Review

Best Practice Compendium: "Greener Tech In Africa"

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Best Practice Compendium—"Greener Tech in Africa"

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Abstract

Africa's digital sector has expanded rapidly, driving growth in communication, commerce, and innovation. Yet this progress risks deepening carbon emissions, e-waste, and resource dependence if sustainability is overlooked. This compendium examined best practices from across the continent to show how digital transformation can align with environmental responsibility. Through case studies of renewable-powered infrastructure, certified recycling initiatives, and circular economy enterprises, it identified pathways for reducing ICT's ecological footprint while enabling inclusive growth. Cross-cutting themes such as SME participation, gender-responsive strategies, clean mobility, and climate-smart agriculture demonstrated how greener technologies can support resilience and equity. A practical toolkit provided steps for organisations to assess and improve their sustainability performance, while the discussion of scaling strategies stressed partnerships, financing, and governance as critical enablers. The findings suggested that Africa's digital future can be both innovative and sustainable when guided by deliberate policies and collaborative action.

Keywords: Africa; sustainability; ICT; green innovation; renewable energy; circular economy; digital transformation; inclusive growth

Introduction

"By moving up the value chain and processing resources closer to home, Africa can maximize its economic gains, cut carbon emissions, and build resilient, equitable economies," says Wanjira Mathai, Managing Director for Africa and Global Partnerships, World Resources Institute. Africa is on the threshold of an unprecedented digital transformation, one that could redefine its economic, social, and environmental trajectory. The continent's internet economy is projected to contribute over US $700 billion to GDP by 2050 if enabling policies and investments materialize (IFC & Google, 2020). This growth powered by fintech, e-commerce, AI, and connected infrastructure presents extraordinary opportunities for inclusion and innovation. Yet it also carries significant risks if it follows the extractive, high-carbon pathways of the past. The challenge is clear: Africa already generates and imports millions of tonnes of e-waste annually, much of it processed informally, exposing workers and communities to hazardous materials (ITU & UNITAR, 2024). At the same time, energy demand from telecom networks and data centers is accelerating, often met with fossil-fuel generation (IEA, 2022). Without deliberate intervention, these trends could undermine the African Union's climate commitments, pollute ecosystems, and exacerbate public health burdens. Yet this is also a historic opportunity. Africa holds 60% of the world's best solar resources (IEA, 2022), a young, innovation-driven workforce, and a rapidly growing network of green technology entrepreneurs. With strategic investment in renewable-powered ICT infrastructure, circular device economies, and low-carbon policy frameworks, the continent can leapfrog outdated, polluting models and emerge as a global leader in climate-smart digital development. This compendium is both a call to action and a

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roadmap. It curates proven, context-specific approaches from solar-powered rural broadband in Kenya (GSMA, 2023), to e-waste collection networks in Nigeria (UNEP, 2023), to green data center initiatives in South Africa (Reuters, 2024) showing that sustainable digital growth is not only possible, but already underway. The task ahead is to scale these solutions, embed them into national digital transformation strategies, and align investment flows with both connectivity and climate goals. By acting now, Africa can ensure its digital future is not just connected, but also clean, inclusive, and resilient.

Faced with increasing environmental challenges, sustainability has become an essential guiding principle for building a better future. The demands of the modern era require innovative approaches and a shift in mindset toward sustainable practices to confront climate change, safeguard biodiversity, and secure the well-being of generations to come. This article examines the importance of sustainability today and highlights key areas where individuals, communities, and businesses can play a role in creating a greener, more resilient world (Global Sustainability Magazine, 2023).

