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AFRICA'S ENERGY POVERTY IN AN ARTIFICIAL INTELLIGENCE (AI) WORLD: STRUGGLE FOR SUSTAINABLE DEVELOPMENT GOAL 7

Jake Okechukwu Effoduh*

ABSTRACT

Energy poverty remains a significant challenge in Sub-Saharan Africa (SSA), where approximately 600 million people lack proper access to electricity. This paper examines the region's current state of energy poverty, highlighting its socio-economic impacts and the barriers to achieving Sustainable Development Goal 7 (SDG7), which aims for affordable, reliable, sustainable, and modern energy for all by 2030. Despite the region's rich renewable energy potential, inadequate infrastructure, economic constraints, and governance issues continue to impede progress. This work employs a doctrinal research methodology, focusing on the critical analysis of existing legal and policy frameworks relevant to energy poverty and the integration of AI in energy management. This paper presents an overview of energy poverty in SSA, underpinned by current statistics and trends. It then examines the dual role of artificial intelligence (AI) and how it impacts this area: while AI technologies, through its data centre s, for example, significantly increase energy consumption, AI also offers innovative solutions for energy management, efficiency, and the integration of renewable energy sources. This paper critically analyzes these dynamics using Marxist and Third World Approaches to International Law (TWAIL) frameworks to understand the broader socio-economic inequalities and global power dynamics at play. Major findings indicate that current policy frameworks are inadequate in addressing the unique challenges of energy poverty and the growing role of AI in the energy sector. The paper reviews existing policy and regulatory frameworks, identifying gaps and proposing actionable recommendations for integrating AI into policies to address energy poverty. It concludes with actionable policy recommendations to achieve a just and inclusive energy transition, contributing to the broader discourse on sustainable development and technological equity.

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Keywords: Energy Poverty, Artificial Intelligence, SDG7, Sub-Saharan Africa, Technology Equity.

1. INTRODUCTION

Energy poverty is a pervasive challenge in Sub-Saharan Africa (SSA), where much of the population lacks access to reliable, affordable, and sustainable energy services.[1] According to the International Energy Agency (IEA), 43 percent of the total population in Africa lacks access to electricity, with the vast majority residing in SSA.[2] This inadequacy hampers economic development, exacerbates social inequalities, and hinders progress toward Sustainable Development Goal 7 (SDG7), which aims to ensure universal access to modern energy by 2030.[3] Concurrently, the increasing influence of artificial intelligence (AI) technologies presents opportunities and challenges for the region's energy situation.

The intersection of energy poverty and AI is complex, reflecting broader socio-economic and political dynamics. Historically, the energy infrastructure in SSA has been shaped by colonial legacies and post-colonial developmental challenges, leading to uneven distribution and access.[4]

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1 Bruno Emmanuel Ongo Nkoa, Sosson Tadadjeu, and Henri Njangang, 'Rich in the dark: Natural resources and energy poverty in Sub-Saharan Africa' (2023) 80 Resources Policy <https://doi.org/10.1016/j.resourpol.2022.103264.> accessed 10 June 2024; Paul G Munro, Shanil Samarakoon and Greg A van der Horst, "African energy poverty: a moving target" (2020) 15 Environ. Res. Lett. 15 <https://iops cience.iop.org/article/10.1088/1748-9326/abaf1a/meta> accessed 10 June 2024; Belay Begashaw, 'Africa and the Sustainable Development Goals: A long way to go' (29 July 2019) Brookings <https://www.brookings.edu/articles/africa-and-the-sus tainable-development-goals-a-long-way-to-go/> accessed 11 June 2024

2 International Energy Agency "Africa Energy Outlook 2022" World Energy Outlook Special Report <https://www.iea.org/reports/africa-energy-outlook-2022 /key-findings> accessed 11 June 2024

3 Elias Zigah and Anna Creti, 'A Comparative Analysis of Electricity Access Initiatives in Sub-Saharan Africa' pp 271–306 in Gromek-Broc, K. (eds) Regional Approaches to the Energy Transition (Springer, Cham, 2023).

4 Esther Mwema and Abeba Birhane, 'Undersea cables in Africa: The new frontiers of digital colonialism' (2024) 29 First Monday <https://doi.org/ 10.5210/fm.v29i4.1363 7> accessed 11 June 2024; G20 and Sustainable Energy for All, 'Energy Poverty: addressing the intersection of Sustainable Development Goal 7 (SDG7), development and resilience' Executive Note for the G20 Energy Transition Working Group and the G20 Climate Sustainability Working Group (June 2021) <https://www.seforall.org/system/files?file=2021-06/G20-SEforALL-Energy-poverty-executive-note.pdf> accessed 10 June 2024.

Reliance on traditional biomass for cooking and limited electrification restricts economic activities, education, and healthcare in many areas.[5]

The proliferation of AI technology has now represented a transformative force in various sectors, including the energy sector, where its applications can drive significant improvements. Innovative AI technologies can potentially enhance energy management and efficiency, optimize energy grids, and integrate renewable energy sources more effectively.[6] For instance, AI-driven smart grids can predict and manage energy demand, reduce losses, and incorporate solar and wind power, which are abundant in the region.[7] However, AI also comes with risks related to increased energy consumption,[8] climate change,[9] and deepening existing inequalities.[10]

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5 Stephen Enyinnaya Eluwa and Oluwaseun Kilanko, 'Biofuel as an alternative for Sub-Saharan Africa's transition to cleaner energy' (2024) Academia Green Energy <https://doi.org/10.20935/AcadEnergy6227> accessed 10 June 2024.

6 Chinedu Ibegbulam and others, 'Role of Artificial Intelligence in Electrification of Africa' (2023) 4 Engineering Science & Technology Journal 456 - 472; Carol Ryan, 'Energy-Guzzling AI Is Also the Future of Energy Savings' Wall Street Journal (12 April 2024) <https://www.wsj.com/business/energy-oil/ai-data-centers-energy-savings-d602296e> accessed 11 June 2024.

7 European Commission, 'The potential of AI to improve energy efficiency' (28 November 2023) <https://build-up.ec.europa.eu/en/news-and-events/news/potential-ai-improve-energy-efficiency> accessed 10 June 2024.

8 Alexandra Sasha Luccioni, Yacine Jernite and Emma Strubell, 'Power Hungry Processing: Watts Driving the Cost of AI Deployment?' arXiv (23 May 2024) <https://arxiv.org/abs/2311.16863> accessed 12 June 2024; Muhammad Uzair Mehmood and others, 'A review of the applications of artificial intelligence and big data to buildings for energy efficiency and a comfortable indoor living environment' (2019) Energy and Buildings, 202.

9 OECD, 'Measuring the environmental impacts of artificial intelligence compute and applications: The AI footprint' (2022) OECD Digital Economy Papers 341 <https://doi.org/10.1787/7babf571-en> accessed 12 June 2024; Matthias C. Rillig and others, 'Risks and Benefits of Large Language Models for the Environment' (2023) 57 Environmental Science & Technology 3464–3466; Andrés Domínguez Hernández and others, 'Mapping the individual, social, and biospheric impacts of Foundation Models' In The 2024 ACM Conference on Fairness, Accountability, and Transparency (FAccT '24) (6 June 2024) <https://doi.org/10.1145/3630106.3658939> accessed 12 June 2024; Christelle Tessono, 'AI Governance Needs a Climate Change Strategy' CIGI DPH Working Paper (20 June 2024) <https://www.cigionline.org/publications/ai-governance-needs-a-climate-change-strategy/?trk=feed_main-feed-card_feed-article-content> accessed 25 June 2024.

10 Chinasa T. Okolo, 'AI in the Global South: Opportunities and challenges towards more inclusive governance' Brookings (1 November 2023) <https://www.brook

AI data centre s are energy-intensive,[11] and their high-power consumption can exacerbate existing energy deficits in a region where many already lack reliable electricity. The infrastructure required for AI is also costly, which can divert resources from essential services and infrastructure development. Moreover, the digital divide in SSA means that the benefits of AI are likely to be concentrated in urban areas, further marginalizing rural communities. Furthermore, the global energy demand driven by AI increases carbon emissions, indirectly affecting Africa through climate change impacts such as extreme weather and agricultural disruptions.[12]

While countries in SSA Africa have shown commitment to achieving SDG7, they often lack an integrated approach that considers the energy footprint of AI and promotes sustainable AI practices. This complexity is not fully addressed in the current policy frameworks in the region, creating a significant gap in balancing the benefits and costs of AI in the context of SDG7.

