Carbon Literacy for Generative AI: Visualizing Training Emissions Through Human-Scale Equivalents

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NEURAL INFORMATION PROCESSING SYSTEMS

AIXPERT

The Problem

State-of-the-art models consume hundreds of megawatt-hours of electricity for just production. This energy releases alarming rates of Carbon emissions into our atmosphere, detrimental to our environment.

Current reporting uses abstract metrics (metric tons of CO2) that are disconnected from everyday human experience. We bridge this gap by creating a standardized, clear, and relatable set of data and visualizer..

Methodology

We analyzed 13 State-of-the-Art Models (2018–2024), utilizing:

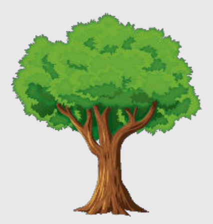
- GPT-4, 2, and 3
- DeepSeek V3
- LlaMa-2, 3 and 3.1
- BERT base and large
- RoBERTa
- BLOOM
- OPT
- GOPHER

We represented this data as:

- **Reported Data (R):** Official technical reports (e.g., LLaMA-2, LLaMA-3).
- **Estimated Data (E)**: Derived from FLOPs, GPU hours, and hardware specs
- We used two main formula for our comparisons:

TREE COMPARISON:

`Emissions / 25kg`



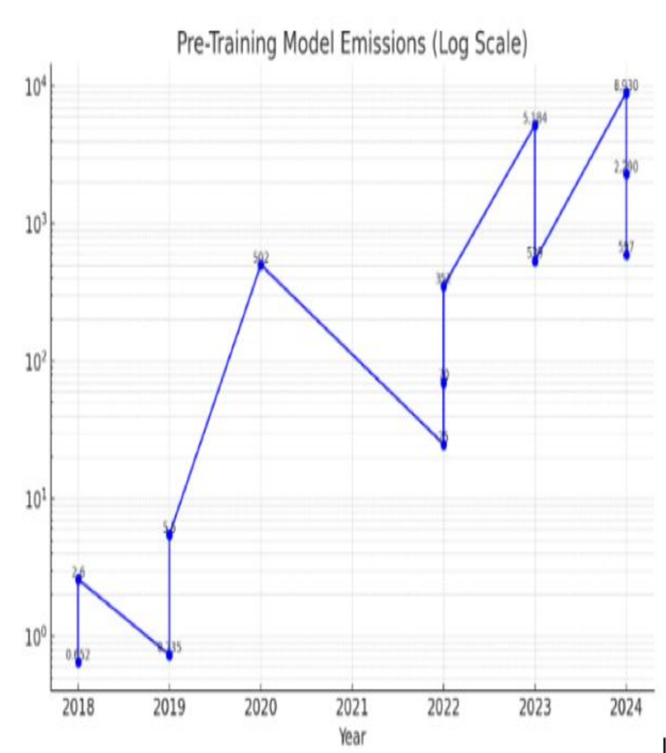
HUMAN YEARS COMPARISON:

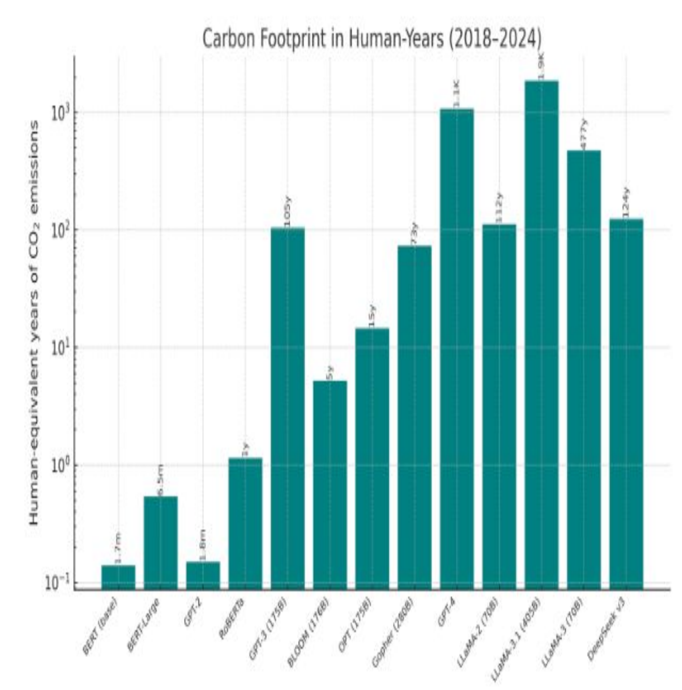
`Emissions / 4,800kg`

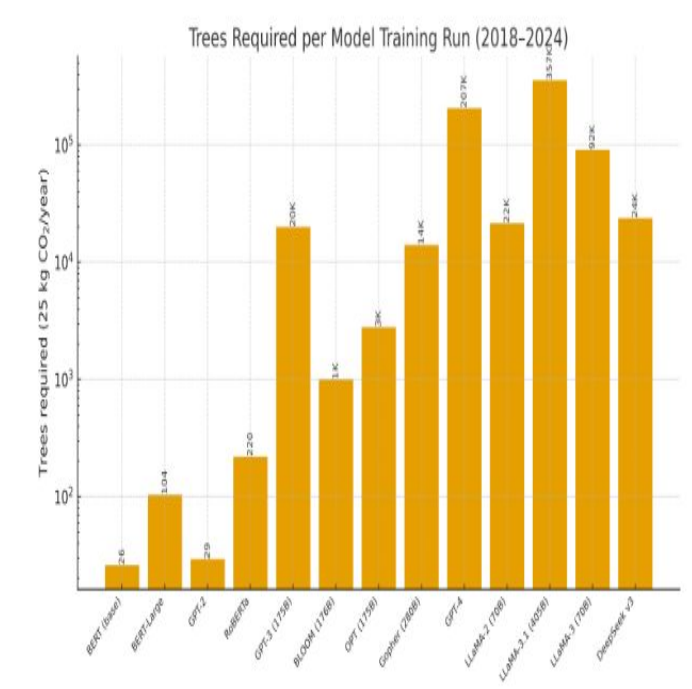
Abstartic Values to Visualizer

Model	Year	CO_2 (t)	CO_2 (kg)	Type	Trees (25 kg/yr)	Human yrs (4,800 kg/yr)
BERT (base) [5]	2018	0.652	652 [7]	E	26.1 trees	≈0.14 yrs (≈1.7 mo.)
BERT-Large [5]	2018	2.6	2,600 [1]	E	104 trees	≈0.54 yrs (≈6.5 mo.)
GPT-2 (OpenAI) [21]	2019	0.735	735 [7]	E	29.4 trees	≈0.15 yrs (≈1.8 mo.)
RoBERTa [15]	2019	5.5	5,500 [1]	E	220 trees	≈1.15 yrs
GPT-3 (175B) [3]	2020	502	502,000 [20]	E	20,080 trees	≈104.6 yrs
BLOOM (176B) [14]	2022	25	25,000 [20]	E	1,000 trees	≈5.21 yrs
OPT (175B) [28]	2022	70	70,000 [20]	E	2,800 trees	≈14.6 yrs
Gopher (280B) [22]	2022	352	352,000 [20]	E	14,080 trees	≈73.3 yrs
GPT-4 (OpenAI) [19]	2023	5,184	5,184,000 [1]	E	207,360 trees	≈1,080 yrs
LLaMA-2 (70B) [26]	2023	539	539,000 [17]	R	21,560 trees	≈112.3 yrs
LLaMA-3.1 (405B) [18]	2024	8,930	8,930,000 [1]	E	357,200 trees	≈1,860 yrs
LLaMA-3 (70B) [18]	2024	2,290	2,290,000 [18]	R	91,600 trees	≈477 yrs
DeepSeek v3 [4]	2024	597	597,000 [1]	E	23,880 trees	≈124 yrs

The compiled data set shows model,, year, Co2 emissions, reported/estimated and tangible values such as tree absorption and human years for the general public to comprehend with ease. To further visualize this we present graphs that show immediate impact.







These graphs show **emission jumps** alongside visualizing equivalences per AI model. Beyond this, we created an interactive visualizer sorting AI models by emissions impact, year, and company, allowing anyone to see impact.

- **Personal scale (<1000kg)**
- **Car scale (1k-100k kg)**
- **Plane scale (100k-1m kg)**
- **Industrial scale (1M+ kg)**

Key Results

- **Accountability and Transparency:** Over 85% of state-of-the-art models (11 of 13) lack officially **reported** carbon data. This lack of transparency undermines accountability and prevents critical sustainability efforts.
- **An exponential rise** in training emissions as model size increases from 2018-2024 signaling that with model growth and time, emissions will continues to rise.
- **Literacy Gap::** Opaque, metric-ton reporting is inaccessible to non-experts. Our work translates this data into human and ecological equivalents (Trees, Human Years) to drive informed action.

Mitigation

The primary mitigation step is standardized reporting. We call for mandatory, standardized disclosure of training emissions, integrated directly into every Model Card to allow for clear sustainable strategies.

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