The Greener Tech in Africa compendium has been prepared as a practical guide to support Africa's digital transformation in a way that is both inclusive and environmentally sustainable. Its central purpose is to provide policymakers, ICT operators, investors, development partners, researchers, and innovators with a collection of tested practices that demonstrate how digital growth can be aligned with sustainability imperatives. By doing so, it seeks to bridge the gap between ambitious digital agendas, such as the African Union's Digital Transformation Strategy for Africa (2020–2030), and the urgent need to reduce environmental harm while maximizing the socio-economic benefits of technological advancement (AU, 2020). Africa's digital transformation is unfolding rapidly, with mobile connectivity, fintech, and e-commerce driving new opportunities for growth and inclusion. In 2023, the mobile ecosystem contributed more than eight percent of Sub-Saharan Africa's GDP, and forecasts suggest that the continent's internet economy could add up to US $712 billion by 2050 if enabling conditions are met (GSMA, 2024; IFC & Google, 2020). This momentum is reshaping livelihoods and governance, opening access to education, healthcare, and financial services for millions. Yet alongside this progress are rising environmental costs that, if left unaddressed, could undermine the very promise of Africa's digital future. One of the most pressing issues is the surge in electronic waste. Globally, e-waste reached 62 million tonnes in 2022, with only 22.3 percent formally recycled, and Africa accounts for some of the lowest rates of safe recovery and processing (ITU & UNITAR, 2024). Much of the continent's e-waste is handled informally, exposing workers and communities to toxic substances such as lead, mercury, and cadmium, and contributing to long-term ecological degradation. At the same time, the energy demands of Africa's expanding ICT sector are climbing sharply. Telecom networks, data centers, and cloud services require substantial power, and in many contexts, this is supplied by diesel generators, adding to carbon emissions. Yet Africa holds 60 percent of the world's best solar resources, giving the continent a historic opportunity to power its digital future with clean and renewable energy rather than fossil fuels (IEA, 2022).

Framework for Green Tech Practices

As Africa's digital infrastructure scales rapidly, it's vital to embed sustainability at the heart of its development. The framework below outlines five indispensable domains Energy Management, Materials & Procurement, Waste Management, Digital Efficiency, and Sustainable Governance each informed by concrete evidence from recent African experience

Energy Management

Africa Data Centres (ADC) signed a 20-year Power Purchase Agreement (PPA) with Distributed Power Africa (DPA SA), part of EDF's network, to build a 12 MW solar farm near Bloemfontein. The farm supplies clean energy to ADC's Cape Town facility (CPT1) and, in subsequent phases, to Johannesburg sites through energy wheeling over existing infrastructure. This initiative reduces

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reliance on the volatile grid and underscores a shift toward sustainable digital infrastructure (DatacenterDynamics, 2024; Reuters, 2024).

Materials and Procurement

While detailed examples in the African ICT sector remain sparse, a clear strategic direction emerges: procurement must favour modular hardware, ethically sourced materials, and repairable designs, echoing the disciplined approach seen in structured renewable energy PPAs (DatacenterDynamics, 2024).

Waste Management

Despite generating over 2.9 million tonnes of e-waste in 2019, only approximately 1% of this was formally recycled highlighting a critical gap in environmental management (Adu & Awuah, 2025). Cities like Accra's Agbogbloshie starkly illustrate the risks of informal recycling without proper safeguards. In response, initiatives in Ghana and South Africa are beginning to formalise recycling, introduce Extended Producer Responsibility (EPR) policies, and bridge informal and formal sectors (Adu & Awuah, 2025; Wikipedia, Agbogbloshie).

Digital Efficiency

Though sector-specific African statistics are limited, evidence from solar mini-grids in rural Kenya and Nigeria is telling. A cohort study tracking over 2,600 households and businesses found that incomes quadrupled post-mini-grid installation. Women gained more decision-making power, and reductions in kerosene usage improved health outcomes (Carabajal et al., 2024). These socioeconomic impacts underline the transformative potential of efficient, decentralised renewable energy systems.

Sustainable Governance

Governance anchors all green innovation. ADC's adoption of ISO 50001-level energy management alongside its FPSA underscores corporate accountability (Africa Data Centres press release). On the public policy front, Nigeria's ambitious 2025 initiative pledging US$200 million for 400 rural mini-grids demonstrates government-industry synergy in achieving clean energy access targets (Reuters, 2025).

Best Practice Profiles

A number of best practice profiles highlight how renewable energy and sustainable infrastructure are being advanced across Africa. One notable example is the Solar-Powered Data Centre in Bloemfontein, South Africa, led by Africa Data Centres (ADC) in partnership with DPA Southern Africa. Through a 20-year power purchase agreement (PPA), ADC is developing a 12 MW solar farm to supply its Cape Town data centre (CPT1), with future plans to extend energy provision to Johannesburg via wheeling frameworks (DatacenterDynamics, 2024). The benefits of this initiative include substantial decarbonisation, reduced reliance on diesel and grid electricity, and enhanced resilience to South Africa's energy crises, while also demonstrating leadership in green data infrastructure. Implementation steps have involved negotiating and formalising the PPA, constructing the solar farm, leveraging wheeling arrangements to deliver power, and planning expansion to Johannesburg data centres while integrating international energy efficiency standards. The main challenges lie in navigating complex municipal negotiations, regulatory hurdles, and grid constraints.

