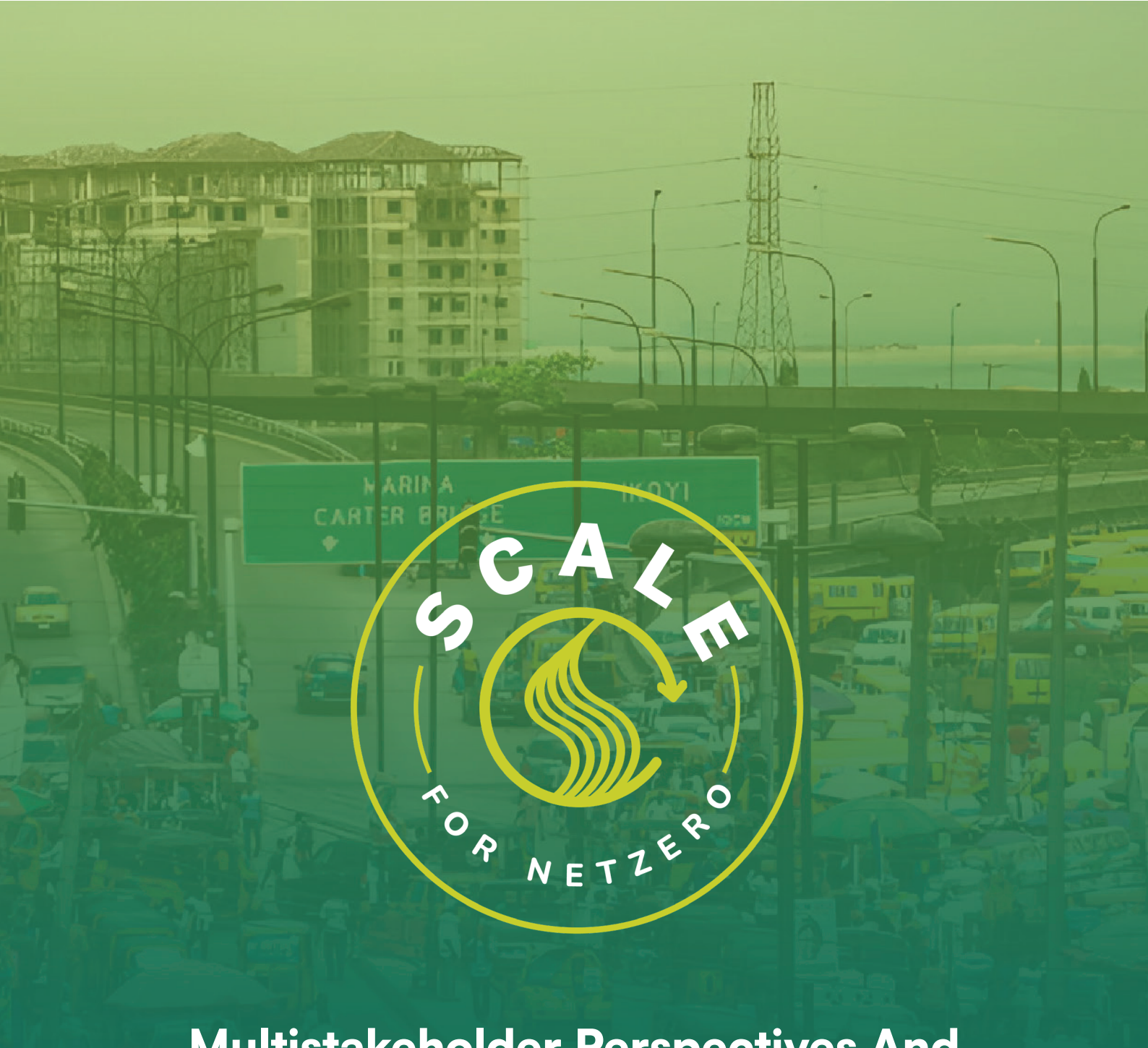

Multistakeholder Perspectives And Situational Analysis Of Digital Waste Contributions And Recommendations For Net Zero Transition In Nigeria

A Technical Report

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Under the SCALE for NetZero Program

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Contents

Acknowledgements

AREAi is grateful to the numerous individuals and organizations whose invaluable contributions made this report possible.

This technical report would not be possible without the funding support provided for SCALE (Smart Climate Awareness, Learning and Empowerment) for NetZero Transition Program by the United Kingdom's Foreign, Commonwealth and Development Office through its Digital Access Program (DAP).

The writing, compilation and completion of this report has also relied heavily on the dedication and expertise of AREAi colleagues and external collaborators from the Centre for Digital Development and Innovation Research (CDDIR) and EcoChampions: Gideon Olanrewaju, Charles Falajiki, Lawson Omoniyi, Praise Adebisi, Wonderful Akanbi and Temilade Salami.

We'd like to especially thank the Digital Access Program team led by the Country Adviser, Idongesit Udoh, Oluwadamilola E. Sowemimo (Programme Manager) and Laraba Adegbenro (Project Design and Delivery Officer) for their continued leadership and visionary guidance towards the strategic development and meticulous execution of the different intervention components of the SCALE Initiative.

This technical report was developed with significant input and support from several stakeholders within the technology ecosystem in Nigeria, including over 35 technology startup founders and innovators who physically attended and offered valuable insights at the regional consultations hosted across 3 major cities including Lagos, Abuja and Port Harcourt.

Our sincere thanks go to the representatives from government agencies, industry leaders, technology hubs leads, technology start-up founders, data processing centers operators, circular economy experts, academic researchers, civil society organizations and other entreprenuers who who provided critical input and feedback throughout the development of this technical report.

Copyright, Design, Photography and Production: thank you to all those involved in the design and production of this year's report and related assets: Ayomikun Dada, Ajibola Ojediran, Opeolu Adeyemi and Elizabeth Ajiboye.

Published in 2025 by Aid for Rural Education Access Initiative (AREAi)
DigiHub, 2 ICS Dr, Dakibiyu, Abuja 900108, Federal Capital Territory, Nigeria

This report was designed and produced by the Aid for Rural Education Access Initiative (AREAi),
under the SCALE for NetZero Program, sponsored by the UK Government through its Digital Access Program (DAP).

For further information, please contact: lanre@areai4africa.org

About Smart Climate Awareness, Learning and Empowerment (SCALE)

The **SCALE (Smart Climate Awareness, Learning and Empowerment) for NetZero Transition Program** is a multilayered intervention with a comprehensive approach to mitigate the environmental impact of Nigeria's burgeoning tech ecosystem through a combination of activities that ranges from evidence generation, knowledge management and mobilization, incentivized capacity development, media-driven public awareness, and high-level policy advocacy activities.

The project undoubtedly represents a novel pioneering effort to leverage evidence based, citizens-led approaches to catalyze unprecedented progress in digital sustainability awareness and supporting the use of technology in a way that is environmentally responsible, socially equitable, and economically viable.

Studies indicate that, if unchecked, the ICT sector could contribute nearly 14% of global GHG emissions by 2040. Despite concerted efforts to reduce global greenhouse gas emissions (GHGE) per the Paris Agreement, the Information and Communication Industry (ICT) has received little attention even though it is a significant contributor to GHG emissions. To avoid catastrophic consequences from climate change, all sectors of the global economy, including Information Communication Technology (ICT), must keep their greenhouse gas (GHG) emissions in line with the Paris Agreement.

Undoubtedly, the role of the digital technology ecosystem or the ICT industry globally or in Nigeria, remains critical to reducing green house gas emissions and enabling net zero transition efforts. It is therefore important to galvanise broad political and industrial actions and more significantly, a coordinated response that leverages informal approaches in mobilising concerted efforts across the ICT sector.

Premised on this foregoing, the SCALE initiative seeks to leverage evidence-based research, practice and policy actions to facilitate a decrease in the environmental impact of the Nigeria's technology ecosystem through a combination of approaches which include:

1. To design and launch an open-source measurement tool that enables technology stakeholders (startups, digital centers, ICT hubs etc) to access, measure, track and report their carbon footprint.

2. To build and establish a strong collaborative partnership with and within the Nigerian tech ecosystem stakeholders, including
tech startups, startup Incubators and co-working hubs, digital learning partners, payment processing companies, telecommunications and data center services providers and hardware production centers, that will translate into improved eco-consciousness in digital production and consumption processes.

