https://www.iea.org/reports/energy-and-ai

**Why it matters:** The gold-standard authoritative report on AI's energy trajectory. Projects data center demand doubling to ~945 TWh by 2030, with AI growing to 35–50% of data center load. Essential for any policy or advocacy audience.

### 3. IEA — Carbon Footprint of Streaming Video

*International Energy Agency, 2020* — https://www.iea.org/commentaries/the-carbon-footprint-of-streaming-video-fact-checking-the-headlines

**Why it matters:** Peer-reviewed debunking of inflated streaming energy figures. Puts streaming at 77–240 Wh/hour — the basis for the '1 hour Netflix = 250–800 AI prompts' comparison. Shows how energy comparisons require careful methodology.

## 🌍 Global Energy Context

### 4. IEA — World Energy Outlook 2024

*International Energy Agency, 2024* — https://www.iea.org/reports/world-energy-outlook-2024

**Why it matters:** Sector-by-sector breakdown of global energy use. Confirms data centers at ~1.5% of global electricity. Indispensable for the 'AI vs. everything else' framing.

### 5. Our World in Data — Energy Production and Consumption

*Our World in Data (regularly updated)* — https://ourworldindata.org/energy

**Why it matters:** Best publicly available visualizations for sector-level comparisons. Excellent for presentations and non-specialist audiences. Fully transparent about data sources (IEA, BP, Ember).

## 🍔 Cheeseburger & Lifestyle Energy Comparisons

### 6. Lifecycle Energy of a Cheeseburger (Stockholm University / Swiss Federal Institute of Technology)

*Ulf Sonesson & Christel Cederberg, 2000 — via Open the Future* — http://www.openthefuture.com/2006/12/the_footprint_of_a_cheeseburge.html

**Why it matters:** The original lifecycle analysis finding 7–20 MJ of energy per cheeseburger. Forms the basis of the '7,000–18,000 AI prompts per cheeseburger' comparison. The underlying study is peer-reviewed; the blog provides accessible context.

### 7. AI Energy Use in Everyday Terms

*Marcel Salathé, Substack, 2024* — https://engineeringprompts.substack.com/p/ai-energy-use

**Why it matters:** Excellent accessible explainer comparing AI energy use to LED bulbs, kettles, car rides, and streaming. Good for audiences unfamiliar with watt-hours. Grounded in the same Epoch AI data.

## 🔍 AI Environmental Overviews

### 8. Carbon Brief — AI: Five Charts Putting Data Centre Energy Use Into Context

*Carbon Brief, 2024* — https://www.carbonbrief.org/ai-five-charts-that-put-data-centre-energy-use-and-emissions-into-context/

**Why it matters:** Five clear charts comparing AI energy to other sectors. Scientifically rigorous, journalist-friendly. Strong on the importance of grid mix and the difference between energy use and carbon emissions.

### 9. Wikipedia — Environmental Impact of Artificial Intelligence

*Wikipedia (well-sourced synthesis, continuously updated)* — https://en.wikipedia.org/wiki/Environmental_impact_of_artificial_intelligence

**Why it matters:** Useful neutral overview with primary citations. Good jumping-off point for audiences wanting a balanced summary without industry spin.

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*Prepared for environmental nonprofit use. Statistics reflect best available data as of May 2025. Energy figures are approximate and vary by model, query length, and data center efficiency. Always cite primary sources when presenting to scientific audiences.*