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# The Precarious Pirouette: Artificial Intelligence and Environmental Sustainability

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**ABSTRACT**

The exponential ascension of artificial intelligence (AI) prompts profound inquiries concerning equitable access to its advantages versus environmental externalities. While trailblazing economies relish AI's benefits such as economic expansion and technological eminence, the colossal energy required to train and operate AI systems exacts a hefty toll on the environment, disproportionately burdening marginalized nations. This imbalanced paradigm epitomizes disparities of the digital divide, with impoverished nations bearing externalities while lacking access to innovations. This study aims to explore the intricate relationship between AI and environmental sustainability through a qualitative methodology encompassing a literature review and document analysis of industry practices and viewpoints. The findings unveil AI as a double-edged sword, with empirical analyses exposing its striking carbon emissions and resource depletion, which if left unchecked, could impede global decarbonization initiatives. However, AI also demonstrates strong potential for optimizing energy systems, predictive modelling, and advancing climate solutions if conscientiously developed. The study elucidates this conundrum and proposes responsible innovation pathways involving renewable energy adoption, enhanced efficiency, optimized hardware, carbon accounting, transparency, and legislative mindfulness. Integrating climate justice and digital divide perspectives illuminates avenues for steering AI's trajectory towards environmental stewardship and inclusive accessibility through proactive collaboration across sectors. Ultimately, collective wisdom will determine whether AI ushers in climate justice or injustice.

**Keywords:** Artificial intelligence, climate change, energy efficiency, carbon emissions, climate justice

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## 1. INTRODUCTION

The escalating power demands of artificial intelligence (AI) present an environmental justice dilemma: those least responsible for the consequences disproportionately bear the greatest burden. This study examines this inequity through the converging lenses of climate justice and digital divide frameworks. It contributes to the existing literature by providing a comprehensive analysis of AI's environmental impact, addressing the gap in understanding the implications of unchecked AI development on global decarbonization efforts and proposing solutions to mitigate the adverse effects.

The recent explosion of interest in AI, fuelled by user-friendly tools like ChatGPT, has led to surging demand for AI infrastructure and computing power. This growing adoption across industries carries a heavy energy cost that could soon overburden existing power grids. Projections portend that by 2030, AI could claim over 10% of the world's electrical bounty (Luccioni, 2020), its accompanying emissions imperilling crucial efforts to relinquish carbon. The veil of opacity shrouding developmental practices further derails any attempts at accountability (Dhar, 2020). To accurately assess impact and navigate promising trajectories, a thorough and all-encompassing inquiry is imperative.

While the theoretical framework explores climate justice and digital divide perspectives, the literature review delves into empirical analyses unveiling the striking carbon emissions and voracious resource consumption entwined with AI systems. For instance, training a single AI model can emit as much carbon as five cars in their lifetimes (Hao, 2019). The study aims to elucidate the potential environmental repercussions from unbridled AI progression and propose solutions to harmonize AI innovation with ecological boundaries.

Fostering this harmonization necessitates a multifaceted approach involving enhanced efficiency, renewable energy procurement, optimized hardware, carbon accounting, and supportive policies. However, technical solutions alone are insufficient; a collective shift in mindset prioritizing environmental stewardship over narrow self-interest is essential. As experts emphasize, progress should be redefined as holistic advancement benefiting humanity through climate justice and just transitions, rather than exclusive gains for the technocratic elite (Dobbe & Whittaker, 2019).

Promoting open access to intellectual capital over proprietary ownership offers potential pathways, as does sustainable investment in developing nations for inclusive participation (Gichuki, 2022). Nonetheless, avoiding another extractive paradigm depends on recognizing our shared future within planetary limits. With thoughtful intentions and wisdom, AI could unveil solutions to issues of inequity and ecological constraints if stewardship prevails over self-interest. As Rolnick et al. (2021) summarize, "With responsible innovation, AI can become integral to an energy future that balances decarbonisation, resilience, and accessibility." Achieving this necessitates transparency, accountability, and global cooperation centered on climate justice.