3. To promote citizens-led net zero and smart energy transition, via the design, and facilitation of simplified and interactive learning experiences and knowledge development processes.

4. To produce and widely disseminate series of research-based, policydriven,and practice-focused information materials that outlines the various contribution outlets that can result in the reduction in the GHG emissions resulting from digital technology products or services.

5. To conduct tailored online and offline advocacy activities that seeks to increase preparedness of government agencies and stakeholders (public and private technology producers and users) responsible for the planning, structuring, provision, and management of tech-driven management of digital waste.

Glossary of Terms

AI	Artificial Intelligence
CCUS	Carbon capture utilization, and sequestration
CDNs	Content Delivery Networks
EEE	Electrical and Electronic Equipment
ECN	Energy Commission of Nigeria
EPR	Extended Producer Responsibility
GHG	Greenhouse gases
ICT	Information and Communication Technology
IEA	International Energy Agency
IoT	Internet of Things
LT-LEDS	Long-Term Low Emission Development Strategy
MRV	Monitoring, Reporting, and Verification systems.
NAEIS	National Atmospheric Emission Inventory System
NESREA	National Environmental Standards and Regulations Enforcement Agency
NITDA	National Information Technology Development Agency
NDCs	Nationally Determined Contributions
NCC	Nigerian Communications Commission
P2P	Peer-to-Peer
PoW	Proof-of-Work
PPPs	Public-Private Partnerships
REMP	Renewable Energy Master Plan
SCALE	Smart Climate Awareness, Learning and Empowerment
NDLF	National Digital Literacy Framework
UEEE	Used Electrical and Electronic Equipment
VOCs	Volatile organic compounds

Executive Summary

This technical report examines the critical intersection of Nigeria's rapidly expanding digital economy and its environmental consequences, with specific focus on greenhouse gas (GHG) emissions from the Information and Communication Technology (ICT) sector and their implications for Nigeria's net-zero aspirations.

The global ICT sector currently accounts for approximately 4% of total GHG emissions, with projections indicating a potential surge to 14% by 2040 without appropriate interventions. Within Nigeria's context, while the digital sector is experiencing exponential growth, its environmental impact remains largely under-researched and inadequately addressed through existing policy frameworks. The energy sector, which powers most ICT operations, contributes approximately 34% of Nigeria's total GHG emissions, with a significant portion attributable to data centers, telecommunication networks, and electronic waste management practices.

Nigeria's digital carbon footprint is driven by several interconnected factors that require urgent attention. The importation of second-hand electronics represents a significant environmental challenge, with weak regulatory enforcement exacerbating e-waste accumulation and subsequent emissions. Approximately 25-30% of Used Electrical and Electronic Equipment (UEEE) imports are non-functional upon arrival, effectively constituting e-waste from the point of entry. Unlike South Africa, which has implemented a robust Extended Producer Responsibility (EPR) framework, Nigeria lacks effective mechanisms to hold technology companies accountable for product lifecycle management.

The absence of stringent import restrictions allows obsolete or near-end-of-life devices to enter the country continuously, contributing to informal dismantling practices that release hazardous substances into the environment.

Energy-intensive data centers and digital innovation hubs constitute another major driver of ICT-related emissions in Nigeria. Due to the unreliable national power grid, most data centers rely heavily on diesel generators as primary or backup power sources, significantly increasing their carbon footprint compared to global counterparts that increasingly utilize renewable energy.

The growing demand for cloud computing, artificial intelligence applications, and big data analytics has intensified energy consumption within this sector. Digital innovation hubs that support Nigeria's burgeoning technology entrepreneurship ecosystem also contribute substantially to emissions through their high-performance computing systems, blockchain platforms, and cryptocurrency mining operations. Rapid technological obsolescence presents a persistent challenge in Nigeria's digital ecosystem. The accelerated pace of technological advancement has dramatically shortened the lifecycle of digital devices, leading to premature disposal and substantial e-waste generation.

Unlike Rwanda, which has established mandatory e-waste take-back schemes, Nigeria lacks structured frameworks to address product end-of-life management. The report highlights Lagos' Computer Village as a significant generator of e-waste due to high turnover rates in refurbished electronics.

Executive Summary

The absence of circular economy principles in Nigeria's technology sector continues to exacerbate the environmental burden of rapid obsolescence. The report identifies critical gaps in Nigeria's current policy landscape concerning ICT-related emissions, including the absence of emission measurement standards, lack of digital sustainability frameworks for technology enterprises, limited incentives for green ICT adoption, inadequate recycling infrastructure, and ineffective implementation of Extended Producer Responsibility programs.

These policy shortcomings undermine Nigeria's capacity to effectively regulate and mitigate the environmental impact of its growing digital sector. To address these challenges comprehensively, the report proposes targeted recommendations for both government and private sector stakeholders. For the Nigerian government, strengthening regulatory frameworks around e-waste management, developing comprehensive digital sustainability standards, and creating fiscal incentives for green technology adoption are prioritized.

The private sector is encouraged to embrace energy-efficient technologies, implement sustainable procurement practices, and invest in circular economy business models. Collaborative approaches between government and industry stakeholders are emphasized as essential for developing integrated solutions to Nigeria's digital carbon footprint challenges.

As Nigeria continues its digital transformation journey, balancing technological advancement with environmental sustainability remains imperative. The findings and recommendations presented in this report provide a roadmap for aligning Nigeria's digital growth trajectory with its climate commitments and net-zero transition aspirations.

1. Introduction

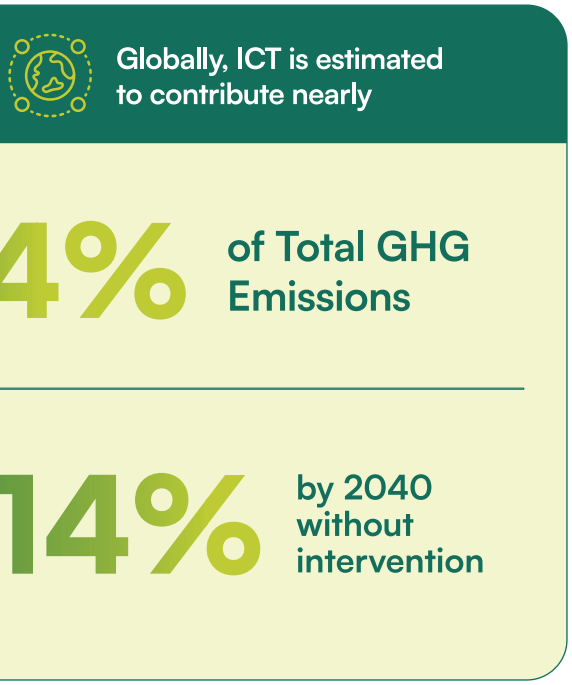
Current State of ICT-Related Emissions in Nigeria

The rapid expansion of the digital economy has transformed industries, enhanced connectivity, and stimulated economic growth. However, the increasing reliance on Information and Communication Technology (ICT) has also contributed to a significant rise in greenhouse gas (GHG) emissions. Globally, ICT is estimated to contribute nearly 4% of total GHG emissions, with projections suggesting this could exceed 14% by 2040 without intervention.

In Nigeria, the digital sector is growing rapidly, yet its environmental impact remains largely under-researched. While the current state of ICT-related emissions in Nigeria presents a complex picture, the technology ecosystem contributing significantly to the country's carbon footprint.

The carbon footprint of the technology sector has always remained a concern with the National Communication on Climate Change reports that the energy sector accounts for approximately 34% of Nigeria's total GHG emissions, a substantial portion of which is attributed to ICT operations, including data centres, telecommunication networks, and electronic waste. Nigeria's burgeoning technology ecosystem has led to an increase in ICT infrastructure investment, raising concerns about its environmental impact.

The production, installation, and usage of ICT equipment have been linked to a significant portion of carbon emissions globally, with some estimates suggesting that ICT accounts for 2% of the world's carbon emission.