The primary objective of this paper is to critically examine the relationship between energy poverty in SSA and the increasing influence of AI. It seeks to understand how AI technologies can both exacerbate and mitigate energy poverty in the region and evaluate the policy and regulatory frameworks that can influence these dynamics. Through the lens of Marxist and Third World Approaches to International Law (TWAIL) perspectives, this paper aims to provide a nuanced analysis of the socio-economic and legal challenges and to offer informed recommendations for achieving SDG7.

This paper is divided into six sections, each addressing the intersection of energy poverty in SSA and the rise of AI. The first section introduces SDG7 and its significance for global energy access by 2030. The second section analyses the state of energy poverty in SSA, highlighting electrification rates, reliance on traditional biomass, and socio-economic impacts. The third

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ings.edu/articles/ai-in-the-global-south-opportunities-and-challenges-towards-more-inclusive-governance/> accessed 11 June 2024; Andrés Domínguez Hernández and others (n 9).

11 Alexandra Sasha Luccioni, Yacine Jernite and Emma Strubell (n 8); Mariana Mazzucato, 'The ugly truth behind ChatGPT: AI is guzzling resources at planet-eating rates' The Guardian (30 May 2024) <https://www.theguardian.com/commentisfree/article/2024/may/30/ugly-truth-ai-chatgpt-guzzling-resources-environment> accessed 14 June 2024.

12 Andrés Domínguez Hernández and others (n 9); Christelle Tessono (n 9).

section examines the influence of AI, focusing on innovation opportunities and the challenges of increased energy consumption. The fourth section explores AI's role in the socio-economic and legal challenges of achieving SDG7 in SSA, using Marxist and Third World Approaches to International Law (TWAIL) perspectives. The fifth section evaluates policy and regulatory frameworks, identifying gaps in sustainable and inclusive energy solutions. The paper concludes with actionable policy recommendations to ensure equitable access, protect vulnerable communities, and promote SDG7 goals for SSA.

2. SUSTAINABLE DEVELOPMENT GOAL 7 (SDG7)

SDG7 is a cornerstone of the United Nations' 2030 Agenda for Sustainable Development, aimed at ensuring access to affordable, reliable, sustainable, and modern energy for all by 2030.[13] The ambitious targets set under SDG7 include ensuring universal access to affordable, reliable, and modern energy services, substantially increasing the share of renewable energy in the global energy mix, and doubling the global rate of improvement in energy efficiency.[14]

Energy is central to nearly every major challenge and opportunity the world faces today.[15] A lack of access to energy hinders human and economic development, perpetuates poverty, and limits access to critical services like healthcare and education.[16] For instance, access to modern energy services reduces the need for harmful practices such as burning wood, charcoal, and animal dung for cooking and heating, which are linked to respiratory diseases and other health issues.[17] Improved energy access enhances the delivery of healthcare services by powering clinics and ensuring the availability of life-saving equipment.

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13 United Nations, 'Goal 7: Affordable and Clean Energy' (SDG Knowledge Platform, no date) <https://sdgs.un.org/goals/goal7> accessed 28 May 2024.

14 Brindha Ramasubramanian and Seeram Ramakrishna, 'What's next for the Sustainable Development Goals? Synergy and trade-offs in affordable and clean energy (SDG 7) (2023) 6 Sustain Earth Reviews 17.

15 United Nations (n 13).

16 Ibid.

17 Ibid.

In SSA, where energy poverty is pervasive, achieving SDG7 is particularly challenging yet critical. The region faces unique barriers, including inadequate infrastructure, financial constraints, and governance issues.[18] However, the global push for a clean energy transition presents a significant opportunity to address these challenges and set the region on a sustainable development path. As the world becomes increasingly AI-enabled, understanding the impact of these technologies on energy poverty is essential for crafting policies that support inclusive and equitable energy access.

3. ENERGY POVERTY IN SUB-SAHARAN AFRICA (SSA)

Various definitions of energy poverty highlight its multifaceted nature.[19] Energy poverty occurs when households or communities lack access to affordable, reliable, and modern energy services.[20] Access to electricity in SSA is notably limited.[21] The region is characterized by the highest rates of energy poverty globally, with profound implications for economic development, health, education, and overall quality of life.[22] Approximately 600 million people, nearly 48 percent of the population, do not have access to electricity,

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18 Bruno Emmanuel Ongo Nkoa, Sosson Tadadjeu, and Henri Njangang (n 1); Dmitriy Li, Jeong Hwan Bae and Meenakshi Rishi, 'Sustainable Development and SDG-7 in Sub-Saharan Africa: Balancing Energy Access, Economic Growth, and Carbon Emissions' (2023) 35(1) Eur J Dev Res. 112-137; Brindha Ramasu bramanian and Seeram Ramakrishna (n 14).

19 G20 and Sustainable Energy for All (n 4); Paul G Munro, Shanil Samarakoon and Greg A van der Horst (n 1); Sonal Jessel, Samantha Sawyer and Diana Hernández, 'Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature' (2019) 12 Front Public Health 357.

20 Dlzar Al Kez and others, 'Energy poverty assessment: Indicators and implications for developing and developed countries' (2024) 307 Energy Conversion and Management <https://doi.org/10.1016/j.enconman.2024.118324> accessed 21 June 2024.

21 Chukwuka G. Monyei and others, 'Regional cooperation for mitigating energy poverty in Sub-Saharan Africa: A context-based approach through the tripartite lenses of access, sufficiency, and mobility' (2022) 159 Renewable and Sustainable Energy Reviews <https://doi.org/10.1016/j.rser.2022.112209.> accessed 20 June 2024.

22 Ibid.

according to the International Energy Agency (IEA).[23] This figure is even more alarming in rural areas, where electrification rates can fall below 20 percent.[24] There is considerable disparity among countries within the region; for instance, South Africa, Ghana, and Kenya have made significant strides in expanding electricity access, whereas nations like Chad, Niger, and the Democratic Republic of Congo have electrification rates that remain below 20 percent.[25] Such disparities highlight the uneven progress and the complex nature of the energy poverty problem across SSA.

The reliance on traditional biomass for cooking and heating is another critical aspect of energy poverty in the region. Over 80 percent of the population depends on wood, charcoal, and animal dung, which are inefficient and polluting energy sources.[26] This dependence comes with significant health risks, particularly respiratory diseases, and results in premature deaths, especially among women and children who are most exposed to indoor air pollution.[27] Furthermore, the widespread use of biomass contributes to environmental degradation, including deforestation, which exacerbates the region's vulnerability to climate change and further depletes its natural resources.[28]

SSA's energy infrastructure is often outdated and inadequate. Power generation capabilities are typically insufficient and unreliable, leading to frequent outages and significant energy losses due to inefficient transmission and distribution networks. The region generally requires substantial investments to upgrade existing infrastructure and expand capacity. As of 2023, the African Development Bank estimated that achieving universal

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23 International Energy Agency, 'SDG7: Data and projections' (2023) <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity> accessed 18 June 2024.

24 Ibid.

25 Ibid.

26 Maklewa Agoundedemba, Chang Ki Kim and Hyun-Goo Kim, 'Energy Status in Africa: Challenges, Progress and Sustainable Pathways' (2023) 16(23) Energies 7708 <https://doi.org/10.3390/en16237708> accessed 19 June 2024; Stephen Enyinnaya Eluwa and Oluwaseun Kilanko (n 5)

27 Oladipo Idowu and others, 'Health risks associated with the production and usage of charcoal: a systematic review' (2023) 13(7) BMJ Open <https://europepmc.org/article/med/37487686> accessed 21 June 2024.

28 Ibid

electricity access by 2030 would require an annual investment of approximately 50 billion United States Dollars (USD).[29]

4. THE ROLE OF AI IN ENERGY POVERTY

4.1 AI and energy consumption

AI technologies require substantial computational power, particularly for training complex models and processing large datasets.[30] These computational demands increase energy consumption, primarily driven by the infrastructure needed to support AI operations, such as data centre s and high-performance computing facilities.[31]

Data centre s house computational hardware for AI processing and are particularly energy intensive. They require vast amounts of electricity to power servers and cooling systems to maintain optimal operating temperatures.[32] As AI applications expand, the energy demands of data centre s continue to grow. According to a recent report by Goldman Sachs, data centre s around the world currently use between one and two percent of total power. Still, this figure is expected to increase to about three to four percent by the end of the decade.[33] In regions like the U.S.A. and Europe, this

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29 African Development Bank Group, 'Africa's 2030 Universal Electricity Access Goal: Clock running out' (4 April 2023) <https://www.afdb.org/en/news-and-events/ press-releases/adesina-calls-100-billion-annually-achieve-affordable-and-sustainable-energy-africa-2030-60074> accessed 14 June 2024.