## 2. THEORETICAL FRAMEWORK

The burgeoning energy demands of artificial intelligence present an environmental justice dilemma: those least responsible for the consequences disproportionately bear the greatest burden. This paper examines this inequity through the converging lenses of climate justice and digital divide frameworks.

Climate justice perspectives emerge from environmental justice research examining how climate change detrimentally and disproportionately affects marginalized communities despite their negligible greenhouse gas contributions (Holifield et al., 2017). Historical exploitation and socioeconomic disenfranchisement leave these communities especially vulnerable with limited climate resilience resources. Consequently, some populations experience unequal environmental hazard exposure or unjust denial of environmental benefits, raising environmental justice concerns (Mohai et al., 2009). The climate justice movement arose from civil rights activism responding to these disparities, upholding fair treatment, meaningful participation, and the universal right to a healthy environment regardless of race, ethnicity, national origin, or income (MPCA, 2022).

Scholars have developed theoretical frameworks elucidating environmental justice notions to inform research and policy. Gee and Payne-Sturges (2004) delineate how social and environmental factors interact across levels to produce environmental health inequities. Individual factors like genetics and behaviours shape vulnerability, intersecting with socioeconomics, racism, and power imbalances, influencing differential hazard exposure through land use patterns. Grace et al. (2018) present four climate justice dimensions highly relevant to the ethical AI evolution: procedural, distributive, restorative, and social. Those most impacted by AI's ecological effects warrant enhanced participation in development decisions (procedural). AI's environmental costs levied on vulnerable communities require redress through climate financing and resource exchange (distributive). We must acknowledge and remedy damages from unchecked AI progress exacerbating climatic perils (restorative). Equitable sustainability demands reimagining progress as shared prosperity within ecological limits, not disproportionate gains for the technocratic class (social).

The digital divide theory further contextualizes these AI disparities. Dewan and Riggins (2005) probe technological, economic, and social access divides. AI leaders luxuriate in expansive digital capital while developing nations with minimal AI infiltration shoulder relatively cumbersome burdens from surging energy consumption and waste. van Dijk and Hacker's (2018) contemporary model expands divides across motivational, material, skills, and usage dimensions. Profit-driven AI evolution, resource-challenged infrastructures in marginalized communities, limited technical prowess beyond industrial centres, and usage discrepancies from algorithmic bias collectively perpetuate injustice. If left unchecked, artificial intelligence risks unravelling progress towards sustainable, clean energy. Resolving this quandary necessitates industry, government and civil society interventions championing socially responsible, climate just AI, rather than economic myopia. Integrating climate justice and digital divide perspectives illuminates avenues for AI to promote responsible ecological stewardship.

## 3. METHODOLOGY

In this scholarly exploration, a qualitative methodology encompassing a desk-based literature review and document analysis of purposively selected texts has been employed to delve into the environmental ramifications of artificial intelligence. A thorough examination of contemporary interdisciplinary literature on AI and sustainability has been conducted by engaging with academic databases. Publicly accessible corporate and NGO documents were scrupulously assessed utilizing a coding technique to evaluate industry practices and viewpoints concerning AI's ecological repercussions.

These harmonious research methods collectively cultivate an all-encompassing comprehension of AI's multifaceted potential—ranging from exacerbating emissions and energy demands to devising innovative solutions for climate change. The intention of this inquiry is to contribute to the inception of judicious policies and pioneering avenues that harness the inherent merits of AI while safeguarding against its unbridled progression undermining crucial decarbonisation endeavours.

### Justification of the study

In this pivotal exploration, we delve into the profound environmental reverberations of artificial intelligence, whose unrestrained expansion may subsume ongoing sustainability initiatives without our deliberate guidance. Projections portend that by 2030, AI could claim over 10% of the world's electrical bounty (Luccioni, 2020), its accompanying emissions imperilling crucial efforts to relinquish carbon. The veil of opacity shrouding developmental practices further derails any attempts at accountability (Dhar, 2020). To accurately assess impact and navigate promising trajectories, a thorough and all-encompassing inquiry is imperative. This study weaves together the drapery of state-of-the-art understanding from multifarious experts, probing emergent priorities within the industry. Thus, it spawns an array of illuminating insights poised to shape policy and shepherd collective action. As humanity stands betwixt the gargantuan potential of AI and the relentless march of climate upheaval, discerning trade-offs becomes a vital endeavour. Guided by moral compass and sagacity, AI contains within it the power to manifest equitable abundance whilst harmonizing with Earth's ecological boundaries. This scholarly examination endeavours to illuminate pathways for sustainable progress by demystifying pathways conducive to sustainable development.

