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The Net Climate Impact of AI: Balancing Current Costs with Future Climate Benefits

(/pdf?id=Sks4tFDrWA)

NeurIPS 2025 Position Paper Track Submission598 Authors

23 May 2025 (modified: 28 Oct 2025) Submitted to NeurIPS 2025 Position Paper Track
Position Paper Track, Area Chairs, Reviewers, Authors Revisions (/revisions?id=Sks4tFDrWA)
BibTeX

Keywords: ai, climate
TL;DR: This paper explores the dual role of AI as both a climate challenge and a potential climate solution

Abstract:
What is the net impact of artificial intelligence on climate change? Existing studies focus on AI's footprint, but few analyze AI's trade-offs. This paper develops a framework to quantify both the Greenhouse Gas (GHG) emissions and the climate change costs and benefits of AI systems, addressing the time value of carbon and the installed base of existing AI infrastructure. We examine the energy demands of AI, which are growing rapidly and threatening companies' net-zero commitments, while also analyzing AI's potential to enable emissions reductions through applications such as optimized energy systems, demand response, grid management, and electrification acceleration. This research introduces the Net Climate Impact Score (NCIS) of AI, a novel equation to calculate the net climate impact of AI technologies that considers both immediate emissions and potential future benefits, and provides a methodology for assessing AI projects holistically. We demonstrate that while current AI applications are predominantly emissions-intensive, strategic deployment focused on energy system transformation could potentially deliver net climate benefits within specific time frames and applications. However, improvements in energy efficiency and emissions reductions resulting from AI are, absent climate policy, likely to generate both direct and indirect rebound effects that could undermine the emissions reductions and reduce the climate benefits of AI. The research concludes with policy and industry recommendations that propose technological pathways that could maximize AI's positive impact while minimizing its environmental footprint.

Submission Number: 598

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Paper Decision

Decision by Program Chairs 25 Sept 2025, 21:01 (modified: 17 Oct 2025, 12:38) Everyone
Revisions (/revisions?id=XEWM5NtJdj)

Decision: Reject

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Official Review of Submission598 by Reviewer 4Brc

Official Review by Reviewer 4Brc 11 Aug 2025, 20:23 (modified: 15 Aug 2025, 14:47)

Program Chairs, Area Chairs, Reviewers Submitted, Reviewer 4Brc, Authors

Revisions (/revisions?id=Fq6m29sTcA)

Ethics: NO or VERY MINOR ethics concerns only
Position: Yes, the paper argues for or against a position related to machine learning.
Summary:
The paper argues that AI's climate impact must be assessed based on both its emissions and potential to reduce emissions, rather than focusing solely on its carbon footprint. The paper examines AI's climate impact by developing a framework that considers emissions and benefits. It introduces a Net Climate Impact Score equation to calculate impact. The authors show that AI applications create emissions, but strategic deployment could deliver benefits. They note that efficiency gains from AI create rebound effects that reduce benefits. The paper provides a framework for impact assessment that considers carbon time value and infrastructure, while offering recommendations to maximize benefits and minimize footprint.

Author Identification: No.
Support: 4: excellent
Significance: 4: excellent
Presentation: 3: good
Context: 4: excellent
Discussion: 4: very likely
Alternative Position: No
Strengths:

- The position has been well argued with data. Even early quantitative framework such as the proposed net climate impact score can be a valuable starting point
- The paper considers important aspects like rebound effect and time value of carbon in analyzing the impact on carbon
- The data points provided throughout are well grounded in literature
- The paper acknowledges the limitations of speculative nature of future benefit estimates and uses range vs point estimates

Weaknesses:

- The paper does not consider any alternative position. For example, focus on carbon does not consider impact on water use, mining of critical minerals, or human exploitation during annotation.
- The proposed equations do not consider regional impacts on grids, pollution, or economy.
- As much of the numbers included are speculative, it would be good to see a validation method before they are used for real-world decisions. How can AI-enabled reductions be measured at scale?
- While the time value of carbon and rebound effect have been discussed, the proposed equations do not incorporate it for estimating net impact
- Opportunity cost of investing in AI vs other climate solutions is not considered
- It is unclear why stakeholders will adopt policies that are based on net climate impact for AI related decision making

Questions:

1. What are the alternative positions to the one you have considered, and how do they fare compared to your arguments? This is a critical aspect missing in the paper.
2. How would you propose measuring and validating AI enabled emissions reductions?
3. How would you incorporate time value of carbon and rebound effects into your equations?
4. How would you incentivize stakeholders to adopt the proposed framework? Why would people stop generating cat videos regardless of what the equation says?

5. More of a comment than question -- impact of inference far exceeds that of training.

Agreement: 5: strongly agree
Rating: 6: Weak Accept: The paper presents a solid argument about an issue of moderate importance to at least one sub-area of theNeurIPScommunity.
Confidence: 5: You are absolutely certain about your assessment. You are very familiar with the related work.
Thoroughness: 5: You read the paper and appendices rigorously and checked all of the details carefully, including references and proofs (if present).
Code Of Conduct Acknowledgement: Yes

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Official Review of Submission598 by Reviewer 7Qe4

Official Review by Reviewer 7Qe4 30 Jul 2025, 13:58 (modified: 15 Aug 2025, 14:47)
Program Chairs, Area Chairs, Reviewers Submitted, Reviewer 7Qe4, Authors
Revisions (/revisions?id=Hu23wtZzwV)

Ethics: NO or VERY MINOR ethics concerns only
Position: Yes, the paper argues for or against a position related to machine learning.
Summary:
This paper argues that, instead of focusing on quantifying, reducing, and regulating the climate impact of AI, one must take a step further to also factor in the benefits from, for example, using AI tools to reduce carbon emissions of AI and other applications.