30 Ben Payton, 'Power mad: AI's massive energy demand risks causing major environmental headaches' Reuters (4 December 2023) <https://www.reuters.com/sustainability/climate-energy/power-mad-ais-massive-energy-demand-risks-causing-major-environmental-headaches-2023-12-04/> accessed 14 June 2024; Bloomberg, 'AI Is Already Wreaking Havoc on Global Power Systems' (21 June 2024) <https://www.bloomberg.com/graphics/2024-ai-data-centers-power-grids/> accessed 27 June 2024.

31 Ibid.

32 AI data centers consume significantly more energy than traditional data centers. Estimates of greenhouse gas emissions outputs of data centres specifically as a proportion of total emissions vary from about 0.6% and 1%. It is difficult to estimate how much of the overall data centre energy use is a result of AI. Calculating the energy use of an AI model is complicated. See Mariana Mazzucato (n 11); Bloomberg (n 30).

33 Goldman Sachs, 'AI is poised to drive 160% increase in data center power demand' (14 May 2024) <https://www.goldmansachs.com/intelligence/pages/AI-poised-to-drive-160-increase-in-power-demand.html> accessed 15 June 2024.

growing electricity demand will contribute to an increase not experienced in decades. Also, carbon dioxide emissions from data centre s could be more than double from 2022 to 2030.[34]

One of the fastest-growing areas of energy demand is generative AI, a type of AI that creates new content, such as text, images, and audio, by learning patterns from existing data of the machine learning process. This requires substantial energy for training and generating responses to queries. For instance, training a large language model like OpenAI's GPT-3 consumes nearly 1,300 megawatt-hours (MWh) of electricity, equivalent to the annual consumption of about 130 US homes.[35] It is reported that a single Google search uses 0.3 watt-hours of electricity, whereas a ChatGPT request consumes 2.9 watt-hours.[36] For context, an incandescent light bulb uses about 60 watt-hours. If ChatGPT were integrated into the nine billion searches conducted daily, it is estimated that electricity demand would increase by ten terawatt-hours annually, equivalent to the energy consumption of approximately 1.5 million European Union residents.[37]

The environmental impact of AI is not limited to energy-related greenhouse gas emissions. Constructing data centre s requires extracting environmentally damaging minerals such as lithium, cobalt, gallium, and germanium. Moreover, substantial quantities of water are consumed during the training and operation of AI systems.[38]

The growing energy needs for AI data centre s worldwide will cause several challenges for SSA. Despite contributing minimally to global carbon emissions, SSA is highly vulnerable to climate change impacts. The region faces extreme weather events, droughts, and changing agricultural patterns, all threatening food security and livelihoods. While the energy needed to run AI

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34 Ibid.

35 Alexandra Sasha Luccioni, Sylvain Viguier, and Anne-Laure Ligozat, 'Estimating The Carbon Footprint Of Bloom, A 176b Parameter Language Model' arXiv (3 November 2022) <https://arxiv.org/pdf/2211.02001> accessed 16 June 2024.

36 Brian Calvert, 'AI already uses as much energy as a small country. It's only the beginning' Vox (28 March 2024) <https://www.vox.com/climate/2024/3/28/24111721/ai-uses-a-lot-of-energy-experts-expect-it-to-double-in-just-a-few-years> accessed 16 June 2024.

37 Ibid.

38 Kate Crawford, 'Generative AI's environmental costs are soaring — and mostly secret' Nature (20 February 2024) <https://www.nature.com/articles/d41586-024-00478-x> accessed 17 June 2024.

data centre s is not directly sourced from Africa, the environmental consequences of increased global energy consumption affect the continent.[39] Climate change-induced disruptions can strain Africa's already fragile energy infrastructure, making it more challenging to achieve SDG7.

4.2 The Potential of AI Technology for Energy Access

Some AI systems have the potential to advance SDG7 for SSA.[40] This is notwithstanding the limitations and challenges of the technology. Some AI tools can facilitate advances in sustainable energy systems by enhancing efficiency, optimizing resource utilization, and promoting the transition to renewable energy sources.[41] Some AI algorithms can analyze vast amounts of data, enabling accurate energy production forecasting from intermittent renewable sources like solar and wind.[42] This predictive capability can allow for better integrating these sources into the grid, ensuring a stable and reliable energy supply. Moreover, AI systems can monitor energy consumption patterns, identify inefficiencies, and make real-time adjustments to optimize energy distribution and reduce waste, maximizing the utilization of existing resources.[43]

As energy systems become increasingly decentralized with the proliferation of distributed renewable sources and microgrids, AI tools could help manage the complexity and ensure grid stability by coordinating and balancing the intermittent supply from multiple sources. AI systems can also analyze data from sensors and smart meters to detect anomalies or potential failures in energy infrastructure, enabling predictive maintenance and reducing

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39 Andrés Domínguez Hernández and others (n 9); Christelle Tessono (n 9).

40 Ricardo Vinuesa and others, 'The role of artificial intelligence in achieving the Sustainable Development Goals' (2020) 11 Nat Commun 233 <https://doi.org/10.1038/s41467-019-14108-y> accessed 16 June 2024.

41 Chinedu Ibegbulam and others (n 6); Tanvi Deshpande, 'Understanding AI for sustainable development in Africa' GSMA (9 February 2024) <https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/blog/understanding-ai-for-sustainable-development-in-africa/> accessed 17 June 2024.

42 Fat Finger, 'The Role of Artificial Intelligence in Optimizing Energy Production' (29 February 2024) <https://fatfinger.io/the-role-of-artificial-intelligence-in-optimi zing-energy> accessed 18 June 2024.

43 Fat Finger (n 42); Zaid Allal and others, 'Machine learning solutions for renewable energy systems: Applications, challenges, limitations, and future directions' (2024) J Environ Manage <https://pubmed.ncbi.nlm.nih.gov/38387355/> accessed 17 June 2024.

downtime, thus improving the reliability and efficiency of renewable energy systems.[44]

Furthermore, AI systems could accelerate the discovery and optimization of new materials and technologies for energy harvesting, storage, and conversion, driving innovation in sustainable energy technologies.[45] There are machine learning models that can predict material properties, generate candidate structures, and optimize synthesis processes, significantly reducing the time and cost of developing new energy solutions.[46]

5. ANALYSIS OF ENERGY POLICIES AND AI IN SUB-SAHARAN AFRICA (SSA)

A strategic framework developed by the African Union (AU) titled "Continental Artificial Intelligence Strategy: Harnessing AI for Africa's Development and Prosperity" guides the development and use of AI across the African continent.[47] This strategy, adopted in July 2024, aims to leverage AI as a driving force for socio-economic transformation, cultural renaissance, and achieving the SDGs. It identifies AI as a key tool for improving energy efficiency, managing resources better, and supporting the integration of renewable energy sources, even though it considers the environmental risks of energy consumption for training and operation and how it contributes to increased CO2 emissions and exacerbates climate change. For example, the high demand for fresh water to cool data centre s poses a threat to regions already facing water scarcity. Also, with AI comes the introduction of electronic waste, which will also affect the environment.[48]

Countries in Sub-Saharan Africa (SSA) have undertaken numerous initiatives to achieve SDG7, focusing on expanding electrification, promoting renewable energy adoption, improving energy efficiency, and creating a conducive environment for energy sector investments through various policies, legal,

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44 Fat Finger (n 42).

45 Zhenpeng Yao and others, 'Machine learning for a sustainable energy future' (2023) 8 Nat Rev Mater 202–215 <https://doi.org/10.1038/s41578-022-00490-5> accessed 18 June 2024.

46 Zaid Allal and others (n 43).

47 African Union, Continental Artificial Intelligence Strategy: Harnessing AI for Africa's Development and Prosperity (July 2024).

48 Ibid at 25.

and regulatory frameworks.[49] This paper analyzes casually selected regulatory approaches in SSA, including case studies from Nigeria, Kenya, and Uganda. While these selected countries have made strides in expanding electrification and promoting renewable energy,[50] their policies and regulatory frameworks may seem to largely overlook the paradox of the technology of AI as both a potential solution for optimizing energy use and a significant contributor to energy consumption. This oversight could obscure the potential of the technology to advance SDG7 in the region.