The deployment of solar mini-grids in rural Kenya and Nigeria, driven by community-led initiatives and supported by development agencies. These projects have delivered transformative impacts: surveys of 2,658 households revealed benefits such as quadrupled median incomes, reduced kerosene expenditure, lower phone-charging costs, improved health through reduced indoor air

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pollution, and better educational outcomes as students gained longer study hours (Carabajal et al., 2024). Implementation steps typically involve engaging communities, financing and installing solar PV systems with storage, training local operators, and conducting pre- and post-intervention surveys to measure outcomes. However, challenges remain around ensuring financial sustainability since tariffs must remain affordable and securing long-term local ownership and capacity-building to sustain the benefits.

In the area of circular economy, e-waste management initiatives in Ghana and South Africa have sought to formalise practices through Extended Producer Responsibility (EPR) regulations, accredited collection centres, and partnerships with formal recyclers. These initiatives bring benefits such as reducing hazardous informal dismantling, recovering valuable resources, and creating safer formal employment opportunities (Adu & Awuah, 2025). Implementation steps include enacting EPR legislation, establishing collection and recycling hubs, providing training to informal sector workers, and rolling out public awareness campaigns to encourage responsible disposal. The challenges are significant, as enforcement demands strong institutional capacity, and the initial capital requirements for formal recycling remain a major barrier.

The Nigeria's Rural Mini-Grids Initiative, spearheaded by the Rural Electrification Agency (REA) in partnership with WeLight and supported by the World Bank and African Development Bank. With a US$200 million investment, the programme aims to install 400 renewable mini-grids and 50 MetroGrids, targeting 1.5–2 million rural and peri-urban residents and raising renewable energy's share from 22% to 50% by 2025 (Reuters, 2025). The benefits of this large-scale, government-backed deployment include clean and reliable energy access, social uplift through electrification, and accelerated public–private sector coordination. Implementation steps have included signing memoranda of understanding, securing multilateral funding, rolling out installations across priority settlements, and establishing monitoring frameworks to track impact and scalability. The challenges are equally considerable, ranging from the logistical complexity of nationwide rollout to ensuring adequate technical maintenance capacity and coordinating across diverse regions and stakeholders.

Together, these cases demonstrate how Africa is advancing sustainable energy solutions, from corporate-led solar farms to community-driven mini-grids, formalised e-waste systems, and national-scale electrification programmes. They underscore both the transformative potential of renewable infrastructure and the persistent challenges of financing, regulation, and institutional capacity that must be addressed for long-term success.

Thematic Deep Dives

Green ICT for SMEs

For Africa's small and medium-sized enterprises (SMEs), the adoption of green information and communication technologies (ICT) is increasingly viewed as a pathway to cut costs, improve efficiency, and foster resilience. Affordability, however, remains a major concern. Innovative financing mechanisms such as pay-as-you-go (PAYG) solar models have revolutionized access to clean energy by spreading costs over time and linking repayment to mobile money platforms. PEG Africa and M-KOPA Solar have demonstrated how SMEs can obtain reliable electricity without large upfront investments, thereby reducing dependence on diesel generators and kerosene lamps (PEG Africa, 2023; Reclaim Africa, 2024).

Zola Electric, operating in Tanzania, Kenya, and Rwanda, has pioneered hybrid solar systems with smart meters, allowing micro-entrepreneurs to pay as little as fifty cents per day for energy. This democratization of clean energy has enabled barbershops, food vendors, and tailors to sustain their businesses while reducing environmental footprints (Native Media, 2024). In Nigeria, GRIT Systems provides multi-source smart metering devices that allow SMEs to monitor consumption in real time, enabling them to optimize energy use and cut operational waste (Africa4Tech, 2024). Together, these solutions underscore that green ICT can be both environmentally sustainable and financially accessible, positioning African SMEs to thrive in a green digital economy.

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Gender and Inclusion in Green Tech

The transition to greener technologies must not only advance sustainability but also inclusion. In Africa, gender-responsive green initiatives have begun to reveal how clean technology can simultaneously empower women and address systemic inequalities. In Benin, the Solar Electric Light Fund (SELF) has implemented Solar Market Gardens, where women's farming collectives utilize solar-powered irrigation to cultivate crops during dry seasons. This intervention has improved nutrition, increased household income, and enhanced women's leadership within communities (Solar Electric Light Fund, 2023).

