UNIVERSITY OF COPENHAGEN

Navigating ESG Data Complexity of AI: Challenges and Opportunities

Talk at EBDVF, Copenhagen

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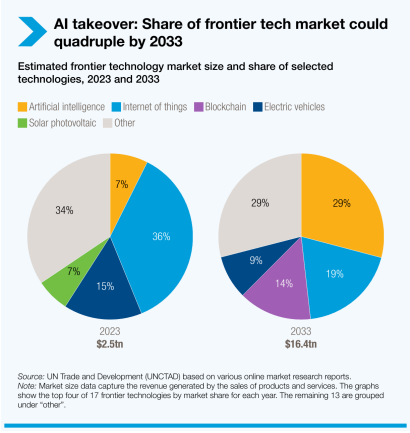
Sustainable **A**rtificial **Int**elligence for **S**ciences (SAINTS) Lab
https://saintslab.github.io

Collaborators: Lasse F. Anthony, Benjamin Kanding, Pedram Bakhtiarifard, Tong Chen, Bob Pepin, Gabriel Samuels, Rasmus Løvstad, Christian Igel, Dustin Wright, Erik Dam and others.

November 12, 2025

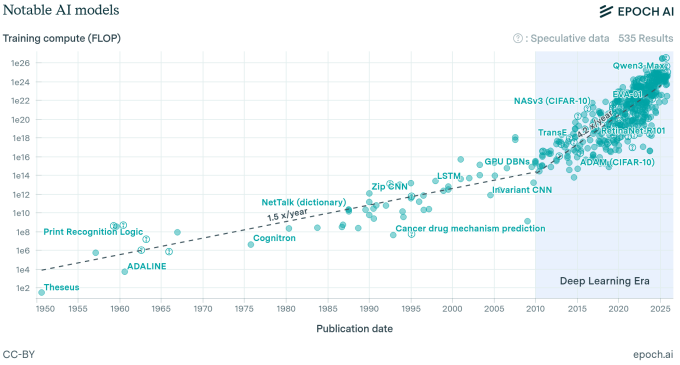
AI Uptake Across Sectors is Expanding

Projected to grow 4x by 2033.



UNCTAD. "AI market projected to hit $4.8 trillion by 2033, emerging as dominant frontier technology" (2025)

AI Development Happening at Break-Neck Pace



"Move fast and break things" approach is pit against compliance requirements.

- Fast-paced technical developments
- Difficult to keep track of risks
- All the more difficult to formulate regulations

AI is More than a Hive of Algorithms. AI is Infrastructure.

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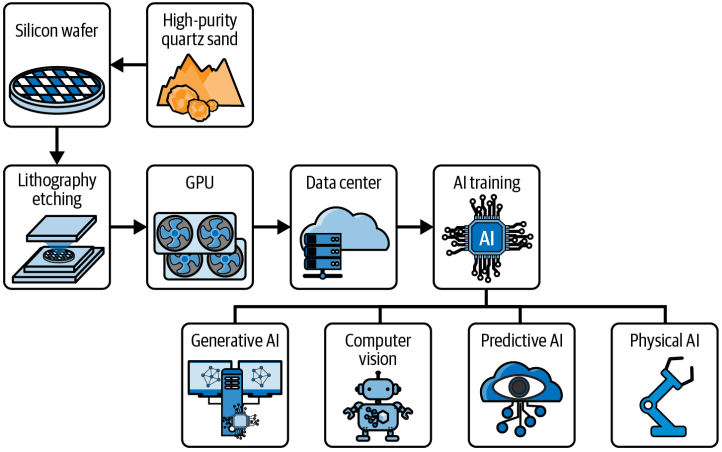

Resource Costs of a Single Frontier AI Model (Llama)[1]

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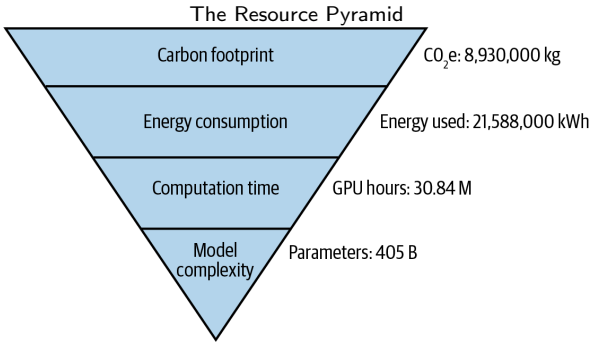