## 4. FINDINGS

### The Enigmatic Dance of AI and Climate Change: A Double-Edged Sword

Beneath the burgeoning canopy of artificial intelligence lies an intricate tapestry of promise and apprehension, embroidered with questions of sustainability. A growing corpus of empirical analyses unveils the striking carbon emissions and voracious resource consumption entwined with the creation and deployment of AI systems (Hao, 2019; Hutson, 2022). This revelation stirs disquietude in the face of potential environmental repercussions from unbridled AI progression. As the boundless potential of artificial intelligence unfurls like the petals of a blossoming flower, it concurrently births an immense responsibility. We must vigilantly ensure that the beguiling allure of analytic prowess does not eclipse our unyielding commitment to fostering a harmonious existence upon this celestial sphere we fondly refer to as home.

In the intricate dance of artificial intelligence's endless evolution, three pivotal catalysts interweave to form the ever-evolving fabric of artificial intelligence: ground-breaking advancements in machine learning algorithms, an inexorable accrual of training data, and burgeoning computational power devoted to neural network optimization. Though indispensable for expansion, these driving forces demand staggering energy outlays—estimations suggest that training

a lone natural language model expels carbon dioxide (CO2) on par with multitudes of transcontinental flights. Hao (2019) opines that training a single AI model can emit as much carbon as five cars in their lifetimes and that includes the manufacture of the car itself. The geographic locale of AI facilities bears resoundingly significant implications; renewable energy grids emit a mere fraction in comparison to their fossil fuel-reliant counterparts.

Moreover, the vast data centres cradling colossal learning models and complex neural networks upon which AI thrives generate an extraordinary thermal output. This profound heat signature is quelled through the practice of evaporative cooling—a technique capable of dissipating intense heat yet yielding copious amounts of water in return (Li, Wang, Shi, & Wang, 2023). The dependence upon water-based cooling methodologies intensifies the global demand for a resource in increasingly scarce supply. It becomes vitally imperative that we contemplate the technological advancements birthed by the artificial intelligence revolution within the contextual framework of our planet's overall well-being. Consequently, invoking the insightful wisdom of Large Language Model (LLM)-driven chatbots such as ChatGPT entails virtually summoning forth 500ml of freshwater. In 2022, this dynamic interplay culminated in Microsoft and Google witnessing a startling escalation in water consumption—34% and 20% respectively—translating to an astonishing 6.4 billion litres for Microsoft alone within that year.

The unsettling opacity shrouding the industry's sustainability practices grips our attention; however, glimmers of hope proliferate like stars awaiting discovery against the expanse of night. These guiding lights manifest as computable carbon accounting, energy-efficient hardware, and legislative mindfulness focused on emissions tracking and transparency. It behoves us to thoughtfully scrutinize the ecological footprints rent upon the Earth by AI systems, encourage responsible innovation, and wield a clarion call to compel corporations toward prioritizing environmental stewardship over myopic measurements devoid of tangible consequences.