The GHG emissions trajectory is also influenced by other sectors whose activities and outputs interconnect with that of the technology ecosystem. On other hand, the telecommunications industry contributes primarily due to the extensive use of diesel-powered generators for base stations. Its significant expansion chiefly includes a teledensity of 101.16% and over 163 million internet users as of March 2024. A study estimated that approximately 4,000 tonnes of CO_2 are released daily from these operations, with an estimated daily fuel cost of over 507 million Naira. On the other hand, the power sector emits around 21.3 million metric tons of CO_2 equivalent as at 2023. There remain tendencies for these emissions to keep rising with the continued dependence of the ICT sector's reliance on electricity and telecommunications.

2. Drivers of Digital Carbon Footprint

As Nigeria experiences rapid digital transformation, the environmental impact of its expanding technology sector is becoming a growing concern. The increased reliance on digital infrastructure, telecommunications, and electronic devices has significantly contributed to greenhouse gas (GHG) emissions, raising Nigeria's digital carbon footprint. While advancements in data centers, telecommunications networks, and consumer electronics have propelled economic growth and digital inclusion, they also come with high energy consumption and environmental costs. Factors such as inefficient energy sources, rising e-waste, and the absence of sustainable digital policies further exacerbate the issue. Understanding these key drivers of Nigeria's digital carbon footprint is essential for developing effective policies that promote green technology practices, ensuring a sustainable digital future. Based on an extensive hybrid consultative process that drew participants from various sectors of the technology ecosystem including Mobility, Fashion, Clean energy, Education, Financial services, Security, Cybersecurity, Youth Employment, we synthesized key findings from expert-led deliberations on what are the most significant contributors to greenhouse gas emissions in Nigeria, particularly within the technology ecosystem and that are digitally-induced.

A. Imported Second-Hand Electronics

Nigeria faces a significant challenge in managing electronic waste (e-waste), with weak regulatory enforcement exacerbating environmental degradation and contributing to greenhouse gas (GHG) emissions.

While NESREA has established some guidelines under the National Environmental (Electrical/ Electronic Sector) Regulations, enforcement remains weak due to inadequate monitoring, insufficient funding, and lack of coordination with industry stakeholders. Nigeria is a major importer of UEEE, driven by the demand for affordable electronics. However, up to 25-30% of these imports are non-functional upon arrival, effectively making them e-waste. The unchecked influx of used and obsolete electronic devices, many of which are improperly disposed of in open landfills or informally dismantled, leads to the release of hazardous substances such as lead, mercury, and brominated flame retardants. These toxic materials not only pose serious health risks but also contribute to indirect emissions through the burning of electronic components. Evidently, weak enforcement of import restrictions allows large quantities of obsolete or near-end-of-life devices, such as cathode-ray televisions, refrigerators, and air conditioners, to enter the country.

Unlike South Africa, which has implemented an Extended Producer Responsibility (EPR) framework mandating manufacturers to take responsibility for the entire lifecycle of their products, Nigeria lacks a robust mechanism to hold tech companies accountable for proper disposal and recycling. Additionally, Ghana has successfully formalized its e-waste sector by integrating informal recyclers into regulated frameworks, providing them with training and financial support to improve waste processing. Nigeria, however, has yet to establish a sustainable national e-waste management strategy that aligns with global best practices.

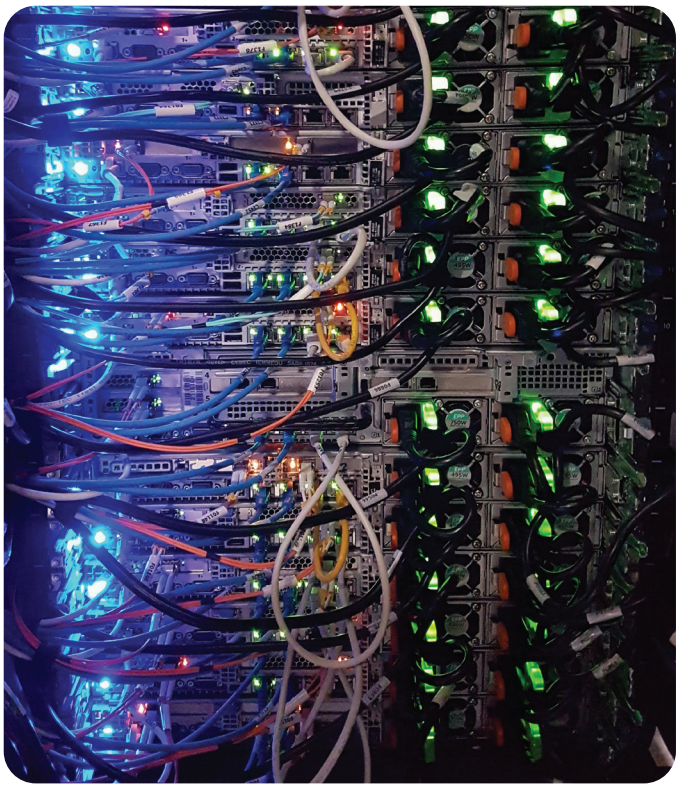
To address this, the Federal Ministry of Environment and NESREA must work collaboratively with the National Information Technology Development Agency (NITDA), state environmental agencies, and local governments to implement stricter e-waste regulations, enhance formal recycling infrastructure, and incentivize tech companies to adopt circular economy models. Without urgent action, Nigeria's growing ICT sector will continue to contribute disproportionately to environmental pollution and carbon emissions associated with inefficient e-waste handling.

2. Drivers of Digital Carbon Footprint

B. Energy-Intensive Data Centers and Digital Innovation Hubs

The rapid expansion of Nigeria's digital economy has led to a surge in data centers and digital innovation hubs, significantly increasing the country's digital carbon footprint. Data centers are among the most energy-intensive infrastructures in the tech sector, requiring vast amounts of electricity to power and cool servers that store and process digital information. In Nigeria, the unreliable national power grid forces most data centers to rely on diesel generators as backup power sources, contributing to high carbon emissions. Unlike countries such as South Africa, which has begun transitioning its data centers to renewable energy sources, Nigeria lacks clear policies or incentives to encourage greener data center operations. Additionally, the demand for cloud computing, artificial intelligence (AI), and big data analytics has intensified, further increasing energy consumption in this sector. Digital innovation hubs, which support startups and technology entrepreneurs, also contribute to rising emissions due to their high energy demands.

These hubs house multiple ICT infrastructures, including high-performance computing systems, blockchain-based platforms, and cryptocurrency mining operations, all of which require constant electricity. Cryptocurrency mining, in particular, is notorious for its immense energy use, as complex computational processes demand significant processing power. In Nigeria, the absence of regulatory frameworks guiding the environmental sustainability of digital hubs means that many operate without consideration for energy efficiency or carbon mitigation strategies.



Meanwhile, Kenya has adopted sustainability measures, encouraging tech hubs to integrate solar energy and smart energy management systems to reduce emissions.

Furthermore, Nigeria's growing e-commerce, logistics, and transport sectors, which depend on data-intensive platforms and cloud services, exacerbate the problem. Online retail platforms, ride-hailing services, and last-mile delivery networks rely on data centers and digital infrastructure to process millions of transactions daily, further increasing energy demands. Without urgent intervention, Nigeria's unchecked growth in data-intensive digital infrastructure will continue to escalate its digital carbon footprint.

2. Drivers of Digital Carbon Footprint

C. Rapid Technological Obsolescence

The short lifecycle of modern electronic devices contributes significantly to e-waste generation. Frequent upgrades in smartphones, computers, and other gadgets lead to the abandonment of older models. For example, Lagos' Computer Village—a hub for ICT sales and repairs—generates substantial e-waste due to high turnover rates in refurbished electronics. The rapid pace of technological advancement in Nigeria's ICT sector has led to a significant increase in electronic waste (e-waste) and associated greenhouse gas (GHG) emissions. The short lifecycle of digital devices, coupled with the fast turnover of new models, has accelerated the accumulation of outdated electronics.

Aerial View Of Computer Village Ikeja Lagos © Voy, 3:01pm On May 28, 2022

2. Drivers of Digital Carbon Footprint

In Nigeria, the demand for newer, more efficient smartphones, laptops, and other ICT devices continues to grow, largely driven by consumer preferences and corporate upgrades. However, without effective policies to regulate product end-of-life management, most obsolete electronics end up in informal waste disposal systems, where they are either incinerated—releasing toxic chemicals and CO_2—or improperly dismantled, leading to further environmental degradation. Unlike countries such as Rwanda, which has introduced mandatory e-waste take-back schemes requiring manufacturers to collect and recycle outdated products, Nigeria lacks a structured framework to address rapid technological obsolescence. The absence of strong Extended Producer Responsibility (EPR) policies forces consumers to bear the burden of disposal, contributing to growing e-waste dumps in urban centres like Lagos and Abuja.