Decentralized energy systems also produce measurable impacts on gender equality. A 2024 study of rural electrification in Kenya and Nigeria found that access to solar mini-grids quadrupled median household incomes and enhanced women's decision-making power, as women could start small businesses and reduce time spent on unpaid domestic labor (Bhatia et al., 2024). Furthermore, women are emerging as leaders in the green innovation space. Côte d'Ivoire's BioAni engages women in the production of organic fertilizer using black soldier fly larvae, combining environmental solutions with women's economic participation (The Africa Report, 2024). Similarly, Coliba in Ghana and Côte d'Ivoire integrates women waste pickers into its recycling supply chain, ensuring better pay and recognition for an often-marginalized workforce (Africa Innovation Summit, 2024). These examples illustrate that inclusive approaches in green tech are essential to ensure equitable access and lasting societal benefits.

Climate-Smart Agriculture and Food Systems

Agriculture remains Africa's largest employer and a critical driver of food security, yet it is also highly vulnerable to climate variability. Greener digital tools are emerging as powerful enablers of climate-smart agriculture. Precision farming platforms such as Apollo Agriculture in Kenya and Farmerline in Ghana combine AI, soil analytics, and SMS-based advisories to optimise fertiliser and water use, boosting productivity while cutting emissions (TAGI Africa, 2024). Digital irrigation systems, powered by solar pumps and IoT sensors, are enabling resource-efficient water use, particularly in semi-arid regions. Beyond productivity, platforms are beginning to link smallholder farmers to carbon markets, allowing them to monetise sustainable practices such as agroforestry and soil carbon storage. Youth-driven agritech innovations from vertical farming systems in Nigeria to drone-based crop monitoring in South Africa keep highlighting the growing ecosystem of solutions that combine food security with sustainability (Africa Civic Lens, 2025).

Green Mobility and Smart Cities

Africa's rapid urbanisation demands cleaner, more efficient mobility and infrastructure systems. Electric vehicle (EV) adoption is gaining traction, with pilot e-mobility programmes in Kenya, Rwanda, and Nigeria introducing electric motorbikes, buses, and charging hubs (The Africa Report, 2024). These initiatives cut urban air pollution and reduce reliance on imported fuels. Smart city initiatives are also integrating digital tools for urban planning, energy management, and intelligent transport systems, such as Lagos's deployment of AI-enabled traffic monitoring to reduce congestion. At the same time, cities are experimenting with smart waste and water management: for instance, Cape Town is piloting IoT sensors to optimise waste collection routes, while Nairobi is exploring data-driven water leak detection. Together, these approaches highlight the potential for African cities to leapfrog into low-carbon, digitally managed urban futures.

Green Finance and Investment Models

The need for scaling greener technologies across Africa requires innovative financial mechanisms. **Pay-as-you-go (PAYG)** models, already transformative in off-grid solar, are being adapted to support ICT, e-mobility, and agricultural solutions (PEG Africa, 2023; Reclaim Africa, 2024). Impact investors and blended finance vehicles are increasingly backing climate-tech startups,

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such as Solar Turtle in South Africa and Ecotutu in Nigeria, which address both social and environmental goals (Ecotutu, 2023; TAGI Africa, 2024). Meanwhile, corporate sustainability financing through green bonds and carbon credit trading is providing larger companies with pathways to align profitability with climate objectives. These models collectively demonstrate that financial innovation is as critical as technological innovation in ensuring Africa's green digital transition.

Youth, Gender, and Inclusion in Green Tech

The continent's demographic dividend positions youth and women as central actors in Africa's sustainability journey. Youth entrepreneurship is at the forefront of Africa's climate-tech landscape, with innovators designing IoT-enabled farming solutions, biogas systems, and AI-powered climate tools (Africa Civic Lens, 2025). Gender inclusion is equally vital: initiatives such as Coliba in Ghana and Côte d'Ivoire are integrating women into recycling value chains, while Benin's Solar Market Gardens empower women farmers through solar-powered irrigation (Solar Electric Light Fund, 2023). Addressing gender gaps in STEM and digital skills is critical to ensuring equitable participation in the green economy. These examples show that Africa's digital sustainability transition must also be a socially inclusive transformation, creating opportunities for those historically left behind.

Measurement, Data, and Impact Tracking

Finally, robust measurement frameworks are essential for tracking the environmental impact of Africa's digital adoption. Tools such as **CarbonTrac** provide real-time monitoring of carbon and water footprints, enabling companies and policymakers to quantify progress. Regional collaborations, including ITU's Green Digital Transformation initiative, are working to harmonise green metrics across borders (ITU, 2022). Integrating impact-tracking frameworks into digital policy will be crucial for ensuring accountability and scaling proven solutions. Without clear measurement, the risk is that green commitments remain rhetorical but with it, Africa can demonstrate global leadership in climate-smart digital development.

