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U.S. Hyperscale Data Centers Emit Over 52 Million Tons of CO2 Annually as COP31 Launches Clean AI Pledge

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A new Harvard University study published in Nature Sustainability reveals that the 403 largest hyperscale data centers in the United States already consume more than 2.1 percent of the nation's total electricity and release over 52 million tons of carbon dioxide (CO 2) in a single year -- more annual greenhouse gas than the entire country of Denmark. Released alongside international climate negotiations at the United Nations COP31 summit in Antalya, Turkey, the findings arrived just as negotiators unveiled a voluntary "Clean AI Pledge" aimed at curbing the energy, water, and carbon footprint of rapid artificial-intelligence expansion.

Crucially, the Harvard researchers built their baseline from satellite imagery and U.S. Environmental Protection Agency (EPA) grid records captured before the newest wave of ultra-large AI training clusters came fully online. That means current and near-term electricity demand -- and associated smokestack pollution -- is poised to climb substantially unless data-center operators shift to zero-carbon power.

What Satellite and Grid Data Reveal About Hyperscale Pollution

Because technology companies rarely publish facility-by-facility power and emissions breakdowns, tracking data-center pollution has long relied on rough industry estimates. To overcome that transparency gap, the Nature Sustainability team combined high-resolution satellite imagery of physical data-center campuses with local electrical-grid fuel-mix data from the EPA.

Across the 403 major U.S. hyperscale facilities analyzed, nearly 60 percent of the electricity powering their servers and cooling systems still came from fossil-fuel power plants, primarily natural gas and coal . A separate 2026 National Bureau of Economic Research (NBER) working paper by Carnegie Mellon University economist Nicholas Z. Muller evaluated roughly 2,800 operational U.S. data centers and estimated about $25 billion in gross external damages from localized air pollution and greenhouse gases, with impacts heavily concentrated in high-growth hubs such as Texas and Virginia.

| Environmental Metric | | Observed U.S. Baseline (2026 Studies) | | Policy / Grid Implication |

| Hyperscale Facilities Analyzed | | 403 major U.S. campuses (Nature Sustainability) | | Baseline predates full wave of next-gen AI scaling |

| National Electricity Share | | >2.1% of total U.S. electricity consumption | | Nearly 60% generated from fossil-fuel sources |

| Annual Carbon Emissions | | >52 million tons of CO 2 per year | | Exceeds annual national emissions of Denmark |

| Broader Air & Climate Damages | | ~$25 billion across ~2,800 facilities (NBER) | |

Concentrated in grid hubs like Texas and Virginia |

Inside the COP31 Clean AI Pledge

Against that backdrop of rising power demand, delegates at the COP31 climate talks introduced the voluntary Clean AI Pledge. The framework invites national governments and technology firms to commit to powering AI and cloud data centers with verifiable clean electricity -- such as wind, solar, or other low-emission generation -- while tightening disclosure standards for both electricity and cooling-water consumption.

A central focus of the pledge is emissions accounting integrity. Climate negotiators and independent researchers have warned that long-term "net-zero" pledges or unbundled carbon offsets can obscure real-time smokestack pollution when fossil-fuel plants are kept running or restarted to meet round-the-clock data-center loads. The Clean AI Pledge pushes instead for transparent, facility-level reporting of present-day emissions.

Why Grid Cleanliness Determines AI's Climate Footprint

Data centers require continuous, uninterrupted electricity 24 hours a day to run high-density computer chips and remove waste heat. When new campuses plug into regional grids powered largely by fossil fuels , every additional megawatt of computing capacity translates directly into higher carbon dioxide and local air-pollutant emissions -- including fine particulate matter and nitrogen oxides that affect nearby communities.

Pairing the new empirical satellite baselines with transparent reporting under initiatives like the Clean AI Pledge gives grid planners and policymakers clearer visibility into where computing growth is straining fossil-heavy power networks -- and where clean-energy siting can decouple artificial intelligence from rising climate pollution.

References & Primary Sources

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