Moreover, international trade dynamics play a role, as Nigeria is one of the largest importers of used electronics from developed nations, exacerbating the problem. To mitigate the environmental impact of rapid technological obsolescence, the Federal Ministry of Environment and the National Information Technology Development Agency (NITDA) must enforce stricter regulations on product lifecycle management, while also promoting circular economy principles such as device refurbishment, component recycling, and incentives for consumers to trade in old devices.

Without proactive intervention, the rapid obsolescence of technology in Nigeria will continue to contribute significantly to ICT-related GHG emissions, undermining national sustainability efforts.

2. Drivers of Digital Carbon Footprint

D. Domestic Consumption of Electrical and Electronic Equipment (EEE) and Consumer Electronics Usage

According to the World Economic Forum, private households account for the majority of EEE consumption in Nigeria, with an installed base exceeding 6.4 million units, including IT devices and consumer electronics. The increasing domestic consumption of Electrical and Electronic Equipment (EEE) is a major driver of Nigeria's digital carbon footprint, significantly contributing to greenhouse gas (GHG) emissions throughout the lifecycle of these products. As Nigeria's population grows and digital connectivity expands, the demand for mobile phones, laptops, televisions, refrigerators, and other electronic appliances has surged. According to the National Bureau of Statistics (NBS), the importation and sale of electronic devices in Nigeria have increased by over 40% in the last decade. The high consumer demand for EEE leads to significant carbon emissions at various stages: from raw material extraction and manufacturing to distribution, usage, and disposal.

Unlike developed economies where energy-efficient and eco-friendly appliances are prioritized, Nigeria still imports a large volume of second-hand and low-efficiency electronics, further exacerbating energy consumption and environmental degradation. Additionally, the usage phase of EEE in Nigeria is heavily dependent on non-renewable energy sources.

Private Household Consumption of EEE in Nigeria

Above 6.4 Million Units

Due to an unstable national grid, many households and businesses rely on fossil fuel-powered generators to run electronic devices, increasing Nigeria's carbon footprint. In contrast, countries like South Africa and Kenya have implemented energy efficiency standards that mandate electronic devices meet minimum environmental performance benchmarks, reducing emissions at the point of consumption. The lack of similar standards in Nigeria allows the continued influx of high-energy-consuming appliances into the market. Furthermore, the short lifespan of many consumer electronics—partly due to planned obsolescence and limited repair options—accelerates e-waste generation. With weak recycling infrastructure, these discarded electronics often end up in landfills, where improper disposal methods release hazardous chemicals and contribute to indirect emissions.

Case Study

E-Waste Generation and Informal recycling practices in Nigeria

As one of Africa's largest importers of used electronic devices, Nigeria generates substantial quantities of e-waste annually, much of which is improperly managed. The lack of formal recycling infrastructure and reliance on informal recycling methods exacerbate both environmental pollution and GHG emissions. According to 2024 Global E-Waste Monitor, Nigeria generated over 500,000 metric tons of e-waste in 2022 with a recycling rate of less than 20%, making it the largest producer in West Africa and the third-largest in Africa after Egypt and South Africa. A significant portion of this waste originates from imported used electrical and electronic equipment (UEEE), 69% of these imports are non-functional or near end-of-life, effectively constituting e-waste upon arrival (Basel Convention Report, 2024).

The informal sector dominates e-waste collection and recycling in Nigeria, employing crude methods such as open burning, acid leaching, and manual dismantling to recover valuable materials like copper and gold. These processes release hazardous substances, including lead, mercury, and cadmium, into the environment while emitting significant amounts of GHGs. Open burning is a prevalent method for managing e-waste in Nigeria due to its low cost and simplicity. However, it is also one of the most environmentally damaging practices. Burning plastic casings from electronics releases CO_2 and CH_4 into the atmosphere. Additionally, incomplete combustion produces black carbon—a short-lived climate pollutant with a global warming potential thousands of times greater than CO_2 over a 20-year period (Blanco-Donado et al., 2022).

For instance, open burning of cables to extract copper releases carbon dioxide (CO_2), methane (CH_4), and dioxins—highly toxic pollutants that contribute to climate change (Basel Convention Report, 2024). The informal recycling sector also employs pyrolysis for extracting metals from printed circuit boards. This process emits volatile organic compounds (VOCs) alongside GHGs like nitrous oxide (N_2O), which has a global warming potential 298 times that of CO_2 over a century (Basel Convention Report, 2024).

The cumulative impact of these emissions underscores the urgent need for regulated recycling practices. Improper disposal of e-waste in landfills is another significant source of GHG emissions. When discarded electronics containing organic components degrade anaerobically in landfills, they release CH_4—a potent greenhouse gas. In Lagos alone, where over 290,000 metric tons of e-waste were generated in 2020, landfill sites like Olusosun have become hotspots for methane emissions due to the accumulation of improperly disposed electronics (Global E-Waste Monitor, 2024).

While formal recycling operations are limited in Nigeria—accounting for less than 20% of total e-waste processed—their energy-intensive nature also contributes to GHG emissions. Smelting operations for recovering metals such as aluminum and copper require high energy inputs, often sourced from fossil fuels due to Nigeria's reliance on diesel generators for electricity production. This energy demand adds an indirect layer of emissions associated with e-waste recycling.

2. Drivers of Digital Carbon Footprint

E. Telecommunications Infrastructure

Nigeria's telecommunications infrastructure is a critical driver of the country's digital carbon footprint, contributing significantly to greenhouse gas (GHG) emissions through energy consumption, equipment manufacturing, and maintenance. As of 2023, Nigeria had over 220 million mobile subscribers, with a penetration rate exceeding 90% (Nigerian Communications Commission - NCC, 2023). The rapid expansion of mobile networks, fiber-optic installations, and broadband services has increased energy demands, particularly as Nigeria's mobile penetration surpasses 90% and internet users exceed 100 million.

Most telecommunications towers, base stations, and switching centers rely heavily on diesel-powered generators due to the country's unstable electricity grid, leading to substantial CO_2 emissions. Similarly, Nigeria has approximately 40,000 telecom towers, with over 80% powered by diesel generators due to unreliable electricity supply and to manage its number of active internet users which recently surpasses 122 million, making it one of Africa's largest digital markets, The telecom sector in Nigeria consumes over 40 million liters of diesel per month, contributing significantly to CO_2 emissions. For example, a single diesel-powered base station emits about 4.6 metric tons of CO_2 annually (International Finance Corporation - IFC, 2021). Evidence points that 2-3% of Nigeria's total CO_2 emissions is mainly from power generation for telecom towers and data centers.

Countries like Rwanda and South Africa boasts of green Telecom Infrastructure, and this is characterised by reduced diesel usage by 20% annually and integration of wind and solar energy into base station operations. This has led to a reduction on diesel dependence by 35%. According to the 2022 Renewable Energy Master Plan — REMP), Nigeria receives an average of 5.5 kWh/m^2 of solar radiation daily, making it highly suitable for solar-powered telecom infrastructure. If just 30% of Nigeria's telecom towers switched to solar energy, the country could cut annual telecom-related CO_2 emissions by over 200,000 metric tons.

Notably, the manufacturing, transportation, and disposal of telecom equipment, such as mobile phones, routers, and fiber-optic cables, contribute to indirect emissions. The increasing demand for high-speed internet, 5G deployment, and IoT (Internet of Things) applications further intensifies the carbon footprint, as these technologies require more data processing and storage capacity, leading to increased energy consumption in data centers.

Without a clear sustainability framework, Nigeria's telecommunications sector will continue to expand unsustainably, increasing emissions. Investing in hybrid power systems, smart grid integration, and sustainable telecom infrastructure is essential for Nigeria to transition to a low-carbon digital economy.