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Consider the Energy Consumption of Datacenters, fueled by Generative AI

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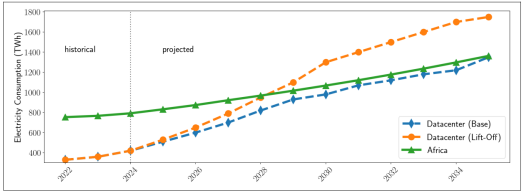

Figure 1-8. Electricity consumption trends for global datacenters and the entire African continent. (Source: for datacenters, the prediction is based on IEA analysis reported in Energy and AI, and for Africa, a 5% compounded average annual growth rate is assumed based on the IEA's Electricity 2025 Report.)

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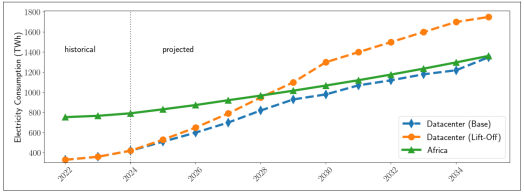

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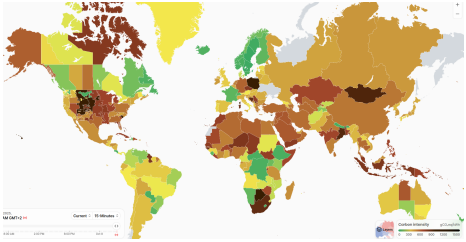

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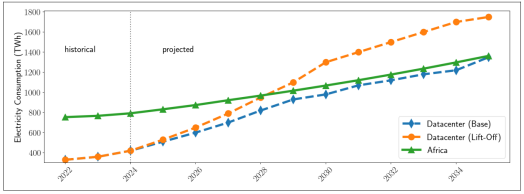

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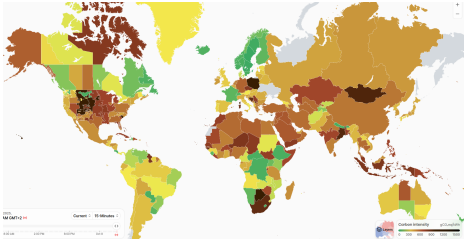

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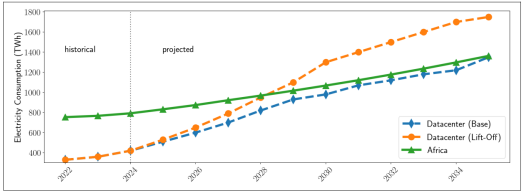

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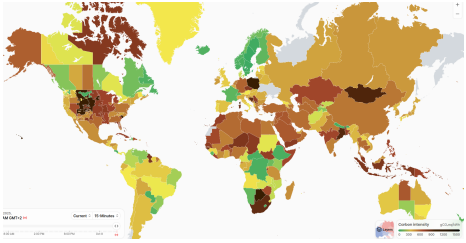

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Embodied emissions due to non-compute related energy, water consumed to cool datacenters, manufacturing energy, mining related impact, electronic waste, etc.

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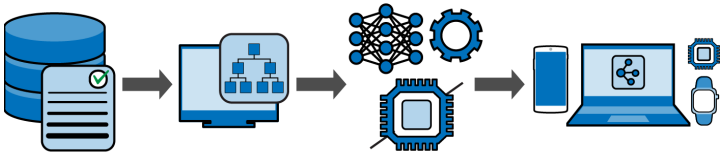

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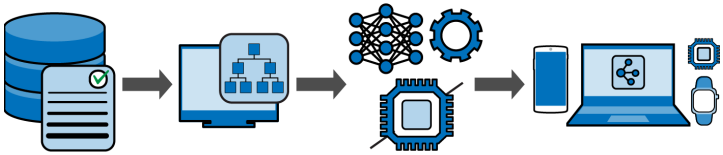

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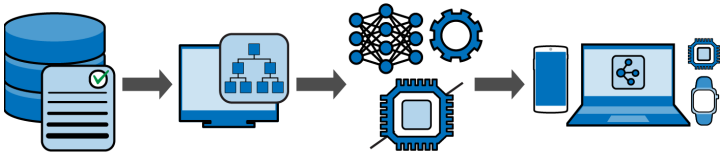

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Rife with *AI-Waste* at each stage of the lifecycle.