5.1 Nigeria

Nigeria's policies and frameworks for achieving SDG7 are focused on expanding electrification, stimulating renewable energy adoption, improving energy efficiency, and creating an environment conducive to investments in the energy sector. Among these frameworks, the Rural Electrification Strategy and Implementation Plan (RESIP) stands out as a notable initiative to expand electricity access to rural and underserved areas, as a significant portion of Nigeria's population resides in rural areas with limited or no access to electricity.[51] As a result, the critical elements of the RESIP include the deployment of mini-grids and solar home systems, the promotion of public-private partnerships (PPPs), and strong community engagement.[52]

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49 Elias Zigah and Anna Creti (n 3); Dmitriy Li, Jeong Hwan Bae and Meenakshi Rishi (n 18).

50 Africa has made progress towards universal energy access in recent years. Electricity coverage increased from 44–56 per cent of the continent's population between 2010 and 2023. See International Energy Agency (n 2).

51 Other initiatives include the National Renewable Energy and Energy Efficiency Policy (NREEEP), Nigerian Renewable Energy Master Plan (REMP), the National Energy Efficiency Action Plan (NEEAP), and the Nigeria Electrification Project (NEP). See João Marcos Mott Pavanelli and others, 'An institutional framework for energy transitions: Lessons from the Nigerian electricity industry history' (2023) 97 Energy Research & Social Science <https://www.sciencedirect .com/science /article/pii/S2214629623000543> accessed 18 June 2024; Esuru Rita Okoroafor, Ejeong Baik and Calista Dikeh, 'A Roadmap to Universal Energy Access in Nigeria. Advances in Science and Technology' Africa International Conference on Clean Energy and Energy Storage (March 2024) <https://doi.org/10.4028/p-3e6efw> accessed 18 June 2024; Odunayo Adewunmi Adelekan and others, 'Energy Transition Policies: A Global Review of Shifts Towards Renewable Sources' (2024) 5(2) Engineering Science & Technology Journal 272-287.

52 Ibid.

Mini grids are small-scale electricity networks that can operate independently or be connected to the national grid[53]. They are particularly suitable for remote areas where extending the national grid would be economically unfeasible.[54] By utilizing locally available renewable energy sources such as solar, wind, and biomass, mini grids provide a reliable and sustainable power supply to rural communities.

Solar home systems, on the other hand, are individual solar power units designed for single households. These systems are relatively inexpensive and easy to install, making them an ideal solution for off-grid rural areas. They provide households with basic electricity needs, such as lighting, phone charging, and powering small appliances.[55] The plan to widely deploy these systems under RESIP is expected to significantly improve the quality of life for many rural Nigerians, reducing reliance on kerosene lamps and generators, which are both costly and environmentally harmful.

A cornerstone of the RESIP is the encouragement of PPPs. These partnerships are necessary for mobilizing the capital and expertise to scale up rural electrification projects.[56] The RESIP facilitates PPPs by providing an enabling environment through favourable policies and incentives. This includes tax holidays, duty exemptions on renewable energy equipment, and streamlined regulatory processes[57]. These incentives are aimed at attracting private sector players to invest in rural electrification projects, ensuring that the goals of the RESIP are met.[58]

Another significant aspect of the RESIP is its emphasis on community engagement. The strategy recognizes that for rural electrification projects to be successful and sustainable, they must involve the local communities in the

53 Olujobi, O.J., et al (2022), Carbon Emission, Solid Waste Management, and Electricity Generation: A Legal and Empirical Perspective for Renewable Energy in Nigeria, International Environmental Agreements: Politics, LAW and Economics, DOI 10.1007/s10784-021-09558>https://link.springer.com/article/10.1007%2Fs107 84-021-09558-z#citeas> accessed August 16, 2024.

54 Ibid.

55 Ibid.

56 Ibid.

57 Olujobi, O.J., Olusola-Olujobi, T., Nigeria: Advancing the Cause of Renewable Energy in Nigeria's Powers Sector Through its Legal Framework, Environmental Policy and Law, (2020),433-444.

58 Ibid.

planning and implementation processes.[59] This participatory approach ensures that the projects are tailored to meet the specific needs and conditions of the communities they serve.

Nigeria's legal framework on AI and emerging technologies is still nascent, with a few scattered regulations and policies that touch upon the broader use of technology rather than AI specifically. For instance, Nigeria's National Artificial Intelligence Strategy (NAIS) of 2024 outlines a comprehensive approach to harnessing the potential of AI for socio-economic development, including its application in achieving SDG7 by fostering AI-driven innovations in the renewable energy sector (which can help manage energy needs, optimize consumption patterns, and contribute to the broader goal of reducing energy poverty).[60] The document recognizes the significant impact AI can have on the energy sector. It acknowledges the importance of leveraging AI to address energy-related challenges, like reducing the carbon footprint through innovative approaches in deploying AI systems,[61] as well as establishing AI clusters powered by clean or sustainable energy sources as part of its strategy to build foundational AI infrastructure.[62] This approach is designed to support the development, deployment, and innovation of AI in a manner that contributes to energy efficiency and sustainability, which is critical for addressing energy poverty in Nigeria. However, one of the key challenges here is the infrastructural limitation within Nigeria, particularly in terms of energy access and reliability. The strategy notes the need for substantial investment in AI infrastructure, however, there are no detailed plans for how these investments will be sourced and implemented, which could be a significant barrier to achieving its objectives.

5.2 Kenya

Kenya has made more significant strides than its subregional counterparts in developing a legal framework for AI and related technologies. The country's Digital Economy Blueprint in 2019 underscores the importance of AI in achieving Kenya's Vision 2030, particularly in energy, where AI could enhance the efficiency and distribution of renewable energy resources.[63]

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59 Ibid.

60 National AI Strategy (NAIS) 2024, Federal Ministry of Communications, Innovation, and Digital Economy, Nigeria.

61 Ibid at 27.

62 Ibid at 28.

63 Kenya Digital Economy Blueprint, Ministry of ICT, Innovation and Youth Affairs, Republic of Kenya, (2019).

However, like Nigeria, Kenya lacks a comprehensive AI-specific legal framework. The regulatory environment is fragmented, and while Kenya has shown interest in adopting AI, the policies are not yet fully aligned with the specific challenges of energy poverty.

The Kenya Off-Grid Solar Access Project (KOSAP) is a critical component of Kenya's efforts to achieve SDG7. Launched in 2017, KOSAP is an essential initiative to provide electricity to Kenya's remote, low-density, and traditionally underserved areas.[64] Funded by the World Bank, KOSAP focuses on deploying solar technology to enhance energy access, thereby contributing to the achievement of SDG7. The critical components of KOSAP include the distribution of stand-alone solar home systems, the establishment of mini-grids, and the promotion of clean cooking solutions.[65]

KOSAP places significant emphasis on distributing stand-alone solar home systems to households not connected to the national grid. These systems are designed to provide essential electricity services such as lighting, phone charging, and powering small appliances.[66] Another critical component of KOSAP is the establishment of mini-grids. These are localized, small-scale electricity networks that can operate independently or in conjunction with the national grid. Mini-grids are particularly effective in areas where extending the national grid is not economically viable.[67]

KOSAP also addresses the need for clean cooking solutions, recognizing that traditional cooking methods, such as using firewood and charcoal, have significant health and environmental impacts. The project promotes the use of clean and efficient cookstoves, which reduce indoor air pollution and the demand for biomass. This component of KOSAP is vital for improving health outcomes and reducing deforestation in rural areas.[68]

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64 See Kenya Off-Grid Solar Access Project <https://www.kosap-fm.or.ke/> accessed 20 June 2024.

65 The World Bank, 'Kenya: Off-grid Solar Access Project for Underserved Counties' <https://projects.worldbank.org/en/projects-operations/project-detail/P160009> accessed 20 June 2024.

66 Christine Majale, Godwin Opinde and Ivan Nygaard, 'Bringing light, connectivity and waste to local communities: A study of the post-consumption value chain for off-grid solar devices in Kenya' (2024) 112 Energy Research & Social Science <https://doi.org/10.1016/j.erss.2024.103516.> accessed 20 June 2024.

67 Ibid.

68 The World Bank (n 63).

It is pertinent to note the policy and regulatory support KOSAP receives from other adjacent initiatives in the energy sector. The country's National Energy Policy provides the overarching framework for energy development, emphasizing the need for sustainable and inclusive energy access. The Energy Act 2019 consolidates the legal framework for the sector, establishing clear guidelines for developing and regulating energy projects, including those focused on renewable energy and rural electrification.

Kenya Vision 2030, the country's development blueprint, identifies energy as a critical enabler of socio-economic development. It outlines ambitious targets for expanding access to electricity and increasing the share of renewable energy in the national energy mix. The Kenya National Electrification Strategy (KNES), developed in 2018, provided a detailed roadmap for achieving universal access to electricity by 2022. It highlighted the role of off-grid solutions, such as those promoted by KOSAP, in reaching the last-mile populations.[69] This goal was unmet.