2. Drivers of Digital Carbon Footprint

F. Blockchain and Cryptocurrency Mining

The rise of blockchain technology and cryptocurrency mining in Nigeria has significantly increased digital energy consumption, contributing to the country's carbon footprint. Nigeria ranks among the top 10 countries for cryptocurrency adoption, with a rapidly growing number of individuals and businesses engaging in mining activities. According to a 2023 Statista report, cryptocurrency adoption in Nigeria is among the highest globally, with 35% of Nigerians engaging in crypto transactions, making it the largest market in Africa. Chainalysis, in 2023, revealed that Nigeria ranked 2nd globally in peer-to-peer (P2P) cryptocurrency transactions, with an estimated transaction volume of over $56 billion between July 2021 and June 2022. Unlike traditional IT operations, cryptocurrency mining requires vast computational power, which results in high electricity consumption and increased GHG emissions.

Bitcoin mining energy consumption: A single Bitcoin transaction consumes approximately 1,173 kWh of electricity—comparable to the monthly electricity consumption of an average Nigerian household. Due to unreliable grid electricity, 80% of crypto miners in Nigeria in Nigeria depend on diesel-powered generators, emitting approximately 2.7 kg of CO_2 per liter of diesel consumed and thereby further exacerbating emissions (Energy Commission of Nigeria — ECN, 2023). Without miners transitioning to energy-efficient Proof-of-Stake (PoS) models instead of energy-intensive Proof-of-Work (PoW) systems, this major driver will continue to inform fossil fuel generation.

2. Drivers of Digital Carbon Footprint

G. Digital Streaming and Cloud Services

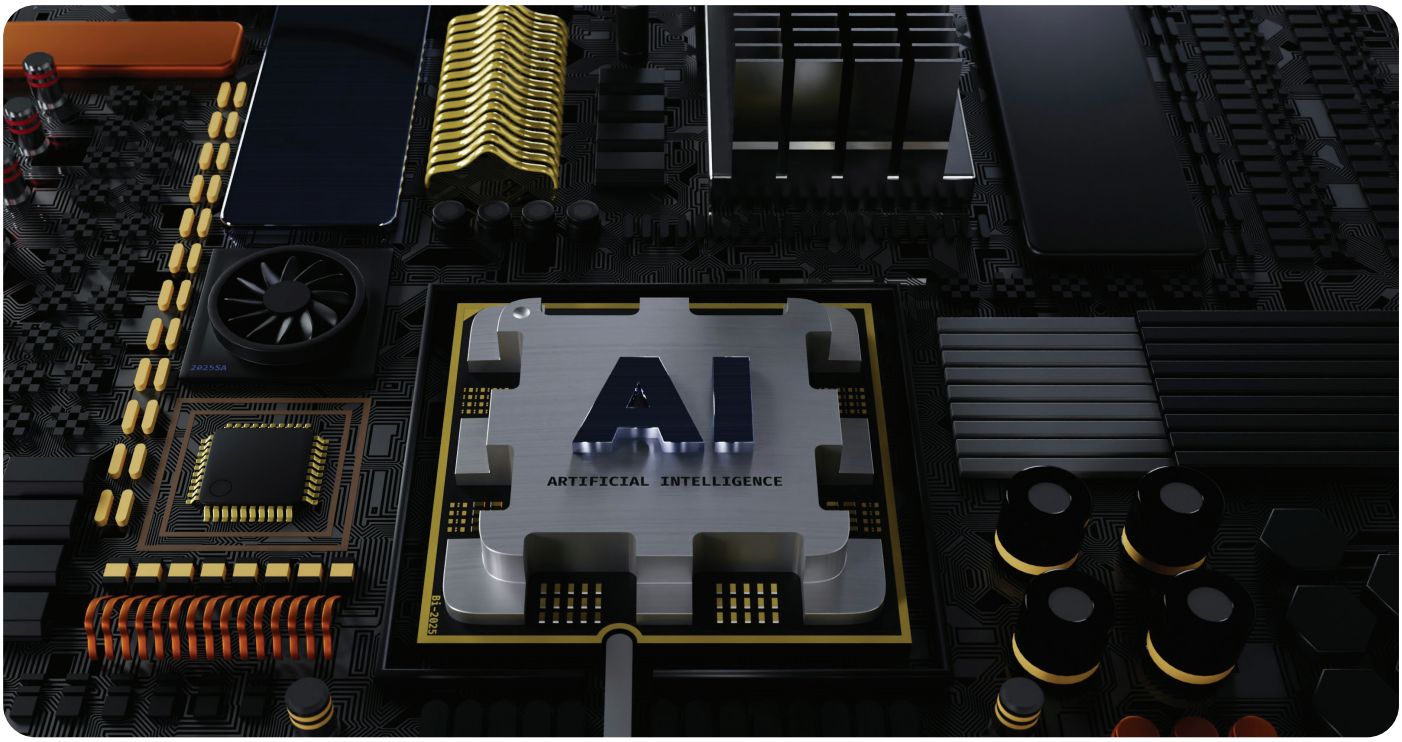
The increasing consumption of digital content through video streaming, online gaming, and cloud-based services is another driver of Nigeria's digital carbon footprint. In 2023, the Nigerian Communications Commission — NCC reports that Nigeria's **internet penetration rate** reached **55.4% in 2023,** with over **122 million active internet users,** leading to an increasing demand for streaming services. Undoubtedly, and unknown to majority of users, platforms like YouTube, Netflix, and social media video content generate massive data traffic, requiring energy-intensive data centers to process and store content. For example, watching one hour of Netflix in HD emits approximately 400g of CO_2, while streaming in Ultra HD (4K) can emit up to 1 kg of CO_2 per hour (International Energy Agency - IEA, 2022).

With Nigeria's growing internet penetration, energy consumption from streaming continues to rise. According to the Ericsson Mobility Report 2023, Nigeria's mobile data traffic is expected to significantly increase from 14 exabytes per month in 2022 to over 40 exabytes per month by 2027, which will put greater pressure on energy demand within the country due to the growing data usage. This projection indicates a substantial rise in mobile data consumption in Nigeria, highlighting the country's expanding digital landscape and with resulting energy implications. As data traffic increases, so does the energy required to power the network infrastructure, raising concerns about energy sustainability. Unlike countries like Kenya, which promotes sustainable cloud computing policies encouraging companies to use renewable energy-powered data centers, Nigeria lacks clear guidelines on sustainable digital consumption. A critical step of reducing GHG emissions apart from encouraging energy-efficient content delivery networks (CDNs) and promoting green cloud computing, public awareness about individual digital consumption through streaming and related services must be revamped.

H. Artificial Intelligence (AI) and Big Data Analytics

AI-driven applications, machine learning models, and big data analytics are expanding rapidly in Nigeria's fintech, healthcare, and e-commerce sectors, driving higher energy use. Disrupt Africa reports in 2023 in Nigeria's AI and big data market is growing rapidly, with investments in AI startups increasing by 55% between 2020 and 2023, making it one of Africa's leading AI hubs. Training complex AI models requires extensive computing power, often consuming the same amount of electricity as multiple households over extended periods.