Local Innovation Highlights: Showcasing African-Developed Green Tech Solutions

Africa's path toward a sustainable digital future is defined by local innovators creating solutions tailored to the continent's realities. In Nigeria, Ecotutu has developed solar-powered cold storage with a **"pay-as-you-chill"** model, giving farmers affordable ways to preserve perishables and reduce post-harvest losses (Ecotutu, 2023). In South Africa, Lumkani has deployed fire-detection sensors linked to microinsurance platforms to protect informal settlements from devastating fires, blending technology with social resilience (Lumkani, 2023).

Youth-driven entrepreneurship further reflects Africa's innovation strength. Projects across Kenya, Ghana, and Nigeria include solar-powered vertical farming systems, IoT-enabled precision agriculture platforms, solar charging networks for e-bikes, and biogas systems derived from organic waste. These solutions address immediate community challenges while offering scalable models for global sustainability (Africa Civic Lens, 2025). Larger agritech enterprises also illustrate the continent's green leadership. Kenya's Twiga Foods reduces food waste by digitally linking farmers and vendors, while South Africa's Aerobotics uses drones and AI to detect crop disease, preventing up to 40 percent of yield losses. Farmerline in Ghana enhances farmer decision-making through AI-based SMS advisories, while Apollo Agriculture in Kenya combines AI, soil analytics, and credit solutions to support smallholders (TAGI Africa, 2024). In renewable energy, South Africa's Solar Turtle offers portable solar kiosks designed for rural communities, further expanding clean energy access (TAGI Africa, 2024).

These examples demonstrate that Africa's digital sustainability story is not only about adoption but also about invention. The creation of homegrown solutions spanning energy, agriculture, waste

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management, and climate resilience African innovators are proving that the continent can define a greener and more inclusive digital economy on its own terms.

Toolkit Section

Greener ICT Action Checklist

With the help of this toolkit, policymakers, sustainability officers, and ICT managers can reduce the environmental impact of data centres, mobile networks, and generally ICT operations.

A. Power and energy

- Calculate the monthly kWh baseline electricity consumption for every site.
- Determine the annual litres and kWh equivalent of diesel used by backup and on-site generator sets.
- Establish a short-term goal for the percentage of renewable energy (e.g., 30% contracted or on-site renewables by 2030).
- Put energy-saving strategies into practice (server power management, virtualisation, server consolidation, and UPS sizing).
- Assess and put into practice more effective HVAC controls, hot/cold aisle containment, and free-cooling in data centres.

B. Procurement and design

- Request for Proposals for servers, storage, and network equipment should incorporate energy efficiency requirements
- Modular hardware should be chosen to increase asset life and streamline upgrades.
- Demand that suppliers reveal the energy consumption and return policies of their products which is a form of circular procurement).

C. Network and operations management

- Conduct quarterly PUE (Power Usage Effectiveness) monitoring in data centres with the goal of reducing PUE by X% annually.
- When traffic permits, set up network components and mobile base stations to operate in low-power sleep modes.
- Reduce technician travel and increase uptime by utilising predictive maintenance and remote management.

D. Interaction between on-site renewables and the grid

- Examine the viability of installing solar and batteries on towers and data centres; if on-site is not feasible, look into PPAs for off-site renewable energy. One example of PPA-backed data-center renewables is the 12 MW solar project by Africa Data Centres.
- Prioritise hybrid solar + battery + efficient genset solutions to minimise diesel use in areas with low grid reliability (such as Orange Guinea).

E. Circularity and waste

- Establish a program for the return and refurbishment of business equipment, such as laptops and phones.
- Track the kilogrammes of e-waste that are collected and recycled each year; separate and hire certified e-waste recyclers.
- When appropriate, sign up for or support national eco-levies or Extended Producer Responsibility (EPR) programs.

F. Stakeholders, reporting, and governance

- As much as possible, adopt or align with an ISO 14001 environmental management standard and an ISO 50001 energy management standard.

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- Respect the Extended Producer Responsibility (EPR) framework in Nigeria. This implies that businesses need to register with EPRON, the industry organisation set up to finance and oversee the collection of e-waste (UNEP, 2023).
- Release a yearly sustainability report or CDP disclosure that includes KPIs for energy, emissions, and e-waste.
- Incorporate sustainability provisions into RFPs and supplier contracts.