5.3 Uganda

Uganda is in the early stages of developing a legal and regulatory framework for AI and other emerging technologies. Uganda's energy sector, heavily reliant on hydropower, faces significant challenges, including limited access to electricity in rural areas. The Energy for Rural Transformation (ERT) Program, launched in 2001, is a comprehensive initiative to provide electricity and modern energy services to rural areas of Uganda.[70] Funded by the World Bank and the Government of Uganda, the ERT Program focuses on enhancing energy access through various means, including expanding grid electricity, deploying off-grid solutions, and promoting renewable energy technologies.[71]

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69 Mohammed Takase, Rogers Kipkoech and Paul Kwame Essandoh, 'A comprehensive review of energy scenario and sustainable energy in Kenya' (2021) 7 Fuel Communications <https://doi.org/10.1016/j.jfueco.2021.100015.> accessed 20 June 2024.

70 Ibrahim Mukisa and others, 'Clean Energy Use and Sustainable Development Paradox: The Case of Clean Cooking Solutions in Uganda' pp. 81-95 in Abdulkadri Toyin Alabi and Ahmet Kardaşlar (eds.) Africa Studies Effects of Environmental Factors on Economic Development (Iksad Publications, Ankara, 2023).

71 Padmasai Lakshmi Bhamidipati, Ulrich Elmer Hansen and James Haselip, 'Agency in transition: The role of transnational actors in the development of the off-grid solar PV regime in Uganda' (2019) 33 Environmental Innovation and Societal Transitions, 30-44.

One of the essential components of the ERT Program is expanding grid electricity to rural areas. This involves extending the national electricity grid to reach more remote communities. By doing so, the program aims to provide reliable and affordable electricity to rural households, businesses, and institutions.

Recognizing that grid extension is not always feasible or cost-effective, the ERT Program also focuses on off-grid solutions. These include deploying solar home systems, mini-grids, and other renewable energy technologies. Solar home systems provide a sustainable and affordable source of electricity for individual households, allowing them to power lights, charge phones, and run small appliances. Mini grids, which are localized electricity networks, offer a reliable power supply for communities not connected to the national grid.[72]

The ERT Program promotes using renewable energy technologies to enhance energy access in rural areas. This includes developing small-scale hydropower projects, wind energy, and biomass energy solutions. Promoting renewable energy technologies under the ERT Program aligns with Uganda's broader goals of increasing the share of renewables in the national energy mix and reducing greenhouse gas emissions.[73]

The success of the ERT Program is supported by Uganda's broader policy and regulatory framework for the energy sector. While other policies and frameworks contribute to the wider energy framework in Uganda, the ERT Program's targeted approach is unique in its focus on ensuring that even the most underserved communities gain access to modern, reliable, and sustainable energy.[74] The National Energy Policy 2002 provides the overarching framework for energy development in Uganda, emphasizing the need for sustainable and inclusive energy access.[75] The Renewable Energy Policy 2007 outlines the government's commitment to promoting renewable

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72 Matt Piggins, 'Powering Rural Transformation: Solar PV in Rural Uganda' (2014) Independent Study Project (ISP) Collection 1781 <https://digitalcollections.sit.edu/isp_collection/1781> accessed 21 June 2024.

73 Ibrahim Mukisa and others (n 62).

74 See Christopher D. Gore, Electricity in Africa: The politics of transformation in Uganda (Vol. 39) (Boydell & Brewer, 2017).

75 Val Hyginus Udoka Eze and others, 'Assessing Energy Policies, Legislation and Socio-Economic Impacts in the Quest for Sustainable Development' (2023) 6 International Journal of Education, Science, Technology, and Engineering, 68-79.

energy technologies and increasing the share of renewables in the energy mix.[76]

Uganda Vision 2040, the country's long-term development blueprint, identifies energy as a critical driver of socio-economic development. It sets ambitious targets for expanding access to electricity and increasing the use of renewable energy sources. The vision emphasizes the importance of modern energy services in achieving sustainable development and improving the quality of life for all Ugandans.[77]

6. INTEGRATION OF AI IN ENERGY POLICIES OF SUB-SAHARAN AFRICA

A critical analysis of energy policies in SSA reveals a significant gap in addressing the impact of AI on the region's energy situation.[78] Current frameworks primarily focus on conventional methods of improving energy efficiency and expanding electrification without adequately considering AI's implications. Notably, there is a dearth of recognition of the energy demands associated with AI technologies, including the substantial burden imposed by data centres and AI operations. Existing policies and strategies do not account for this additional energy consumption, and regulations fail to provide specific guidelines for deploying and managing AI technologies in the energy sector. This oversight leaves room for unchecked energy use and potential inefficiencies.

Despite growing awareness of the energy-intensive nature of AI technologies, measures to mitigate their environmental impact remain quite absent from extant energy policies in the SSA region. There is hardly any emphasis on promoting energy-efficient AI algorithms or sustainable data centre practices. Consequently, the need for sustainable deployment of AI technologies, including developing low-energy AI algorithms and energy-efficient data centres, is yet to be addressed.

Several factors contribute to these policy and regulatory gaps. To begin with, there is a general lag in adopting advanced technologies in SSA, partly due to limited awareness and understanding of AI and its potential impacts on

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76 Ibid.

77 Ibrahim Mukisa and others (n 68).

78 Elias Zigah and Anna Creti (n 3).

various sectors of the economy.[79] Policymakers and stakeholders may not fully grasp the dual conflicting nature of the technology as providing a possible solution and a contributor to energy consumption. Meanwhile, in other regions like Europe and North America, AI is increasingly integrated into the energy sector to drive efficiency and resiliency and possibly reduce emissions.[80] Meanwhile, in Ghana, for example, while there have been discussions on utilizing AI for energy efficiency, the understanding of its energy consumption implications is still nascent.

In addition, SSA's energy policies are often developed and implemented in silos, with different agencies focusing on specific aspects such as electrification, renewable energy, and energy efficiency. This fragmented approach hinders the integration of AI considerations, which require a holistic view of the energy ecosystem. Effective integration of AI into energy policies necessitates close coordination among various government agencies, including those responsible for technology, environment, and energy. In Kenya, for instance, the Ministry of Energy, the Ministry of ICT, and the Ministry of Environment operate quite independently, making cohesive AI policy formulation challenging. However, inter-agency collaboration in many SSA countries is often weak due to bureaucratic hurdles and a lack of clear communication channels. In South Africa, despite efforts to promote inter-agency collaboration, bureaucratic challenges persist, slowing down the possible consideration of AI in energy policies.

Regulatory and institutional challenges further constrain efforts to integrate AI into energy policies. The absence of specific regulations or guidelines for deploying and managing AI technologies in the energy sector allows unchecked energy consumption by AI applications and data centre s. In Uganda, the regulatory framework for AI is still in its infancy, and there are no clear guidelines on how AI can be integrated into the energy sector. Public institutions in the region can be slow to adapt to new technologies and innovations, and regulatory frameworks are often rigid, resisting changes that would incorporate AI considerations into existing policies. In Tanzania, for example, the slow pace of regulatory reform may be one of the several factors

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79 Kadijatou Diallo and others, 'Case Studies of AI Policy Development in Africa' (2024) Data & Policy 1–12 <https://arxiv.org/html/2403.14662v1> accessed 13 June 2024.

80 Paul Dabber, 'The Role of Artificial Intelligence in Powering America's Energy Future', Center on Global Energy Policy (CGEP) (19 October 2023) <https://www.energypolicy.columbia.edu/publications/the-role-of-artificial-intelligence-in-powering-americas-energy-future/> accessed 21 June 2024.

hampering the adoption of innovative AI solutions within their energy sector.

Implementing AI technologies also requires significant financial investment in infrastructure, research, and development. The SSA region quite generally faces substantial resource constraints that limit the ability to consider the technological integration of AI within the energy sectors. For instance, in Zambia, limited financial resources may restrict investments in the necessary infrastructure to support AI deployment. Nigeria may have more financial resources than Zambia, but the technical capacity to deploy and manage AI solutions may be limited, with a shortage of skilled professionals who can design, implement, and oversee AI-driven energy projects. Such scarcity of trained AI professionals poses a significant barrier to the adoption of AI technologies in the energy sector. The digital infrastructure is necessary to support AI technologies, such as high-speed internet and reliable power supply, is often lacking in many parts of SSA and even in countries like South Africa, Kenya and Ethiopia, where the internet infrastructure may be better than, say, Niger, Gambia and Zambia, This deficiency generally hampers the effective deployment and scaling of AI solutions across the region.