This work proposes to take a more holistic approach to consider the potential benefits of AI for climate mitigations and balance it with the carbon impact of AI. This is challenging because, first, the cost is incurred now while the reduction often comes later. Second, the scope is broad. Nonetheless, the paper describes three major factors to consider for the net carbon impact of AI: rebound effects, time value of carbon, energy and emission impact of AI.

While this work takes the first step describing what such framework can look like, there are many aspects that fall short. The model estimating the carbon cost of AI is preliminary and so is the methodology for potential benefits. It'd be great if the authors can continue the work to establish the described framework, refine and validate it with key use cases. The reviewer believes such a tool, by enabling what-if analysis, would be useful to many.

Author Identification: No.
Support: 2: fair
Significance: 2: fair
Presentation: 1: poor
Context: 2: fair
Discussion: 3: possibly
Alternative Position: No
Strengths:
The idea to make a framework assessing the net carbon impact of AI is commendable.

Weaknesses:
The framework for estimating the net carbon impact of AI needs significant improvement for it to be useful.

The paper is written with excessive direct quotes from other sources, such as news articles with eye-catching titles, hand-wavy projections. More scientific rigor is expected for a NeurIPS position paper.

Questions:
The idea to make a framework assessing the net carbon impact of AI is commendable. However, the scope is broad. Can you be more specific about the scope of carbon quantification across the "lifecycle" that will make it a useful tool? What are some key use cases you envision the tool enables? Can you please provide a few concrete examples?

Agreement: 4: agree

Rating: 4: Borderline reject: The paper presents a position, but the reasons to reject, e.g., unclear reasoning or limited support for the claims, outweigh reasons to accept.
Confidence: 4: You are confident in your assessment, but not absolutely certain. It is unlikely, but not impossible, that you did not understand some parts of the submission or that you are unfamiliar with some pieces of related work.
Thoroughness: 4: You read the paper and appendices and checked most of the details, including references..
Code Of Conduct Acknowledgement: Yes

Add: **Official Comment**

Official Review of Submission598 by Reviewer 26VL

Official Review by Reviewer 26VL (Vivek Kumar Mishra (/profile?id=~Vivek_Kumar_Mishra1))
23 Jul 2025, 11:49 (modified: 15 Aug 2025, 14:47)
Program Chairs, Area Chairs, Reviewers Submitted, Reviewer 26VL, Authors
Revisions (/revisions?id=Tb9WaRbPlT)

Ethics: NO or VERY MINOR ethics concerns only
Position: Yes, the paper argues for or against a position related to machine learning.
Summary:
This paper develops a framework to quantify AI's net climate impact, balancing its greenhouse gas emissions against potential benefits like optimized energy systems. It introduces the Net Climate Impact Score (NCIS), a novel equation factoring in emissions, benefits, and the time value of carbon. The paper highlights AI's growing energy demands (1.5-4% of global emissions) but argues strategic applications (e.g., grid management, electrification) could reduce emissions by 1.5-10% by 2030. It warns of rebound effects undermining benefits without policy support. Contributions include the NCIS framework, a mixed-methods approach, and policy recommendations to minimize AI's footprint while maximizing its climate potential.

Author Identification: No.
Support: 4: excellent
Significance: 2: fair
Presentation: 3: good
Context: 3: good
Discussion: 4: very likely
Alternative Position: Yes, and alternative positions are well-considered and named but not addressed
Strengths:
The NCIS framework for estimating AI's climate impact while weighing costs and benefits is expertly developed in this paper. It has a solid foundation thanks to its mixed-methods approach (literature, surveys, interviews) and 47 references (IEA, World Bank). It identifies pressing problems, such as data center energy consumption, and makes practical policy suggestions. It adds depth and is extremely pertinent to NeurIPS and climate research because of its emphasis on rebound effects and the time value of carbon.

Weaknesses:
Empirical case studies of AI applications (such as particular grid optimizations) could enhance the paper. Accessibility is diminished by its technical terminology and small OCR mistakes (such as "edationion"). Giving non-AI solutions (like expanding renewable energy) precedence over AI-driven ones is an alternate viewpoint that hasn't been thoroughly investigated. It would be strengthened by additional discussion on how to apply NCIS in environments with limited resources.

Questions:
How feasible is NCIS adoption in developing countries with limited data?

Agreement: 4: agree
Rating: 7: Accept: The paper presents a solid argument about an important issue that remains unresolved and is of importance to at least one sub-area of the NeurIPS community.

Confidence: 4: You are confident in your assessment, but not absolutely certain. It is unlikely, but not impossible, that you did not understand some parts of the submission or that you are unfamiliar with some pieces of related work.
Thoroughness: 4: You read the paper and appendices and checked most of the details, including references..
Code Of Conduct Acknowledgement: Yes

Add: **Official Comment**