The Dual Environmental Impact of AI: An Empirical Assessment of its Problem-Making and Problem-Solving Nature

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Introduction

AI's Dual Environmental Impact

-Training large-scale AI models consumes lots of water, electricity and create carbon emissions and e-waste.

-At the same time AI can reduce the environmental harm by optimizing the energy, water and climate systems.

The Problem

-Software Engineering lacks the reliable frameworks to measure AI's net ecological trade-offs.

-Without the consistent metrics and data it is unclear if AI is a problem maker or solver.

What is the net environmental impact of large-scale AI, considering both the resource consumption of model training and the efficiency gains AI delivers in domains such as energy and water management?

Why This Matters

01

Problem-Maker

energy use, water consumption, CO_2 emissions, e-waste

02

Problem-Solver

smart grids, renewable forecasting, water optimization

gorodenkoff. (2023, November 28). *Data center* [Stock photo]. iStock. https://www.istockphoto.com/photo/data-center-gm1809659600

Research Design

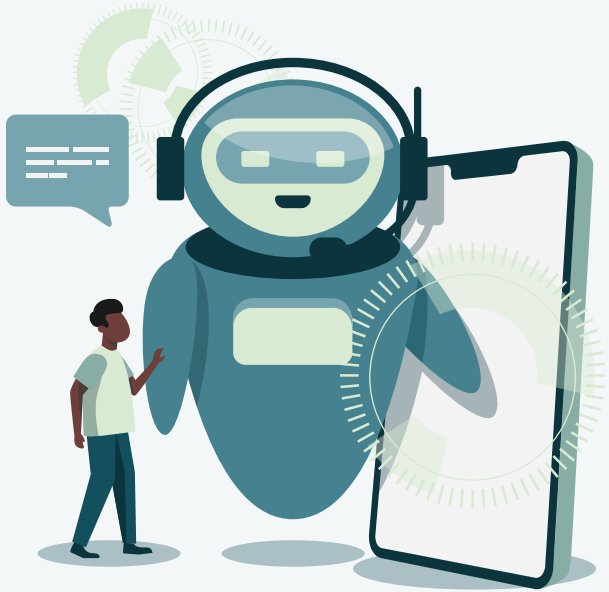
Collect AI training cost data

Collect AI sustainability benefit data

Compare costs vs. benefits

Research Gap

- Software Engineering lacks frameworks to measure AI's ecological trade-offs
- No standard way to compare costs vs. benefits
- Consequence: risk of unsustainable integration of AI



Methodology

Method

Examine the resources needed to train AI models as well as efficiency improvements AI can bring to energy systems

Contingency

Conducting face to face interviews and gather first-hand data from local departments at Colorado State University (CSU)

Method

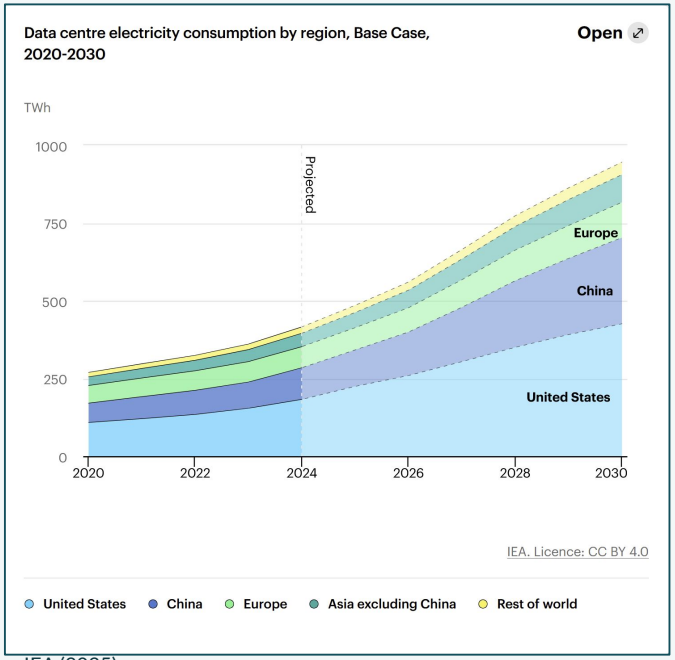
- We plan to use data from publicly available sources, such as the International Energy Agency (IEA)
- We will use a mixed methods approach to data collection:
  - Quantitative data will be extracted from official reports, statistics, and datasets
  - Qualitative data will be taken from case studies on AI and water and energy use
- This method was chosen due to its efficiency and simplicity

Contingency Plan

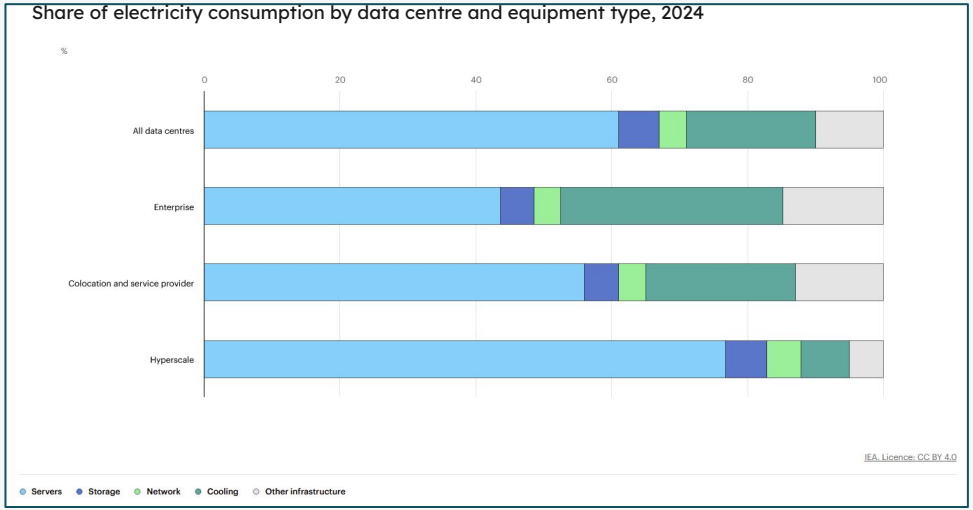
- In person visit to the College of Agriculture to carry out an interview:
- Which AI systems or tools are currently being used in the college for agriculture management?
  How has AI been applied to monitor or optimize irrigation, soil health, or crop yield?
  Are there any AI projects aimed specifically at reducing water or energy use?

- In person visit to the CS department at CSU
- Compare both of these results against each other, and conclude whether
  AI has more benefits than drawbacks or vice versa on the small scale.

Data Sets



IEA (2025)



IEA (2025)

Year	Model	# of Parameters	Dataset Size
2019	BERT [39]	3.4E+08	16GB
2019	DistilBERT [113]	6.60E+07	16GB
2019	ALBERT [70]	2.23E+08	16GB
2019	XLNet (Large) [150]	3.40E+08	126GB
2020	ERNIE-Gen (Large) [145]	3.40E+08	16GB
2019	RoBERTa (Large) [74]	3.55E+08	161GB
2019	MegatronLM [122]	8.30E+09	174GB
2020	T5-11B [107]	1.10E+10	745GB
2020	T-NLG [112]	1.70E+10	174GB
2020	GPT-3 [25]	1.75E+11	570GB
2020	GShard [73]	6.00E+11	–
2021	Switch-C [43]	1.57E+12	745GB

Table 1: Overview of recent large language models

Bender and Gebru, et al (2023)

References

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