Quite recently, the African Union adopted a Continental AI Strategy for Africa,[81] which outlines strategic objectives and action areas for harnessing AI for socio-economic development across the African continent. The document includes some propositions for addressing the integration of AI into Africa's energy framework. The strategy recognizes AI systems, particularly those requiring extensive energy consumption for training and operation, to contribute to increased CO2 emissions and exacerbate climate change (and the high demand for fresh water to cool data centres as posing a threat to regions already facing water scarcity).[82] However, significant electricity is required to run networks and equipment because power outages are common in many SSA countries, with generators and UPS systems often being relied on as primary power sources. Therefore, efforts to explore renewable energy sources to power broadband networks, computing platforms, data centre facilities, and IoT devices are critical for the deployment of AI solutions in SSA.[83] But this will require a reimagined energy infrastructure, necessitating

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81 African Union Commission, Draft Continental AI Strategy for Africa (May 2024). <https://www.nepad.org/news/african-union-artificial-intelligence-continental-strategy-africa> accessed 1 July 2024.

82 Ibid.

83 Ibid.

significant energy ecosystem disruption, as well as regulatory and institutional changes.

7. LESSONS FROM OTHER REGIONS

In contrast to SSA, countries in the European Union (EU), North America, and parts of Asia tend to have quite advanced digital infrastructures and greater access to investment in AI technologies. These jurisdictions are also more likely to invest in energy-efficient data centers and advanced AI research, contributing to the sustainable development of AI applications in their energy sectors. AI technologies are being leveraged to enhance energy efficiency across various sectors in the EU.[84] For instance, the use of AI has proven to optimize building heating and ventilation systems by analyzing data from sensors, outdoor temperatures, and energy use. This optimization can lead to significant energy savings, as demonstrated by a Swedish pilot project where AI-controlled heating resulted in a 20 percent reduction in energy consumption.[85]

These countries' policies often include incentives for developing energy-efficient AI technologies, guidelines for sustainable data center operations, and frameworks for integrating AI into energy management systems. In addition, there is a stronger emphasis on sustainability through specific measures to reduce the environmental impact of AI, such as promoting the development of low-energy AI algorithms and energy-efficient data centers. These jurisdictions are also more proactive in setting standards and guidelines to ensure that AI integration aligns with broader sustainability goals.

For example, the EU AI Act, proposed in April 2021 and adopted in March 2024, is the world's first comprehensive AI regulation.[86] It aims to ensure that

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84 A. Shaji George and A.S. Hovan George, 'A review of ChatGPT AI's impact on several business sectors' (2023) 1 Partners Universal International Innovation Journal 9-23; Nitin Rane, 'Contribution of ChatGPT and Other Generative Artificial Intelligence (AI) in Renewable and Sustainable Energy' SSRN (2023) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4597674> accessed 19 June 2024.

85 European Commission (n 7).

86 European Parliament, regulation (eu) 2024/… of the european parliament and of the council of … laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act)

AI systems used in the EU are safe, transparent, traceable, non-discriminatory, and environmentally friendly.[87] The Act classifies AI systems based on the risk they pose to users, with different levels of regulation applied accordingly. High-risk AI systems, for example, must comply with stringent transparency and accountability requirements, including documenting energy consumption and reporting serious incidents.[88]

The EU AI Act addresses various risks associated with AI in the energy sector, such as lack of transparency, cybersecurity threats, and market dominance. The Act emphasizes transparency and clear responsibilities but has been critiqued for not addressing human autonomy and cybersecurity issues sufficiently.[89]

Significantly, the EU AI Act includes provisions to address the environmental impact of AI systems. Providers of general-purpose AI models must document their energy consumption, and high-risk AI systems must account for any direct or indirect harm to the environment.[90] The Act aims to balance the benefits of AI for environmental sustainability with the need to mitigate its negative impacts, such as high energy consumption and resource use in data centers.

Policymakers in the United States have also initiated legislative measures to address the impact of AI on energy consumption. In February 2024, some Senators in the U.S.A. introduced the Artificial Intelligence Environmental Impacts Act of 2024.[91] This bill directs the National Institute for Standards and Technology to collaborate with academia, industry, and civil society to establish standards for assessing AI's environmental impact and to create a voluntary reporting framework for AI developers and operators. While the passage of this legislation remains uncertain, it will offer valuable insights for

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87 Ibid, preamble.

88 Zuzanna Warso and Kris Shrishak, 'Hope: The AI Act's Approach to Address the Environmental Impact of AI' (21 May 2024) <https://www.techpolicy.press/hope-the-ai-acts-approach-to-address-the-environmental-impact-of-ai/> accessed 19 June 2024.

89 Irene Niet, Rinie van Est and Frank Veraart, 'Governing AI in Electricity Systems: Reflections on the EU Artificial Intelligence Bill' (2021) 4 Front. Artif. Intell., <https://doi.org/10.3389/frai.2021.690237> accessed 19 June 2024.

90 Zuzanna Warso and Kris Shrishak (n 85).

91 U.S. Senate, Artificial Intelligence Environmental Impacts Act of 2024. See full text of the Bill <https://www.markey.senate.gov/imo/media/doc/artificial_intelligence_environmental_impacts_act_of_2024_-_020124pdf.pdf>

SSA on the importance of addressing AI's energy consumption impacts, particularly given that the region is disproportionately affected by the environmental consequences of AI development and deployment.

8. ENERGY POVERTY IN SSA AND AI THROUGH THE LENS OF MARXIST THEORY

Marxist theory, rooted originally in the works of Karl Marx, focuses on the dynamics of class struggle, the exploitation of labour, and the inequalities inherent in capitalist systems.[92] Applying this theoretical framework to the issues of energy poverty in SSA and advances in AI reveals deep-seated structural inequalities and the potential for metastasizing these disparities. As mostly a product of advanced capitalist economies, AI technology requires substantial infrastructure, skills, and technology investment, typically concentrated in wealthier, more developed regions.[93] This leads to a technological divide where affluent urban areas can benefit from AI-driven energy solutions while rural and impoverished communities are left behind. The unequal access to AI technologies mirrors broader patterns of inequality within the capitalist system, where technological advancements primarily serve the interests of the capitalist class.[94]

8.1 Class Struggle, Capital Accumulation, and Energy Distribution

The energy poverty in SSA can be seen as a manifestation of the broader class struggle, where the working class and rural populations are deprived of basic energy services essential for economic development and improved living standards.[95] The high costs of electricity and the lack of grid connectivity in

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92 See Massimo Modonesi, Alfonso Garcia Vela and Maria Vignau Loria (eds.), The Concept of Social Class in Contemporary Marxist Theory (ibidem Press, Stuttgart and Hannover, 2022).

93 Daniel Morley, 'Artificial Intelligence: Doomsday for humanity, or for capitalism?' In Defence of Marxism (05 May 2023) <https://www.marxist.com/artificial-intelligence-doomsday-for-humanity-or-for-capitalism.htm> accessed 19 June 2024.

94 Chinasa T. Okolo (n 10).

95 Hui Wang and others, 'An assessment of energy poverty in sub-Saharan Africa: the role of financial inclusion and education' (2023) 56 Econ Change Restruct 4689–4711 <https://doi.org/10.1007/s10644-023-09568-8> accessed 19 Junes 2024.

rural areas further entrench the economic disparities between the urban elite and rural communities.[96]

Marxist theory emphasizes the concept of class struggle, which is the conflict between different classes with opposing interests.[97] In SSA, the class struggle manifests in controlling and distributing energy resources. The capitalist class, comprising multinational corporations and local elites, often controls energy production and distribution systems. These entities prioritize investments that yield high returns, such as urban electrification projects and industrial energy supplies, which cater to the needs of businesses and affluent consumers.[98]

Conversely, the working class and rural communities face significant barriers to accessing modern energy services. Energy infrastructure in rural areas is underdeveloped, and the costs of extending the grid are high. As a result, many rural communities remain dependent on traditional biomass for cooking and lack reliable electricity, perpetuating energy poverty. The capitalist emphasis on profitable ventures leads to neglecting unprofitable yet socially necessary investments in rural electrification and sustainable energy solutions.

Capital accumulation, a central tenet of Marxist theory, refers to the process by which wealth is concentrated in the hands of the capitalist class through the exploitation of labour and resources. In the energy sector, capital accumulation is evident in the concentration of investments in large-scale energy projects, such as hydropower dams and fossil fuel extraction, which are often financed by international capital and controlled by multinational corporations. These projects frequently lead to the displacement of local

96 The Climate Reality Project, 'Mobilizing clean energy to address energy poverty West Africa' (July 10, 2023) <https://www.climaterealityproject.org/blog/mobilizing-clean-energy-address-energy-poverty-west-africa> accessed 21 June 2024.