2. Drivers of Digital Carbon Footprint

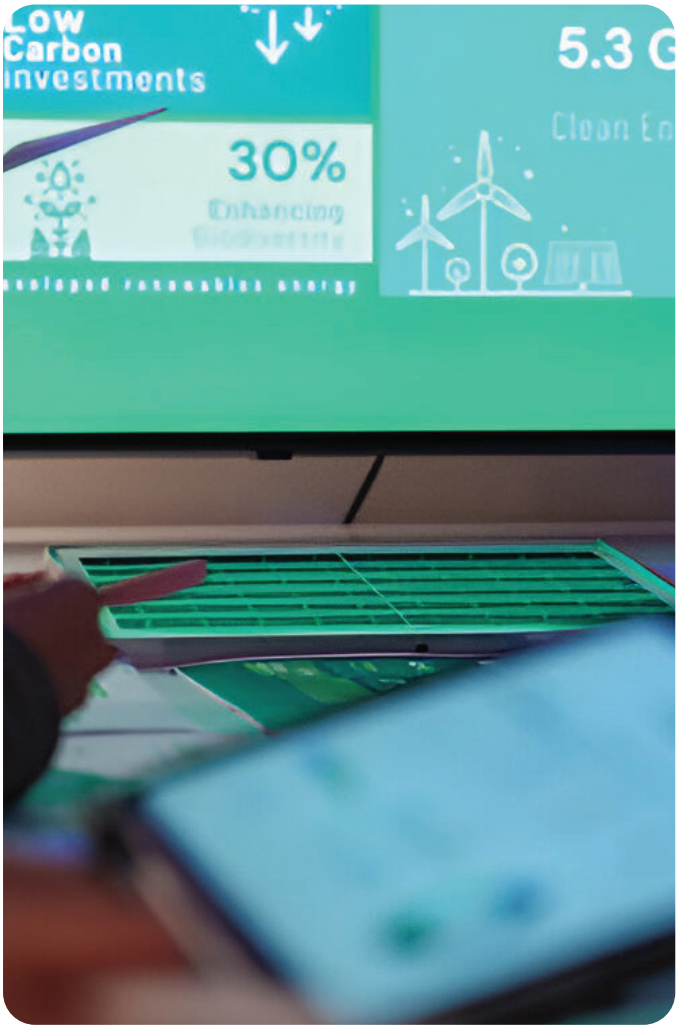


It normally takes over 1,287 MWh of electricity, emitting 552 metric tons of CO_2, which is equivalent to driving 1.2 million kilometers in a petrol-powered car, in training an advanced AI model like GPT-3. In recent developments, Nigeria's AI-powered financial services and fintech platforms consume an estimated 1.5 GWh annually, mostly from fossil-fuel-generated electricity. The increasing use of AI for automation, financial services, and security operations further compounds Nigeria's energy demands, primarily from fossil-fuel-based sources. Moreover, AI automation in banking, healthcare, and manufacturing is projected to increase Nigeria's total data processing energy consumption by 40% over the next five years. This projection doubles the current estimation of emissions currently being generated as a function of current AI-enabled technological processes.

3. Policy Landscape for GHG Emissions Regulations and Gaps in Nigeria

Nigeria has made some progress in climate policy that clearly outlines ambitious goals in addressing GHG emissions and driving the country's net zero transition, including the National Energy Transition Plan and commitments under the Paris Agreement. The Nigeria's Climate Change Act (2021) provides a foundational legal framework to advance its net-zero ambitions, setting an overarching goal to achieve net-zero GHG emissions between 2050 and 2070.

However, there are key gaps in the instrumentation of these policies that greatly impedes the country's net zero transition efforts.



Lack of Emission Measurement Standards

One of the most significant policy gaps in managing ICT-related greenhouse gas (GHG) emissions in Nigeria is the absence of standardized emission measurement frameworks. Without reliable and consistent measurement standards, it is difficult to assess the full environmental impact of Nigeria's rapidly growing tech sector, including data centres, telecommunications networks, and digital infrastructure. Unlike countries such as South Africa, which has integrated carbon reporting mandates through its National Atmospheric Emission Inventory System (NAEIS), Nigeria lacks a centralized emissions database for ICT-related activities.

This gap hampers policy implementation, as government agencies such as the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the National Bureau of Statistics (NBS) lack the necessary data to formulate targeted mitigation strategies. Additionally, the lack of sector-specific emission guidelines prevents ICT companies from accurately tracking and reporting their carbon footprint, reducing accountability. The absence of standardized reporting requirements also means that foreign and local tech investors have no clear guidelines for adopting sustainable practices, limiting the country's ability to attract green investments.

Moreover, without a clear emissions baseline, Nigeria struggles to align its climate policies with global commitments such as the Paris Agreement, which requires participating nations to implement transparent monitoring, reporting, and verification (MRV) systems.

3. Policy Landscape for GHG Emissions Regulations and Gaps in Nigeria

Nigeria faces a significant challenge in managing electronic waste (e-waste), with weak regulatory enforcement exacerbating environmental degradation and contributing to greenhouse gas (GHG) emissions. While NESREA has established some guidelines under the National Environmental (Electrical/Electronic Sector) Regulations, enforcement remains weak due to inadequate monitoring, insufficient funding, and lack of coordination with industry stakeholders. The unchecked influx of used and obsolete electronic devices, many of which are improperly disposed of in open landfills or informally dismantled, leads to the release of hazardous substances such as lead, mercury, and brominated flame retardants. These toxic materials not only pose serious health risks but also contribute to indirect emissions through the burning of electronic components.

Unlike South Africa, which has implemented an Extended Producer Responsibility (EPR) framework mandating manufacturers to take responsibility for the entire lifecycle of their products, Nigeria lacks a robust mechanism to hold tech companies accountable for proper disposal and recycling. Additionally, Ghana has successfully formalized its e-waste sector by integrating informal recyclers into regulated frameworks, providing them with training and financial support to improve waste processing. Nigeria, however, has yet to establish a sustainable national e-waste management strategy that aligns with global best practices. To address this, the Federal Ministry of Environment and NESREA must work collaboratively with the National Information Technology Development Agency (NITDA), state environmental agencies, and local governments to implement stricter e-waste regulations, enhance formal recycling infrastructure, and incentivize tech companies to adopt circular economy models. Without urgent action, Nigeria's growing ICT sector will continue to contribute disproportionately to environmental pollution and carbon emissions associated with inefficient e-waste handling.

The Climate Change Act establishes critical scaffolding for Nigeria's net-zero transition but requires urgent operationalization and its provisions require stricter enforcement to bridge ambition with action on lowering industry-based emissions.

3. Policy Landscape for GHG Emissions Regulations and Gaps in Nigeria

Lack of Digital Sustainability Standards for Technology Startups, Data Centers, and Innovation Hubs

The absence of clear digital sustainability standards for Nigeria's growing technology sector—including startups, data centres, and innovation hubs—poses a significant policy and practical gap in managing ICT-related greenhouse gas (GHG) emissions. With Nigeria emerging as one of Africa's leading tech ecosystems, hosting thousands of startups and multiple data centers, the energy demand and environmental impact of these digital enterprises continue to rise.

Unlike South Africa, which enforces green data center regulations under its Carbon Tax Act, and Kenya, which has integrated sustainable ICT guidelines into its Vision 2030 strategy, Nigeria lacks comprehensive policies requiring tech firms to adopt energy-efficient and climate-smart operations. While the Nigeria's Climate Change Act (2021) mandates that companies with 50+ employees must implement emission reduction measures and report annually and non-compliance risks fines, there are no documented evidence of implementation and resulting penalties for defaulters because there is no system for such management or coordination.

The rapid expansion of computing-intensive sectors such as artificial intelligence (AI), cloud computing, and software development has escalated electricity consumption, often relying on diesel-powered backup systems due to the country's unstable power supply. Similarly, cryptocurrency mining, which requires high-powered computing, has grown in popularity in Nigeria but operates without regulation on its energy use, exacerbating its carbon footprint.

Additionally, the transport and logistics sector, which heavily integrates digital platforms for ride-hailing, e-commerce deliveries, and supply chain management, contributes significantly to emissions through fossil fuel-powered vehicle fleets. Many tech startups operating in this space lack incentives or requirements to transition to electric vehicles or other low-emission alternatives. In contrast, Rwanda has mandated sustainability reporting for logistics companies and promotes electric mobility within its digital economy sector.

The lack of sustainability guidelines in Nigeria means that data centers, fintech firms, and logistics startups continue to expand without environmental accountability. To address this, the Federal Ministry of Communications and Digital Economy, in partnership with the National Information Technology Development Agency (NITDA) and the Energy Commission of Nigeria (ECN), must establish national digital sustainability standards. These standards should include energy efficiency benchmarks for data centers, incentives for tech startups to use renewable energy, and emission reduction targets for digital transport services.

Without such measures, Nigeria's booming tech industry will remain a growing contributor to ICT-related emissions, undermining national and global climate commitments.

3. Policy Landscape for GHG Emissions Regulations and Gaps in Nigeria

Zero or Limited Incentives for Green ICT or Green Technology Practices

The lack of structured incentives for Green ICT and sustainable technology practices represents a significant policy and practical gap in Nigeria's efforts to manage ICT-related greenhouse gas (GHG) emissions. Unlike countries such as South Africa, which provides tax credits for renewable energy adoption in ICT operations, or Kenya, which has introduced targeted grants for startups developing green innovations, Nigeria lacks comprehensive incentive programs to drive sustainable digital transformation. Without fiscal policies such as tax rebates, grants, and low-interest loans, technology companies and startups in Nigeria have little motivation to invest in energy-efficient data centers, smart grid solutions, and low-emission computing.