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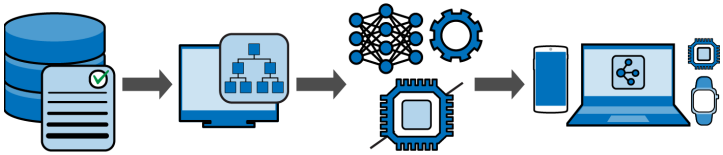

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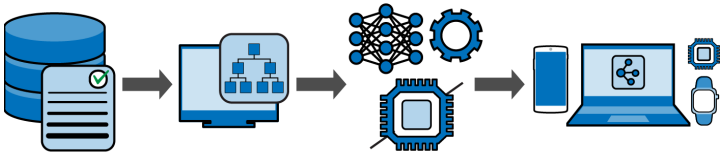

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How do we start, though?

You can't improve what you don't measure[3]

[3] Often attributed to Peter Drucker

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Table: Methods for Estimating the Carbon Footprint of Deep Learning

Tool	Track	Predict	Report	Pip	Vis.	API	GPU	CPU

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Experiment-Impact-Tracker	✓	✗	✓	✓	✗	✗	✓	✓
CarbonTracker	✓	✓	✓	✓	✗	✗	✓	✓
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- ML Emissions Calculator is a self-reporting tool
- All tools except [1] measure DRAM power costs
- Carbontracker also allows aggregating over DL model development lifecycle

[3] Often attributed to Peter Drucker

Tracking & predicting Carbon Footprint of Training Deep Learning Models

carbontracker

- Open-source tool released under the MIT license
- Track and predict the energy consumption and carbon emissions of training DL models
- Python package available through PyPi

```
~$ pip install carbontracker
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https://github.com/lfwa/carbontracker

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- Ease-of-use with minimal setup
- Compatibility with different environments and platforms
- A wide array of configurable options
- Optional comprehensive logging to files
- Aggregating log files

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Additional Code to Training Scripts

```python
from carbontracker.tracker import CarbonTracker

tracker = CarbonTracker(epochs=max_epochs)

# Training loop.
for epoch in range(max_epochs):
    tracker.epoch_start()

    # Your model training.

    tracker.epoch_end()

# Optional: Add a stop in case of early termination before all monitor_epochs has
# been monitored to ensure that actual consumption is reported.
tracker.stop()
```

Figure: Example of the default setup added to training scripts.

Carbontracker wrapper

```
carbontracker myscript arg1 arg2 --log_dir ./logs
```

Output of Carbontracker

```
CarbonTracker: The following components were found: GPU with device(s)
↪  TITAN RTX. CPU with device(s) cpu:0, cpu:1.
CarbonTracker: Carbon intensity for the next 1:54:54 is predicted to be
↪  54.09 gCO2/kWh at detected location: Copenhagen,Capital Region,DK.
CarbonTracker:
Predicted consumption for 100 epoch(s):
        Time:   1:54:54
        Energy: 1.159974 kWh
        CO2eq:  62.744032 g
        This is equivalent to:
        0.521130 km travelled by car
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How Far do Measurements like these take us to ESG Reporting?

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Challenges persist at three abstractions:

- Theoretical
- Tooling
- Putting to Practice

Let's explore them using CarbonTracker as a case-study.

Theoretical: What Are We Reporting?

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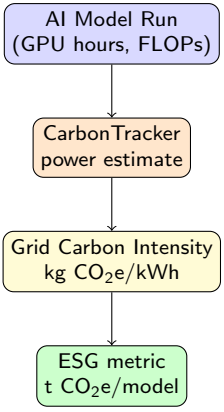
- Translate AI workload (GPU hours, FLOPs) into emissions for ESG frameworks.
- CarbonTracker links runtime energy use with grid emission factors to estimate CO_2e.
- Key boundary choice: which parts of the AI lifecycle count (training, inference, data, hardware).
- Reported numbers depend on assumptions about location, time, and marginal versus average emissions.
- Lack of solid theoretical foundation for full impact: limited use of physical laws, lifecycle analysis, and certified guarantees for end to end environmental effects.