Step-by-Step Guide to Conducting a "Green Audit" in Digital Businesses

In conducting a green audit for a digital business, it is important to tick the following boxes.

- Preparing for the audit: This is done by gathering information about the business's energy consumption, water usage, waste generation, transportation practices, and other relevant factors.
- Conducting the audit: The next phase after obtaining and gathering the necessary information is to collate it and conduct the audit.
- Analyze the results: In this phase, the data collected are analysed with focus on inefficiencies or areas of high environmental impact.
- Developing an Action Plan: This is the final phase of the audit. The findings of the audit are used to develop outlines and realistic goals based on the potential impact and feasibility. It would contain recommendations and the findings.

Scaling Strategies

Partnerships for Replication

In achieving greener tech in Africa, there is the need to per together for better results. To multiply greening efforts, stakeholders must aim to work together. It is essential to understand that achieving a greener tech in Africa requires the partnership and efforts of different organisations, businesses, companies working together for the cause. For example, at the 2023 Africa Climate Summit, Smart Africa helped launch Green Data Center Guidelines, co-authored by ITU and World Bank, to share best practices on renewables integration, energy efficiency, e-waste, and community engagement.

Also,governments and multilateral development banks also partner with the industry, for example, according to International trade administration(2024), Kenya's government collaborated with U.S. and UAE firms to facilitate a 1GW green data center project

At the corporate level, partnerships like MTN-Ericsson show how joint pledges and technology-sharing can amplify impact. According to Ericsson (2022), only 8.6 per cent of the material we use (in the telecommunications industry) forms part of the circular economy. This means less than 10 per cent of the material used in the world in a year is recycled or reused in some way. As a result, Ericsson partnered with MTN to provide equipment that uses less power and to help build MTN's take-back program.

Across Africa, coalitions are forming to enable a sustainable and greener future for the tech industry. In recent years, there has been the rise of industry coalitions that unite operators, policymakers, and civil society to increase greener digital transformation in Africa. For example the EU's Green Digital Coalition which is supported by the European Commission and coordinated by GSMA works with NGOs and expert organisations to develop methods of evaluating the net environmental impact of digital technologies (GSMA 2023).

In the same vein, multi- stakeholders networks are contributing to shaping a sustainable digital future for Africa. The Partnership for Digital Access in Africa (PDAA) which was launched in 2024 is a non profit consortium uniting government of African countries, private sector firms and global development actors to increase Africa Internet Access rate from 40% to 80% by 2030 with a promise to embed sustainability principles in infrastructure rollouts (White House, 2024; Mastercard Foundation, 2024). As analysts note, "collaborations across government, private sector and civil society are required" so that digital growth proceeds sustainably (Muya C. 2023)

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Funding & Incentive Opportunities

Funding is an essential factor to achieving a greener tech in Africa. There are many funding streams that can increase the green ICT in Africa as African climate funds have begun to target digital infrastructure. For example, the new $400 million Early-Stage Climate Infrastructure Fund (AGIA) of Africa50's plans to develop bankable projects in renewables, clean transport and ICT (Ecofin Agency 2025). Similarly, the Green Climate Fund invested $253 million in the Africa Finance Corporation's "Climate Resilient Fund," which aims at financing climate-proof energy, transport and telecom projects (African Finance Corporation 2023)

In the same light, there are bilateral and multilateral grants that can be tapped from. For example, the EU's Joint Innovation Facility offers €100-250k grants to African-led consortia building digital solutions for climate resilience (Vota W 2025). Also, international Development agencies (e.g., UKAID, FCDO, KfW) frequently support climate-smart tech projects.

At the country level, governments of the African countries can generate money through certain programs. Some countries have started incubating this.

According to **Bogdan-Martin, D. (2022, March 25)** Ghana's has placed an eco levy on e-waste and this has helped significantly in raising funds for recycling. Nigeria is actively exploring tax incentives to promote renewable energy solutions in the telecommunications sector. (Oke Akinkugbe, A. O. 2025). The Kenya Digital Economy Acceleration Project (World Bank) includes climate-smart components that help organise private investment in broadband powered by green energy (International Trade Administration2024).