This gap is evident in the operations of Nigeria's growing data center industry, which continues to rely on diesel-powered backup systems rather than transitioning to renewable energy sources. Similarly, there are no targeted incentives for sustainable cryptocurrency mining, despite its high energy consumption and potential for cleaner energy integration. The absence of supportive government policies has also hindered the growth of green logistics, where incentives could encourage ride-hailing and e-commerce companies to transition to electric or hybrid delivery fleets.

Green IT and green technology practices can significantly reduce GHG emissions and enhance Nigeria's net-zero transition by promoting energy efficiency, reducing electronic waste, and integrating renewable energy solutions.

Tech startups can adopt energy-efficient coding practices, optimize cloud computing resources, and design low-power-consuming software. Companies can transition to solar-powered data centers, implement circular economy models for e-waste recycling, and electrify logistics fleets. Individuals can minimize their digital carbon footprint by choosing energy-efficient devices and supporting sustainable digital services. These strategies, supported by strong policies and incentives, will lower Nigeria's ICT-related emissions and accelerate its transition toward a sustainable digital economy. Without urgent interventions, the absence of incentives will continue to discourage private sector investment in Green ICT, limiting Nigeria's ability to meet its climate goals and transition to a low-carbon digital economy.

Inadequate Recycling Infrastructure

A major challenge in managing ICT-related greenhouse gas (GHG) emissions in Nigeria is the lack of an efficient recycling infrastructure, particularly for electronic waste (e-waste). The country generates hundreds of thousands of metric tons of e-waste annually, but most of it is either informally dismantled, incinerated, or disposed of in landfills, leading to environmental pollution and significant carbon emissions. Unlike South Africa, which has developed a structured recycling industry through its National Waste Management Strategy, Nigeria's recycling sector remains largely unregulated and underdeveloped.

3. Policy Landscape for GHG Emissions Regulations and Gaps in Nigeria

This gap exists due to several factors, including weak policy enforcement, a lack of investment in recycling technologies, and limited public awareness of proper disposal methods. The absence of government-supported e-waste collection and processing centers forces informal recyclers to use crude and environmentally hazardous methods, such as burning circuit boards to extract valuable metals.

In contrast, countries like Ghana have successfully introduced e-waste recycling plants with extended producer responsibility (EPR) schemes, where manufacturers take part in waste collection and recycling efforts. To address this, the Federal Ministry of Environment and the National Environmental Standards and Regulations Enforcement Agency (NESREA) must collaborate with the private sector and international organizations to develop state-of-the-art recycling facilities.

Additionally, incentives such as tax breaks and funding support should be provided to local entrepreneurs and startups specializing in e-waste recycling. Strengthening Nigeria's recycling infrastructure will not only reduce the environmental impact of ICT-related emissions but also create economic opportunities in the green technology sector.

Low accountability or Lack of stringent Extended Producer Responsibility (EPR) policies and programs

The absence of a stringent Extended Producer Responsibility (EPR) framework in Nigeria remains a critical gap in managing ICT-related greenhouse gas (GHG) emissions.

EPR policies, which require manufacturers and importers to take responsibility for the lifecycle of their electronic products, including recycling and disposal, have proven effective in countries such as South Africa and Rwanda.

In Nigeria, while NESREA has outlined some producer responsibility regulations, enforcement remains weak due to limited compliance monitoring, inadequate infrastructure, and a lack of clear financial incentives for producers. Nigeria's Climate Change Act (2021) encourages circular economy practices for ICT and manufacturing sectors, though enforcement mechanisms are still under development. Many tech companies in Nigeria operate without obligations to retrieve and recycle their products, leading to widespread improper disposal of electronic waste, which contributes to increased GHG emissions through landfill accumulation and informal burning of e-waste. Unlike Kenya, which has established producer take-back programs supported by the government and private sector, Nigeria lacks a coordinated system to ensure that manufacturers and retailers of electronic goods participate in sustainable disposal initiatives. To address this, NESREA, in collaboration with the National Information Technology Development Agency (NITDA) and the Standards Organisation of Nigeria (SON), must establish legally binding EPR regulations with strict enforcement mechanisms.

Additionally, partnerships between manufacturers, recyclers, and state environmental agencies should be fostered to create an efficient circular economy for electronics. Without the implementation of a well-structured EPR system, Nigeria will continue to struggle with uncontrolled e-waste generation, escalating ICT-related emissions, and missing opportunities for green economic growth.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4. Practical and Policy Recommendations for Promoting Digital Sustainability in Nigeria

As Nigeria's digital economy expands, so does its environmental footprint, with Information and Communication Technology (ICT) emerging as a major contributor to greenhouse gas (GHG) emissions. From energy-intensive data centers and widespread electronic waste to inefficient telecommunications infrastructure, the country faces significant sustainability challenges. However, addressing these challenges requires a multi-pronged policy approach, integrating regulatory oversight, green incentives, and stakeholder collaboration. For Nigeria to mitigate its ICT-driven carbon footprint, here are actionable policy and practical multi-stakeholder recommendations, as informed by citizens' experiences and expertise, that align with global best practices to promote a low-carbon digital economy and enable a just net zero transition.

For the Nigerian Government

1. **Policy and Regulatory Frameworks**

   • **Mandatory Emissions Reporting:** Enforce annual GHG emissions reporting for ICT companies, using standardized tools to track digital carbon footprints.

   • **E-Waste Management Legislation:** Strengthen and enforce Extended Producer Responsibility (EPR) laws to ensure proper recycling and disposal of ICT hardware.

   • **Green ICT Standards:** Develop and mandate energy efficiency standards for data centers, telecom networks, and electronic devices.

2. **Incentivizing Renewable Energy Adoption**

   • Provide tax incentives for ICT companies that power operations with at least 50% renewable energy.

   • Subsidize renewable energy solutions for tech hubs and startups to reduce reliance on fossil fuels.

3. **Capacity Building and Awareness Campaigns**

   • Launch national campaigns to educate businesses and citizens on sustainable ICT practices, including energy-efficient device usage and e-waste recycling.

   • Integrate sustainability modules into STEM education curricula to build a future workforce skilled in green technologies, more practically an integration into the Nigeria's The National Digital Literacy Framework (NDLF), capacity development content which supports school children to become climate-aware and environmentally conscious.

4. **Investments in Green Infrastructure**

   • Expand decentralized renewable energy grids to power rural tech hubs and reduce emissions from diesel generators.

   • Establish public-private partnerships to fund green data centres equipped with efficient cooling systems and renewable energy sources.

4. Practical and Policy Recommendations for Promoting Digital Sustainability in Nigeria

5 Monitoring and Accountability Mechanisms

• Create a centralized digital platform for real-time monitoring of emissions from the ICT sector, ensuring transparency and compliance with climate goals.

• Regularly update carbon budgets for the ICT sector as part of Nigeria's Long-Term Low Emission Development Strategy (LT-LEDS).

For Technology Stakeholders (Private Sector)

1 Adoption of Green Technologies

• Transition to energy-efficient servers, cloud computing solutions, and low-power devices to minimize operational emissions.

• Invest in circular economy models, such as refurbishing old devices and sourcing recycled materials for production.

2 Operational Sustainability Practices

• Optimize data center operations by adopting advanced cooling technologies like liquid cooling or free-air cooling systems.

• Implement remote work policies where feasible to reduce the carbon footprint associated with commuting and office energy use.

3 Corporate Social Responsibility

• Partner with local communities to establish e-waste collection centres and recycling facilities, ensuring safe disposal of electronic waste.

• Support research initiatives focused on developing low-carbon technologies tailored to Nigeria's unique challenges.

4 Collaboration with Government

• Actively participate in policy dialogues to co-develop practical solutions for reducing tech-led emissions while fostering innovation.

• Share best practices from global operations to help localize sustainable ICT practices in Nigeria.

5 Digital Literacy Initiatives

• Conduct training programs, as part of employment onboarding processes, for employees on adopting eco-friendly practices in daily operations, such as reducing unnecessary device usage or optimizing power consumption settings.

Joint Recommendations (Government & Private Sector)

1 Research & Development (R&D)

• Invest jointly in R&D projects focused on low-carbon technologies such as hydrogen fuel cells, carbon capture utilization, and sequestration (CCUS), or direct air capture systems.