97 Ho-Won Jeong and Eleftherios Michael (eds), 'Theories of Conflict' pp. 2105-2113 in Lester Kurtz, Encyclopedia of Violence, Peace, & Conflict (2nd ed) (Academic Press, 2008); Massimo Modonesi, Alfonso Garcia Vela and Maria Vignau Loria (n 84).

98 Peter Ross, 'The Relevance of Marx's Value Theory in the Age of Artificial Intelligence' (4 October 2023) <https://cosmonautmag.com/2023/10/the-relevance-of-marxs-value-theory-in-the-age-of-artificial-intelligence/> accessed 22 June 2024.

communities, environmental degradation, and social unrest, further entrenching the marginalization of the working class and rural communities.[99]

AI technologies can reinforce these capital accumulation patterns when deployed in the energy sector. For instance, AI-driven energy management systems and smart grids require substantial upfront investments and sophisticated technology, typically accessible only to large corporations and wealthy urban areas. This concentration of technological and financial resources perpetuates unequal energy distribution, as rural and low-income communities lack the capital and infrastructure to benefit from AI innovations.

8.2 Energy Distribution and Social Inequality

The capitalist priorities of profit and efficiency deeply influence the distribution of energy resources in SSA. AI technologies have the potential to optimize energy distribution and enhance efficiency, but their benefits are unevenly distributed. In urban areas, AI systems can improve grid reliability, reduce energy losses, and integrate renewable energy sources, enhancing the overall quality of energy services. However, in rural areas, where energy infrastructure is lacking, the benefits of AI are minimal.

This unequal distribution of energy resources exacerbates social inequality. Access to reliable and affordable energy is a fundamental economic and social development determinant. Without modern energy services, rural communities face limitations in education, healthcare, and economic opportunities, reinforcing cycles of poverty. The capitalist system's focus on maximizing returns prioritizes energy investments in already economically advantaged areas, further marginalizing disadvantaged communities.

The environmental impacts of AI, such as climate change and ecological degradation, affect everyone globally. However, the burdens of these consequences are not shared equally among populations and regions. As rightly noted, "the allocations of benefits and risks replicate existing patterns of environmental injustice, coloniality, and 'slow violence' , in which a disproportionate exposure to risks and harms is borne by marginalized communities; be these in terms of pollution, destruction of local ecosystems,

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99 Jan Corfee-Morlot and others, 'Achieving Clean Energy Access in Sub-Saharan Africa' Financing Climate Futures <https://www.oecd.org/env/cc/case-study-achieving-clean-energy-access-in-sub-saharan-africa.pdf> accessed 22 June 2024; Esther Mwema and Abeba Birhane (n 4).

or involuntary displacement."[100] Meanwhile, the economic benefits of AI models mainly accrue to their owners, even if they are open-source, exacerbating the unequal distribution of benefits and risks.[101]

9. ENERGY POVERTY IN SSA AND AI IMPACTS FROM A TWAIL PERSPECTIVE

Third World Approaches to International Law (TWAIL) is a critical legal theory that examines the role of international law in perpetuating global inequalities, particularly those affecting the Global South.[102] TWAIL scholars argue that international law has historically been used to legitimize and maintain the dominance of powerful states over weaker ones.[103] In this sense, therefore, the international legal order is inherently biased in favour of developed nations and perpetuates the marginalization of the Global South. This bias is evident in how energy resources and technologies are distributed and accessed. Energy poverty in SSA is not merely a result of domestic shortcomings but is deeply intertwined with historical patterns of exploitation and contemporary global inequalities.[104]

Applying TWAIL to the issues of energy poverty in SSA and the increasing influence of AI reveals how international legal frameworks and global power dynamics contribute to these challenges and offer pathways for more equitable solutions. Through this approach, it can be argued that historical and contemporary global power dynamics and international legal structures contribute to the perpetuation of energy inequalities and shape the deployment of AI technologies.

The deployment of AI technologies in the energy sector, while promising significant benefits, can reinforce these inequalities. AI technologies are primarily developed and controlled by corporations and institutions based in

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100 Andrés Domínguez Hernández and others (n 9).

101 Ibid

102 Obiora Chinedu Okafor, 'Critical Third World Approaches to International Law (TWAIL): Theory, Methodology, or Both?' (2008) 10 International Community Law Review 371-378; Usha Natarajan, 'Third World Approaches to International Law (TWAIL) and the environment' pp. 207–236 In Andreas Philippopoulos-Mihalopoulos and Victoria Brooks (eds) Research Methods in Environmental Law (Cheltenham, UK: Edward Elgar Publishing, 2017).

103 Usha Natarajan (Ibid).

104 Esther Mwema and Abeba Birhane (n 4).

the Global North. These entities dominate modern technology, leading to a concentration of knowledge, capital, and infrastructure in developed countries. As a result, SSA faces significant barriers to accessing and benefiting from AI innovations in energy. Addressing this divide requires a problem-driven approach that considers African countries' unique needs and contexts rather than a one-size-fits-all solution imposed by external actors.[105]

From a TWAIL perspective, therefore, the proliferation of AI reflects and perpetuates historical patterns of dependency and underdevelopment.[106] The region's reliance on foreign technology and expertise may be exacerbating existing energy inequalities, as local contexts and needs are often overlooked in favour of the profit-driven motives of multinational corporations. This is also where the market liberalization model for using AI to drive sustainable development can lead to a situation where human rights considerations are sidelined by market forces or given less importance. This can result in the exploitation of labour, environmental degradation, and social inequalities in SSA. For example, a TIME magazine investigation exposed OpenAI's ChatGPT (which was hailed as one of 2022's most impressive technological innovations with a valuation of billions of US dollars aiming to build "superintelligent" machines and making OpenAI one of the world's most valuable AI companies), used outsourced Kenyan labourers earning less than 2 dollars per hour.[107] This could confirm why Upendra Baxi warns about

> The exploitation of… sweat labour through… discrimination even in subsistence wages, is the hallmark of contemporary economic globalization. So is the creation of a "global risk society" through… the very legible scripts of "organized irresponsibility" and "organized impunity" for corporate offenders… What distinguishes the paradigm shift is the 'legitimation' of extraordinary imposition of human suffering in the cause and the course of the present contemporary march of global capital. In the "modern" epoch of human rights, such suffering was considered per se legitimate. "Contemporary" human rights logics

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105 Lorenzo D'Auria, 'Knowledge Accumulation and Artificial Intelligence: A Marxian Perspective' Philosophy World Democracy (19 March 2024) <https://www.philosophy-world-democracy.org/articles-1/knowledge-accumulation-and-artificial-intelligence-a-marxian-perspective> accessed 23 June 2024.

106 Andrés Domínguez Hernández and others (n 9).

107 "OpenAI Used Kenyan Workers on Less Than $2 Per Hour: Exclusive | Time", online: <https://time.com/6247678/openai-chatgpt-kenya-workers/>.

> and paralogics challenged, and at times denied, this self-evident axiom. The paradigm shift seeks to cancel the historic gains of the progressive universal human rights movement in seemingly irreversible ways. It seeks to mute the voices of suffering and, in the process, regress human rights futures.[108]

Those suffering in Baxi's referenced "global risk society" lack the resources, bargaining power, and legal protections necessary to navigate the competitive market environment, exacerbating inequalities and human rights violations. Therefore, a market liberalization model for using AI to drive sustainable development can disproportionately affect developing countries in SSA, which are already on the weaker end of global power imbalances. Unequal trade relationships and unequal access to resources and markets can hinder the ability of countries in SSA to advance the SDGs.

9.1 Historical Context and Contemporary Implications for Sub-Saharan Africa

The historical exploitation of African resources by colonial powers has left a legacy of underdevelopment and inadequate infrastructure.[109] This is evident in the insufficient electricity infrastructure that hampers universal access to electricity by 2030. The reliance on solid cooking fuels and the lack of modern energy services indicates the continued marginalization of SSA in the global economic system. This legacy of infrastructural imbalance continues to impact the region, where large-scale energy projects often prioritize industrial and urban areas over rural communities.

In the contemporary context, these historical injustices are compounded by neoliberal policies emphasizing market liberalization and privatization. Such policies, often imposed by international financial institutions, prioritize profit maximization and attract foreign investment at the expense of equitable energy access. International financial institutions and donor countries often impose conditions on aid and investment that prioritize their interests over the needs of SSA countries. This can lead to underinvestment in critical infrastructure like electricity.[110]

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108 Upendra Baxi, Voices of Suffering and the Future of Human Rights, 8 Transnational L. & Contemp. Probs. 125, 170 (1998) 168 – 169.