A seminal 2019 study pierced the veil of energy usage and carbon emissions inherent to the cultivation of common natural language processing models, surmising that one such creation exhales an astounding 626,000 pounds of carbon dioxide equivalent – aligned with the lifetime exhalations of five average passenger vehicles (Strubell et al., 2019). Generative AI entities, such as ChatGPT, which can weave human-like textual tapestries, impose even greater resource voracity. The birth of ChatGPT proclaimed an emission of over 550 tons of carbon dioxide (CO2), resonating with the ecological impact of 550 roundtrip sojourns betwixt New York and San Francisco (Saenko, 2022). The carbon footprint permeating AI's utilization is similarly substantial; a single AI query emits a carbon dioxide (CO2) cloud four to five times vaster than its internet search counterpart – approximating 1gramme of carbon dioxide (CO2) (Jennifer, 2023). Bearing witness to over 1.5 billion ChatGPT queries in March 2023 alone, these emissions accumulate with bewildering rapidity (Jennifer, 2023). As corporations interweave AI into search engines and multifarious products, queries and commensurate emissions may propagate exponentially. Lying at the crux of these staggering digits is AI's prodigious hunger for computational power, heightening the call for energy resources. Calculating the labyrinthine algorithms of AI necessitates specialized hardware such as graphics processing units (GPUs), which voraciously consume 10-100 times more power than their conventional counterparts (Dhar, 2020).

The recent explosion of interest in artificial intelligence, fuelled by user-friendly tools like ChatGPT, has led to surging demand for AI infrastructure and computing power. This growing adoption across industries carries a heavy energy cost that could soon overburden existing power grids. For example, training a single AI model can consume as much electricity as 120 households use in an entire year (Freeman, 2023). Leading AI firms require more energy than major cities just to train their algorithms. Current GPUs and CPUs are designed for gaming, not optimized for AI's parallel computing needs. Training an AI model may require hundreds or thousands of servers operating in parallel and presenting an immense energy challenge. Data centres focused on AI already consume around 3% of global electricity, with cooling accounting for 40% of their power draw. Experts forecast the growth rate of processing power for AI to double from 6-7% to 15% annually as adoption expands. Yet energy is not the only bottleneck - network bandwidth to transfer massive training data between processors also strains capacity. According to Bill Haskell, CEO of Innventure, AI computing demand doubles every 3.4 months, outpacing Moore's Law (Lu, 2017). This exponential growth could overload power grids if left unchecked. Sustainable solutions are needed to supply sufficient energy and cooling for AI's voracious appetite.

The environmental toll also goes beyond electricity use. Manufacturing AI hardware and disposing of obsolete models creates substantial electronic waste (e-waste). For example, training a large neural network can produce over 626,000 pounds of carbon dioxide emissions, equivalent to flying about 650 roundtrips from New York to San Francisco. Energy consumption also has financial costs - estimates show that training complex AI models can incur millions in cloud computing bills. Companies must weigh these planetary and economic impacts against AI's benefits. Some firms are reducing power usage through efficiency, while innovators are developing optimized chipsets for AI's specialized computing needs. But much work remains to ensure AI fulfils its potential responsibly and sustainably.

Rapid AI adoption further exacerbates potential emissions. The AI Index Report revealed that from 2012 to 2018, the computational power needed for AI training increased by over 300,000 times - a rate surpassing efficiency improvements (Amodei & Hernandez, 2018). Consequently, by 2025, AI could produce up to 5.5% of global emissions (Rolnick et al., 2021), directly conflicting with urgent climate targets that call for rapid decarbonization.

The thriving societies engendering and profiting from artificial intelligence possess highly evolved economies with measures in place to buffer the effects of climate change or at least provide alternatives and mitigatory strategies. This digital chasm between developed and developing nations serves as a stark reminder that marginalized communities may not yet be poised to capitalize on the artificial intelligence revolution whilst remaining inevitably subject to its consequences on the environment. From an environmental justice standpoint, one cannot overlook that the ramifications of artificial intelligence systems will disproportionately impact already marginalized populations around the globe. It is disconcerting to acknowledge that these very communities, which shall bear the ecological repercussions of artificial intelligence most heavily, reside on the periphery of reaping its myriad benefits.

**AI driven opportunities for resolving the climate crisis**

Paradoxically, artificial intelligence unveils the potential to address the pressing climate crisis, through means such as enhancing energy efficiency, predictive modelling of extreme weather events, and optimizing transportation systems (Rolnick et al., 2019). For example, machine learning may cultivate "greener AI" by developing more energy-efficient neural network architectures and hardware devices (Cai et al., 2017). AI systems trained with climatic data, could more accurately predict the advent of floods, droughts, and additional calamities, thereby fostering adaptation and resilience. Likewise, intelligent grids powered by AI can streamline energy distribution and storage pathways. While AI's genesis inevitably carries environmental costs, its judicious application holds the key to expedite ecological remedies.