There are emerging opportunities rising up in carbon finance that can be tapped from. For example, the Africa Carbon Markets Initiative (ACMI) has drawn large pledges which includes a $450M purchase commitment potentially opening revenue streams for clean-tech projects which includes efficient data centers or tree-planting to offset ICT footprints. (**Miriri, D. 2023, September 4).** As a whole, stakeholders can utilise and tap climate and digital transformation funds, provide tax/credit incentives for green ICT investments, and consider innovative instruments like carbon credits or green bonds tailored to tech infrastructure.

Policy Alignment for Adoption

Policies are at the marrow of achieving a green future in Africa. Empirical evidence demonstrates that efficiency in institutional frameworks and conducive government policy environments are essential for achieving effective environmental outcomes. **Traoré and Asongu (2024)** show that good institutions and good renewable energy policies have a big impact on the environment in Sub-Saharan African countries.Consequently, policies must integrate digital and green agendas. African governments are gradually embracing this.

The African Union's Digital Transformation Strategy (2020–2030) explicitly calls for "inclusive, sustainable and resilient" value chains**. Moncada, A. C. (2025, July 23).**

Many national ICT strategies now include environmental goals, for example, Kenya's Digital Masterplan runs on an overwhelmingly renewable grid. According to the International Trade Administration. (2024, September 18), over 92% of Kenya's electricity already comes from hydro, geothermal, solar or wind, with a formal policy target of 100% renewables by 2030. This alignment means that new data centers and telecoms can tap stable, green power. Kenya recently announced a 1GW green data center deal on this basis.

Recently, other countries have been following the same pattern. Morocco and Rwanda are coupling their digital ambitions (data centers, IoT, fintech, etc.) with massive renewable build-outs. Regulators can incentivize green ICT by mandating energy audits, offering feed-in tariffs or net-metering for grid-connected ICT facilities, and including ICT emissions in national climate plans (NDCs). Example: South Africa's carbon tax revenues have been used to fund efficiency grants in various sectors—a portion could target telecom or data infrastructure upgrades. Policies on electronic waste and product standards also matter: requiring manufacturers to recycle electronics (as Rwanda has done via public-private e-waste recycling) or setting minimum energy performance standards

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for servers and cooling can nudge the industry toward sustainability. In short, harmonizing ICT regulations with climate and renewable energy policies ensures the digital boom supports, rather than undermines, Africa's sustainability goals

Conclusions

Digital transformation in Africa is a double-edged sword: it could speed up social and economic growth, but it could also trap the continent in high-carbon infrastructure. The evidence compiled in this compendium demonstrates that a third pathway is not only feasible but also actionable, wherein digital growth is deliberately engineered to be low-carbon, resilient, and inclusive. To get there, we need to work together on four pillars that support each other: changing the way we use energy for ICT infrastructure, managing e-waste and making it more circular, changing the way we handle finance and governance to make investments less risky, and being very careful about how we measure and share information.

First, it is very important to decarbonise the digital backbone, data centres, edge facilities, and mobile base stations. African nations have a lot of renewable resources; using these resources to meet the electricity needs of ICT infrastructure can make the system more resilient and cut down on emissions. According to practitioner guides and multilateral analyses, green data-center designs, on-site generation, and long-term power purchase agreements (PPAs) all significantly lower operational emissions and the risk of unreliable grids (International Telecommunication Union & World Bank, 2023). The 12 MW solar PPA to supply Africa Data Centres' South African facilities is an example of a concrete industry project that shows that there are commercially viable models for renewable supply to digital infrastructure (Reuters, 2024). Still, to make these kinds of models work all over the continent, we need standardised procurement, clearer rules for wheeling and grid interconnection, and targeted public-sector de-risking tools to help with the high upfront costs of renewables and storage.

Second, the compendium makes it clear that circularity, especially for electronic waste, needs to be a big part of digital strategies. The Global E-waste Monitor shows that e-waste volumes are growing quickly, but recycling rates are not keeping up, which is especially bad in Africa (International Telecommunication Union & United Nations Institute for Training and Research, 2024). Africa could do a lot of damage to the environment and public health if it doesn't have formal systems for collecting, fixing, and recycling things. It would also miss out on chances to get valuable materials back. Policy tools like Extended Producer Responsibility (EPR), eco-levies, and accredited recycling networks, along with social-inclusive models that include people who work in the informal sector, are proven ways to raise recovery rates while protecting jobs (ITU & UNITAR, 2024).