109 Esther Mwema and Abeba Birhane (n 4).

110 Mustapha Mukhtar and others, 'Juxtaposing Sub-Sahara Africa's energy poverty and renewable energy potential' (2023) 13 Sci Rep 11643 <https://doi.org/10.1038/s 41598-023-38642-4> accessed 20 June 2024.

The suggestion that private sector funding is the most viable way to achieve universal electricity access by 2030 highlights the dependency on external capital, which can perpetuate cycles of debt and underdevelopment.[111] Moreover, advocates of private-sector funding often overlook concerns about the commodification of essential services and the potential for further exploitation.[112] Introducing AI into this skewed situation can exacerbate disparities if not carefully managed.

For instance, AI-driven energy solutions, such as smart grids and predictive maintenance systems, require substantial investment and advanced infrastructure. SSA countries, struggling with limited financial resources and inadequate infrastructure, often cannot deploy these technologies at scale. This results in a dual energy divide: within countries, between urban and rural areas, and globally, between developed and developing regions.

9.2 The Role of International Law and Global Power Dynamics

International law and global power dynamics are critical in shaping SSA's energy and AI interplay. While technological advancements can drive economic development, the current international order often prioritizes the interests of developed countries and multinational corporations over developing regions like SSA.

For instance, intellectual property regimes protect multinational corporations' interests by granting them extensive control over AI technologies. These regimes restrict technology and knowledge transfer to developing countries, limiting their ability to innovate and develop local solutions.[113] Furthermore, investment treaties can constrain the policy space

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111 Kingsley Ikechukwu Okere and others, 'Turning the tide on energy poverty in sub-Saharan Africa: Does public debt matter?' (2023) 282 Energy <https://doi.org/10.1016/j.energy.2023.128365.> accessed 20 June 2024; Mustapha Mukhtar and others (ibid).

112 Mustapha Mukhtar and others (n 102.); Jan Corfee-Morlot and others (n 91).

113 See Ashish Arora, 'Intellectual Property Rights and the International Transfer of Technology: Setting Out An Agenda For Empirical Research In Developing Countries' (2007) WIPO, The Economics of Intellectual Property <https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1012-chapter1.pdf> accessed 19 June 2024; Byron Robayo, 'The Adapting Approach to Intellectual Property from a Developing Country' (May 13, 2024) <https://www.spingarn.ec/blog/the-adapting-approach-to-intellectual-property-from-a-developing-country> accessed 21 June 2024).

of SSA governments, making it difficult to implement regulations that promote equitable energy access and protect local and regional interests.

Global power dynamics are also evident in the role of international financial institutions, such as the International Monetary Fund (IMF) and the World Bank. These institutions often attach stringent conditions to loans and aid, pushing for policies that favour liberalization and privatization. While such policies can attract foreign investment, they can also lead to privatizing essential services, including energy, making them less accessible to people with low incomes.[114]

Even when well-intentioned, international development agendas and aid programs sometimes perpetuate dependency by prioritizing donor-driven projects over locally-led initiatives. This top-down approach can result in solutions that are not well-suited to the local context and fail to address the root causes of energy poverty. The introduction of AI technologies into the energy sector, while offering potential benefits, risks reinforcing these inequalities unless there is a concerted effort to address the underlying power dynamics and ensure that the deployment of AI is inclusive and equitable.[115]

It could help make the contention that the prevailing discourse for the use of AI within this SDG domain – on issues of intellectual property and access to technology, may serve the interests of powerful actors but potentially neglect a broader spectrum of human rights and sustainable development concerns such as algorithmic imperialism, technological racism, or workplace displacement by AI systems in SSA. This might also involve examining power dynamics within the discourse on AI and sustainable development to help

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[114] Lise Johnson and others, ‘Costs And Benefits Of Investment Treaties Practical Considerations For States’ (2018) The Columbia Center on Sustainable Investment, Policy Paper <https://ccsi.columbia.edu/sites/default/files/content/docs/ publications /07-Columbia-IIA-investor-policy-briefing-ENG-mr.pdf> accessed 18 June 2014; International Institute for Environment and Development, ‘Investment treaties and sustainable development: investment protection’ IIED Briefing (May 2014) <https://www.iied.org/sites/default/files/pdfs/migrat e/17240IIED.pdf> accessed 20 June 2024; Glen Biglaiser and Ronald J. McGauvran, ‘The effects of IMF loan conditions on poverty in the developing world’ (2022) 25 J Int Relat Dev <https://pubmed.ncbi.nlm.nih.gov/35694682/ > accessed 19 June 2024; Lorenzo Cotula, ‘Do investment treaties unduly constrain regulatory space?’ (2014) 9, GIL19-31 <https://www.qil-qdi.org/investment-treaties-unduly-constrain-regulato ry-space/> accessed 19 June 2024.

[115] Chinasa T. Okolo (n 10).

scrutinize how trade-related and energy market-friendly discourses affect the advancement of SDG7 in SSA.

10. CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

This paper has analyzed the complex interplay between energy poverty in SSA and the increasing influence of AI in different sectors, including energy, and how these dynamics impact the attainment of SDG7 in SSA. The analysis began with an overview of the current state of energy poverty in SSA, highlighting the significant disparities in electrification rates and reliance on traditional biomass for cooking. The paper then examined the dual role of AI in this context, identifying both its potential to exacerbate energy poverty through increased energy consumption and its promise in optimizing energy grids, facilitating renewable energy adoption, and improving energy efficiency.

The paper also reviewed existing policies and regulatory frameworks in Nigeria, Kenya, and Uganda, assessing their successes and limitations in integrating AI into their energy policies. It highlighted the crucial policy and regulatory gaps of SSA in this regard. Through the lens of Marxist theory and TWAIL perspectives, the paper simplistically highlighted the issues of energy poverty and AI to establish the region's deep-rooted structural inequalities and ongoing exploitation. While there are opportunities for technological advancements to drive economic development, the capitalist framework within which these technologies are being developed and deployed often prioritizes profit over equitable development.[116]

10.2 Recommendations for Policy and Regulation

To achieve SDG7 in SSA, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all, several targeted recommendations can be made. Firstly, there is a need for comprehensive awareness and capacity-building initiatives to educate policymakers and stakeholders on the potential of AI to both enhance energy efficiency and manage its consumption. This includes integrating AI into energy policies to drive efficiency and reduce emissions, similar to practices in Europe and North America. Secondly,

[116] Daniel Morley, 'Artificial Intelligence: doomsday for humanity, or for capitalism?' In Defence of Marxism (05 May 2023) <https://www.marxist.com/artificial-intelligence-doomsday-for-humanity-or-for-capitalism.htm> accessed 19 June 2024.

fostering inter-agency collaboration is essential. Governments should establish mechanisms for coordinated policy-making among agencies responsible for technology, environment, and energy to create a holistic energy ecosystem. Thirdly, regulatory frameworks must be updated to include guidelines for the deployment and management of AI technologies in the energy sector, ensuring they promote sustainability and reduce unchecked energy consumption. Additionally, substantial financial investments are required to build the necessary digital infrastructure and develop local technical expertise. Initiatives to improve high-speed internet access and reliable power supply should be prioritized. Finally, international cooperation and partnerships can play a pivotal role in supporting these efforts through technical assistance, funding, and knowledge transfer. By addressing these areas, SSA can leverage AI to advance SDG 7, ensuring sustainable and modern energy access for the region.

The need for suitable regulation in SSA is heightened because of the AI technological divide, where affluent urban areas benefit from AI-driven energy solutions while rural and impoverished communities are left behind. The unequal access to the benefits of AI technologies reflects broader patterns of inequality within the capitalist system, where technological advancements primarily serve the interests of the capitalist class. Moreover, historical and contemporary global power dynamics and international legal structures contribute to the perpetuation of energy inequalities and shape the deployment of AI technologies. To create an equitable energy environment that aligns with the goals of SDG7, regulatory reforms in Sub-Saharan Africa must consider these broader socio-economic and political contexts. By addressing these challenges, SSA countries can mitigate the negative impacts of AI on energy consumption while leveraging its potential for sustainable and inclusive energy development. Policies that balance liberalization with social equity can prevent the privatization of essential energy services. Empowering local initiatives through community-driven development agendas and building local AI expertise can ensure that energy solutions are contextually relevant and sustainable, addressing the root causes of energy poverty and fostering resilience in the face of global power imbalances.