Tooling: What CarbonTracker Captures

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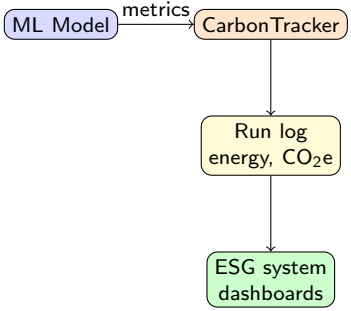
- Hooks into training or inference scripts and samples hardware power use.
- Combines power, runtime, and data center overhead to compute energy in kWh.
- Multiplies energy by regional or user supplied grid factors to get emissions.
- Challenges: partial coverage for distributed runs, different defaults across teams, limited visibility of storage and network.



Practice: From Runs to ESG Reports

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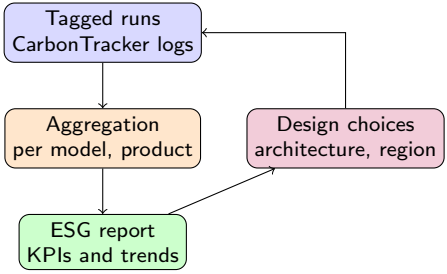
- Decide which runs are tracked and tag them by project, product, and customer.
- Aggregate many CarbonTracker logs into model, product, and period level footprints.
- Use results to guide model size, hardware choice, region, and model reuse.
- Define ownership, review, and documentation so numbers are explainable and comparable over time.



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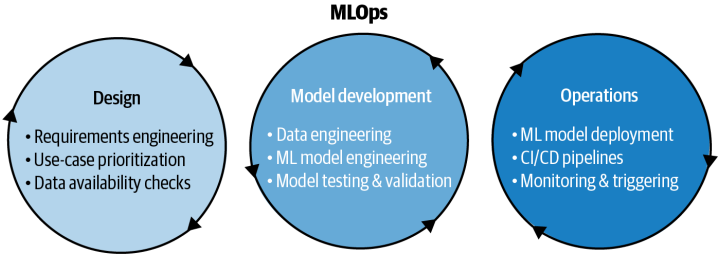

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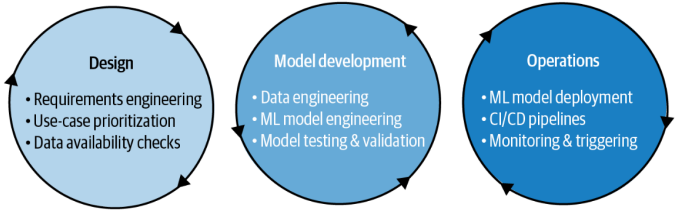

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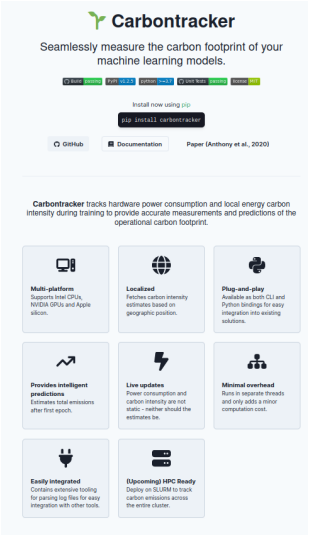

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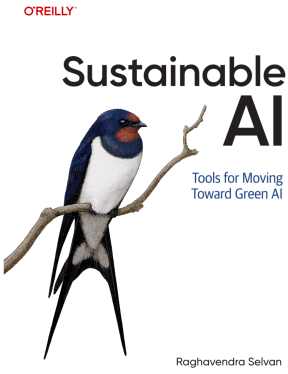

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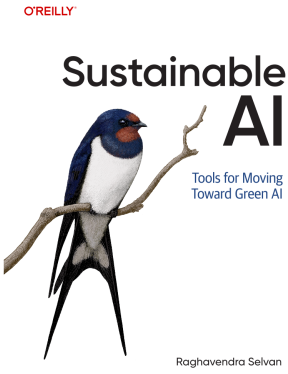

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Reach out

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/raghavian

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