2 Public-Private Partnerships (PPPs)

• Establish PPPs to fund large-scale projects like green data centers or smart city initiatives that integrate sustainable ICT solutions into urban planning.

3 Decarbonizing the Supply Chain

• Collaborate across the value chain to ensure suppliers adhere to green standards, including sourcing materials responsibly and minimizing embodied emissions during manufacturing processes.

4. Practical and Policy Recommendations for Promoting Digital Sustainability in Nigeria

4 Global Knowledge Sharing

• Leverage international collaborations like the UK-Nigeria Sustainable Construction Global Innovation Network to adopt best practices in circular economy models and green ICT infrastructure development.

5 Digital Free Zones for Sustainability Innovation

• Establish digital free zones dedicated to fostering innovation in green technologies, creating an ecosystem where startups can develop solutions aimed at decarbonizing the digital sector.

These recommendations aim to align Nigeria's burgeoning technology ecosystem with its net-zero goals by 2060 while fostering economic growth through sustainable practices. Both government action and private sector innovation are essential for creating a resilient digital economy that minimizes environmental impact.

Conclusion

Nigeria's rapid technological growth, particularly in sectors like energy, digital software and hardware production, automation, manufacturing, telecommunications, e-commerce, and logistics, has significantly contributed to its greenhouse gas (GHG) emissions.

Telecommunications infrastructure alone emits approximately 4,000 tonnes of CO_2 daily due to its reliance on diesel generators for powering base transceiver stations (BTS) and data centers.

Similarly, e-commerce and logistics exacerbate emissions through inefficient transportation networks and energy-intensive digital operations. E-waste accumulation further compounds the problem, with improper disposal methods such as open burning releasing potent GHGs like methane and black carbon.

These trends underscore the urgency of integrating climate-smart solutions into Nigeria's technology sector to align with its Nationally Determined Contributions (NDCs) under the Paris Agreement. Without decisive action, Nigeria risks missing its 2030 emission reduction targets while exacerbating environmental degradation.

To mitigate technology-driven GHG emissions, Nigeria must prioritize the adoption of climate-smart policies. Key measures include enforcing carbon pricing mechanisms for high-emission sectors like telecommunications, incentivizing renewable energy adoption (e.g., solar-powered BTS), and mandating energy efficiency standards for digital infrastructure.

The Climate Change Act (2021) provides a framework for these interventions but requires stronger enforcement mechanisms and financial incentives to accelerate implementation. Furthermore, fostering public-private partnerships can catalyze investments in green technologies while promoting circular economy practices to address e-waste challenges.


POWER ADAPTER

Appendices

Contributing Authors From Regional Consultations

Lagos

Idongesit Udoh
Oluwadamilola Sowemimo
Laraba Adegbenro
Oyindamola Oyinlola-Eyitayo
Betty Adepoju
Ndaman Joshua
Babatunde Oluwabukunmi Victor
Blessed Ola Saint
Ogunade Adekunle
Chinomso Nzenwa

Port Harcourt

Kelvin Ogba Dafiaghor
Opuda Sotonwari
Felix Ogbuji

Abuja

Cynthia E. Chisom
Ayomikun Dada
Ajibola Ojediran
Wonderful Akanbi
Tomiwa Olanrewaju
Lucky Owoicho
Thara Aisha Atta
Ishaku Ayuba
Kenneth Magam
Lucky Bardeson
Joseph Silas
Ayomide Fasan Olanipekun
Anointing Jael Victor
Junaid Eniola Aaliyah
Daniel Obiorah
Umar Adam I. Phid
Ejiroghene Eseoghene
Patrick Inaku
Ukpanwanne Kelvin Louis
Nwaigwe Jeremiah
Ajoga Ezekiel
Salihu Hamman Jidda
Irene Matazo
Iyaji Gloria
Lolo Granville
Onu Abah
Rahama Abah
Augustus June
Blessing Raymond
Raphael Edema
Shaban Haruna
Okonkwo Ebuka
Dede Israel
Ayomide Fasan Olanipekun
Chiedozie Ferdinand
Tobi Williams
Blessing Tarfa
Odeh Friday
Bonojo Adedayo
Friday Ameh Matthew
Charles Obute
Onyenkachi Kingsley Anumata
Abubakar Sadiq Umar
Ajah Mundhir .O.
Abdulwaheed Adedayo Abdulsalam
Eugene Onyirinba
Christian Chidinma Esther
Kelvin Joarhe
Umar Mohammed
Faiz Muhammad
Christian Chidinma Esther

The Green House Gas Protocol Standard

The Greenhouse Gas Protocol (GHG Protocol) is an accounting tool used by organisations and governments to understand, quantify and manage their GHG emissions. It provides the world's most widely used GHG accounting standards. It was created in 2001, when the World Resources Institute and the World Business Council for Sustainable Development identified a need for consistency in how organisations accounted and reported emissions and together introduced the new standard.

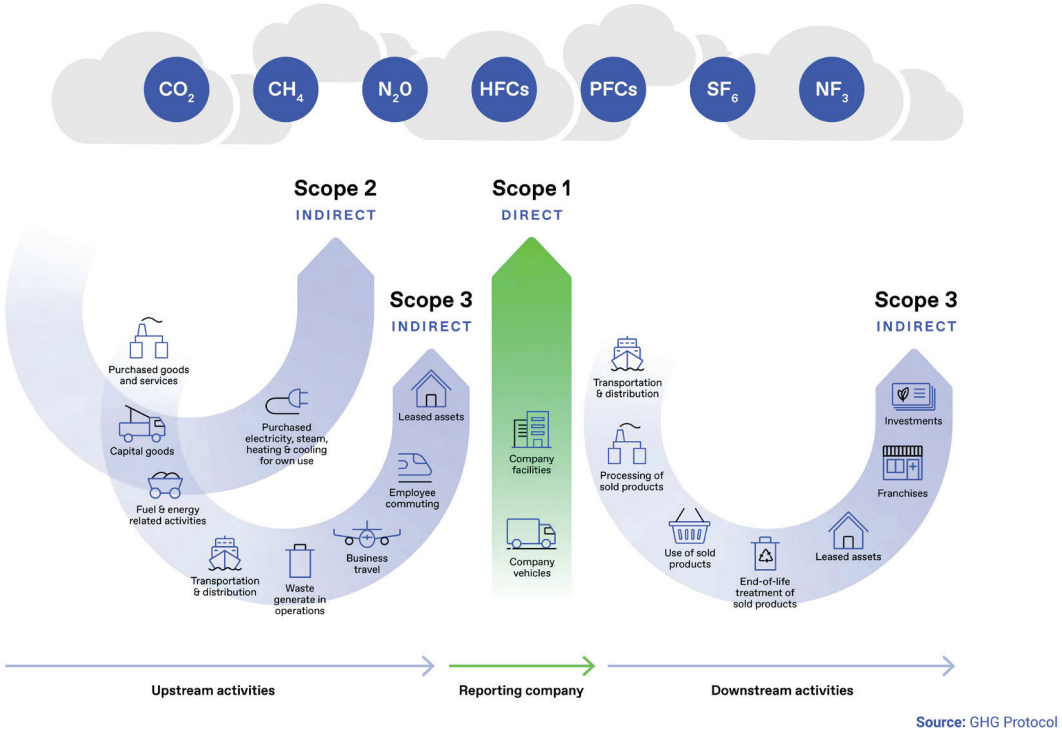
The GHG Protocol categorises emissions into three groups or **'Scopes':**

Scope 1: Direct emissions that result from activities within your organisation's control. This might include onsite fuel combustion, manufacturing and process emissions, refrigerant losses and company vehicles.

Scope 2: Indirect emissions from any electricity, heat or steam you purchase and use. Although you're not directly in control of the emissions, by using the energy you are indirectly responsible for the release of CO2.

Scope 3: Any other indirect emissions from sources outside your direct control. Examples of Scope 3 emissions include purchased goods and services, use of sold goods, employee commuting and business travel, outsourced transportation, waste disposal and water consumption.

Under the GHG Protocol, all organisational footprints must include Scope 1 and 2 emissions. There is more flexibility when choosing which Scope 3 emissions to measure and report, and you can tailor these to reflect your environmental and commercial goals.



Source: GHG Protocol

Source: GHG Protocol & Carbon Trust

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