The orchestration of AI as an instrument for mitigating and adapting to climate change necessitates an interwoven collaboration among technology firms, governmental bodies, and the scientific community. The establishment of legislative frameworks that champion transparency and sustainability in AI systems is indispensable. Equally crucial is the provision of robust training data and subject matter acumen by climate researchers dedicated to cultivating ecologically specialized AI. The adoption of environmentally cognizant innovation practices, coupled with a commitment to open data exchange and computable carbon accounting, will further bolster ecologically beneficial AI development. Through prudent creative processes and mindful applications, artificial intelligence holds boundless promises in combating climatic challenges (Rolnick et al., 2019).

**Perceived Solutions from the Literature**

Nevertheless, there are solutions to alleviate AI's environmental impact. Such approaches encompass computable carbon accounting and auditing, which monitor emissions throughout the machine learning supply chain (Lacoste et al., 2019). Energy-efficient chipsets designed for AI tasks are under development, accompanied by optimized algorithms requiring less intensive training (Cai et al., 2017). Legislation mandating sustainability reporting and practices could also encourage tech companies to prioritize emissions reduction and clean energy procurement. Ultimately AI presents a double-edged sword for energy. While it facilitates remarkable efficiency and grid enhancements, unregulated progress may lead to increased electricity consumption and emissions. However, conscientious development with a focus on ecological consequences can guide AI's path towards climate solutions. Companies should balance techno-economic advancements against external factors, collaborating across industries to ensure AI's positive potential does not overshadow environmental responsibility. With responsible innovation, AI can become a crucial part of an energy future that harmonizes decarbonisation, resilience, and accessibility.

Moreover, feasible strategies exist to address AI's emissions issue. These methods involve enhancing data centre energy efficiency, creating optimized AI hardware, and researching energy-efficient algorithms and neural architectures (Lacoste et al., 2019). Companies can procure renewable energy and prioritize carbon-neutral facilities while implementing carbon accounting to track and disclose emissions across operations. Policies requiring transparency and emission reductions in tech sectors can fortify corporate accountability.

Fundamentally, AI developers must achieve equilibrium between rapid progress and ecological repercussions. If implemented conscientiously, AI offers immense potential to improve energy efficiency, grid management, and climate modelling. However, unrestrained development could exacerbate unsustainable emissions. To prevent surpassing a 1.5°C increase in temperature – the threshold for a climate disaster – requires mindful innovation and cross-sector collaboration. Ultimately, AI can either significantly combat or substantially aggravate today's environmental crises; our collective decisions will dictate its course.

### Implications on the Global South

The escalating power demands of AI could strain African grids already burdened by reliability issues and rising demand. South Africa, possessing the continent's second-largest economy, experiences frequent rolling blackouts due to generation shortfalls (Eskom, 2022). Without substantial investments in new capacity, increased AI adoption could exacerbate these deficits. The halted construction of two coal plants in 2022 (Nzimande, 2022) highlights the challenges, while renewables like solar and wind offer promise but face storage and transmission barriers. Efficient, optimized AI systems that align with South Africa's energy masterplan could foster sustainable growth. However, unchecked expansion of data centres and GPU farms may drastically increase consumption, which is projected to nearly double by 2040 (DoE, 2019). Targeted policies and public-private collaboration are crucial for maximizing AI's benefits while minimizing environmental impact.

Furthermore, AI's mounting energy consumption endangers carbon reduction targets and compromises climate commitments such as South Africa's net-zero goal by 2050 (UNFCCC, 2021). Critics argue that the country relies excessively on carbon-intensive coal power, generating over 200 million tonnes of energy-related CO2 annually (Eskom, 2022). Introducing vast AI infrastructure could raise emissions further unless clean energy procurement and carbon offsets are adopted decisively. Energy-efficient AI systems may help mitigate these effects. African tech hubs like Kenya's Konza Technology City should prioritize renewable energy to limit emissions when expanding AI adoption (Gichuki, 2022). Colocation in more efficient grids like Ethiopia's dam-powered system can also reduce environmental impact. Unrestrained AI growth without optimizing efficiency and energy sources risks negating sustainability benefits from economic development. To ensure that AI supports resilience and inclusivity across Africa, proactive policies must align with each nation's climate objectives through comprehensive impact assessments.

## 5. DISCUSSION AND CONCLUSION

This study has illuminated artificial intelligence's (AI) complex, double-edged relationship with environmental sustainability. AI offers tremendous potential for optimizing energy systems, enhancing efficiency, and propelling climate solutions through sophisticated techniques like machine learning forecasting and automated management. However, the escalating computational demands, energy consumption, and carbon footprint of developing and operating AI also risk grave, unintended ecological consequences.

The empirical evidence exposing AI's environmental toll is disconcerting. Training complex language models like GPT-3 generates staggering CO2 emissions equivalent to hundreds of flights. AI hardware production yields concerning electronic waste levels. Currently, energy-intensive AI data centres consume nearly 3% of global electricity, predominantly from polluting fossil fuels due to opaque energy sourcing. Projections indicate AI could account for over 5% of worldwide emissions within years, conflicting with urgent climate goals. These alarming statistics illustrate how unchecked AI advancement prioritizing efficiency gains could prove catastrophic for sustainability. The immense energy requirements intrinsic to the machine learning pipeline risk overwhelming planetary boundaries if emissions continue unabated. While AI optimizations may yield localized environmental benefits, the existential climate change threat far outweighs limited efficiencies considering the sector's escalating emissions holistically.

Yet promising solutions could mitigate AI's toll if comprehensively adopted: enhanced energy efficiency, renewable energy procurement, optimized AI hardware, sustainable neural architectures, carbon accounting with transparent disclosure, and environmental sustainability policies and incentives. However, technology companies must prioritize responsibility and stewardship over profitability. Robust regulations focused on AI's ecological impacts, not just economic benefits, are essential for accountability. All stakeholders should holistically evaluate AI's advantages and externalities.

Individually, evaluating AI's overall impact is crucial beyond just efficiency gains. For sustainable mobility, emphasizing shared resources over private autonomy minimizes environmental degradation. More broadly, ethical AI prosperity within ecological boundaries requires abandoning extractive, consumption-driven models for responsible, socially conscious innovation centred on environmental justice. Indeed, intentionally developing AI prioritizing these principles demonstrates immense potential for advancing climate justice and equity. AI could empower marginalized communities in climate activism through locally sourced data analysis, support vulnerable nations' loss and damage claims by attributing extreme events, reduce bias excluding marginalized voices in climate science, prioritize equitable clean energy access, integrate Indigenous knowledge systems, and forecast climate migration patterns.

However, such transformative AI applications require grounding innovation in environmental stewardship, social responsibility, and sustainable development principles. Society faces a crossroads - will pursuing AI catalyse ecological renaissance and an equitable carbon-neutral transition? Or exacerbate climate catastrophe, perpetuating unjust impacts

on marginalized populations? The path depends on prioritizing wisdom and conscience over accomplishment alone. In many ways, AI presents a modern Faustian bargain offering expedited advancement but potentially at the cost of ecological endurance. Anthropogenic climate change poses an existential threat, and dedicating AI's immense capabilities towards sustainability, restorative justice, and human rights rather than perpetuating extraction offers hope. Yet balance requires holistic, multistakeholder approaches championing ethics and transparency over self-interest and unsustainable growth.

AI's breathtaking possibilities also risk irreversible degradation when decarbonization remains humanity's preeminent imperative. How the global community develops and implements AI over coming decades will test whether our species can responsibly wield technological prowess for environmental restoration. With moral clarity supporting responsible, planetary-conscious development, pathways can emerge towards climate justice, ecological regeneration, and prosperity elevating our entire species equitably. Though hurdles remain, rallying collaboration towards ethical, existentially aware AI innovation represents our era's greatest opportunity for realizing harmonious prosperity within true ecological limits. The future awaits judicious stewardship.

## Way Forward

Addressing both climate and equity challenges posed by artificial intelligence requires multi-faceted approaches, such as enhancing transparency, increasing renewable energy procurement (Dhar, 2020), optimizing efficiency, and implementing carbon accounting (Lacoste et al., 2019). However, technical solutions alone are not enough. A collective shift in mind set is essential. As experts emphasize, progress should be redefined as holistic advancement benefiting humanity through climate justice and just transitions, rather than exclusive gains for the technocratic elite (Dobbe & Whittaker, 2019). Promoting open access to intellectual capital over proprietary ownership offers potential, as does sustainable investment in developing nations for inclusive participation (Gichuki, 2022). Nonetheless, avoiding another extractive paradigm depends on recognizing our shared future within planetary limits. With thoughtful intentions and wisdom, AI could unveil solutions to issues of inequity and ecological constraints if stewardship prevails over self-interest. As Rolnick et al. (2021) summarize, "With responsible innovation, AI can become integral to an energy future that balances decarbonisation, resilience, and accessibility." This necessitates transparency, accountability, and global cooperation.

## Conclusion

This study illuminated the double-edged implications of artificial intelligence in relation to climate change – serving as both a potential solution and a threat. AI can optimize energy systems, but its growing training requirements and carbon footprint challenge sustainability. Our analysis examined AI's emissions impact, from hardware production to power-intensive data centres, which could hinder crucial decarbonisation efforts without intervention. However, solutions exist such as efficiency enhancements, renewable energy procurement, transparent reporting, and policy-driven innovation with an emphasis on environmental stewardship.

Fundamentally, AI development should be a collaborative process for mutual benefit and adhere to planetary boundaries. If responsibly harnessed, AI could reveal pathways for an equitable transition within ecological limits. This necessitates recognizing our interconnected fates and existential stakes. As governments devise national AI strategies, research must continually direct progress towards climate justice. While challenging questions persist, our era demands conscientiousness and wisdom. With purposeful intent, humanity has the potential to shape AI's next chapter, steering our world towards justice in harmony with a sustainable planet.

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## REFERENCES

Amaya, A., Bach, N., Phillips, C., Tejedor, A., Steinhaeuser, K., Lakkaraju, H., & Kammen, D. M. (2021). Social biases in solar geoengineering research. Nature Climate Change, 11(12), 1063-1067.

Amodei, D., & Hernandez, D. (2018). AI and Compute. OpenAI Blog.

Danish, S. S. (2023). AI-enabled energy policy for a sustainable future. Sustainability, 15, 7643.

Dhar, V. (2020). The carbon impact of artificial intelligence. Nature Machine Intelligence, 2, 423-425. https://doi.org/10.1038/s42256-020-0219-9

Dobbe, R., & Whittaker, M. (2019). AI and climate change: How they're connected, and what we can do about it. Climate Research.

Eskom. (2022). Environmental impact. https://www.eskom.co.za/OurCompany/SustainableDevelopment/EnvironmentalImpact/Pages/CDM_Projects.aspx

Eskom. (2022). Load shedding data. http://loadshedding.eskom.co.za/LoadShedding

Freeman, K. S. (2023). AI and energy consumption: Are we headed for trouble? Imore News.

Gee, G. C., & Payne-Sturges, D. C. (2004). Environmental health disparities: A framework integrating psychosocial and environmental concepts. Environmental Health Perspectives, 112, 1645–1653. https://doi.org/10.1289/ehp.7074

Gichuki, C. (2022). Konza Technopolis eyes AI, manufacturing and agriculture. The Exchange.

Hao, K. (2019). Training a single AI model can emit as much carbon as five cars in their lifetimes: Deep learning has a terrible carbon footprint. MIT Technology Review.

Holifield, R., Chakraborty, J., & Walker, G. (Eds.). (2017). The Routledge Handbook of Environmental Justice. Routledge.

Hutson, M. (2022). Measuring AI's Carbon Footprint: New tools track and reduce emissions from machine learning. IEEE Spectrum.

Jennifer, L. (2023). How big is the CO2 footprint of AI models? ChatGPT's emissions.

Kumari Rigaud, K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., Adamo, S., McCusker, B., Heuser, S., & Midgley, A. (2018). Groundswell: Preparing for Internal Climate Migration. World Bank.

Lacoste, A., Luccioni, A., Schmidt, V., & Dandres, T. (2019). Quantifying the carbon emissions of machine learning. Workshop on Tackling Climate Change with Machine Learning.

Li, R., Wang, W., Shi, Y., & Wang, P. (2023). Advanced Material Design and Engineering for Water-Based Evaporative Cooling. Advanced Materials, 2209460. https://doi.org/10.1002/adma.202209460

Lu, C. (2017). AI, native supercomputing and the revival of Moore's Law. APSIPA Transactions on Signal and Information Processing, 6, E9. doi:10.1017/ATSIP.2017.9

Luque-Ayala, A., Chapman, A., Scuriatti, C., Maia, L., Hunter, C., & Peres, W. (2021). Digital territories: Google Maps as a political technique in the reorganization of urban energy systems. Energy Research & Social Science, 79, 102138. https://doi.org/10.1016/j.erss.2021.102138

Minnesota Pollution Control Agency (MPCA). (2022). Environmental justice framework.

Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. Annual Review of Environment and Resources, 34, 405-430. https://doi.org/10.1146/annurev-environ-082508-094348

Morello-Frosch, R., & Lopez, R. (2006). The riskscape and the color line: Examining the role of segregation in environmental health disparities. Environmental Research, 102(2), 181-196. https://doi.org/10.1016/j.envres.2006.05.007

Nzimande, B. (2022). Minister Blade Nzimande: Abandonment of Kusile units 5 and 6 construction projects. Department of Higher Education, Science and Innovation.

Risser, M. D., & Wehner, M. F. (2017). Attributable human-induced changes in the likelihood and magnitude of the observed extreme precipitation during Hurricane Harvey. Geophysical Research Letters, 44(24), 12,457-12,464. https://doi.org/10.1002/2017GL075888

Rolnick, D., Donti, P.L., Kaack, L.H., Kochanski, K., Lacoste, A., Sankaran, K., Ross, A.S., Milojevic-Dupont, N., Jaques, N., Waldman-Brown, A., Luccioni, A., Maharaj, T., Sherwin, E.D., Mukkavilli, S.K., Körding, K.P., Gomes, C., Ng, A.Y., Hassabis, D., Platt, J.C., ... Bengio, Y. (2021). Tackling Climate Change with Machine Learning. arXiv.

Rolnick, D., Philip, L., Kaack, L., Lacoste, A., Luccioni, A. (2019). Trends and applications in climate informatics. Journal of Parallel and Distributed Computing, 134, 141-150. https://doi.org/10.1016/j.jpdc.2019.08.006

Saenko, K. (2022). The huge carbon footprint of AI algorithms: Machine learning has a disastrous environmental impact. Boston Globe.

Schwartz, R., Dodge, J., Smith, N.A., & Etzioni, O. (2019). Green AI. arXiv preprint arXiv:1907.10597.

Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and policy considerations for modern deep learning research. Thirty-Fourth AAAI Conference on Artificial Intelligence.

Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and Policy Considerations for Deep Learning in NLP. arXiv.

Whyte, K. P. (2018). What do Indigenous knowledges have to offer climate change research? In S. Díaz, J. Settele, E. Brondízio, & H. T. Ngo (Eds.), The IPCC and Indigenous Peoples (pp. 57-59). Intergovernmental Panel on Climate Change.

Wylie, S., Jalbert, K., Dosemagen, S., & Ratto, M. (2022). Advancing climate justice with community-based air quality monitoring and machine learning in California's Imperial County. Geo: Geography and Environment, 9(1), e00107.

Zhou, H., Liu, Q., Yan, K., & Du, Y. (2021). Deep learning enhanced solar energy forecasting with AI-driven IoT. Wireless Communications and Mobile Computing, 2021. https://doi.org/10.1155/2021/9249387

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