Third, finance and governance are what make it possible to connect ambition and action. Studies of Africa's energy and investment situation show that there is still a gap in funding for clean energy. This slows down the rate at which ICT operators can electrify with renewables (International Energy Agency, 2022). The answer is to use blended finance architectures, where concessional capital, guarantees, and development finance encourage private investment. Fiscal measures, like tax breaks and faster allowances, can also help lower the costs of projects that use renewable energy (UNEP, 2023). It is important that national ICT strategies are in line with Nationally Determined Contributions (NDCs) and energy plans so that incentives are aligned and project pipelines are bankable. When this happens, investors can better underwrite PPAs and scale green infrastructure projects (International Trade Administration, 2024).

Fourth, reliable measurement and reporting are necessary for accountability and funding. Industry commitments, such as net-zero pledges and renewable energy targets, are important but not enough on their own. They need to be backed up by time-bound roadmaps, standardised KPIs (like PUE for data centres, percentage of renewables in the energy mix, litres of diesel avoided, and kilograms of e-waste recovered), and third-party assurance. This is what some of the biggest African companies do: several existing operators and data centre groups now publish climate reports and energy metrics, which lets investors and regulators see how things are going (MTN Group, 2024;

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Safaricom PLC, 2023). More people will start using clear reporting, which will reduce the information gap that makes green ICT projects seem riskier and more expensive to borrow money for.

These pillars together suggest a simple strategic plan: turn big ideas into projects that can be funded, and then turn projects into results that can be measured. In practice, this means that governments should change the rules to allow wheeling and long-term PPAs, create tax and grant incentives for retrofitting data centres and towers with renewable energy, and set up EPR frameworks and certified recycling capacity. Companies need to make their transition plans public and focus on investments that quickly cut down on diesel use, like retrofitting solar panels and batteries to towers. They also need to use circular procurement methods. Development finance institutions and impact investors should increase the use of blended instruments, such as guarantees, subordinated capital, and concessional loans, that make it easier for people to switch to renewable energy. Finally, civil society and research institutions should monitor outcomes, disseminate best practice, and ensure the social dimensions of the transition, jobs, inclusion and health, are central rather than peripheral.

If these measures are enacted with urgency and coordination, the payoff is substantial. By the mid-2030s, Africa could host a predominantly renewable-powered digital backbone: data centres operating at materially improved energy efficiencies; thousands of hybrid solar tower sites sharply reducing diesel dependence; robust e-waste value chains that reclaim materials and create formal green jobs; and digital services that enhance climate resilience across agriculture, finance and public services. Achieving this future will require political will, aligned policies and patient capital, but the technical feasibility and the commercial precedents already exist. The compendium's central message is therefore clear: a greener digital Africa is not merely desirable, it is practical and it is essential if the continent's digital opportunity is to be sustainable, equitable and long-lasting.

References

1. Africa Civic Lens. (2025). *Youth techno-entrepreneurship series*. Retrieved from https://africaciviclens.com/2025/07/09/youth-technoentrepreneurship-series
2. Africa Civic Lens. (2025). *Youth-driven agritech innovations in Africa*.
3. Africa Climate Summit takes action towards fostering the green digital transformation in Africa—Smart Africa. (2021, March 30). *Smartafrica.org*. https://smartafrica.org/africa-climate-summit-takes-action-towards-fostering-the-green-digital-transformation-in-africa-launch-of-green-data-center-guidelines/
4. Africa Innovation Summit. (2024). *Exhibitors*. Retrieved from https://www.africainnovationsummit.com/exhibitors
5. Africa4Tech. (2024). *Young African innovators*. Retrieved from https://africa4tech.org/young-african-innovators
6. African Finance Corporation. (2023). *Green Climate Fund commits record US$253 million to AFC's Infrastructure Climate Resilient Fund for Africa*. *Africafc.org*. https://www.africafc.org/es/noticias-e-informaci%C3%B3n/noticias/green-climate-fund-commits-record-us-253-million-to-afcs-infrastructure-climate-resilient-fund-for-africa
7. African Union Commission. (2020). *Digital Transformation Strategy for Africa (2020–2030)*. Retrieved from https://au.int
8. Adu, F., & Awuah, G. B. (2025, May 12). *Towards a circular economy: E-waste management in Africa*. African Centre for Economic Transformation. https://acetforafrica.org/research-and-analysis/reports-studies/reports/towards-a-circular-economy-e-waste-management-in-africa/
9. AP News. (2025, January 12). *A startup city in Kenya tries to tackle Africa's problem of urbanising while poor*. *Associated Press*.
10. Bhatia, M., et al. (2024). *Impact of decentralized solar mini-grids on rural development in Africa*. *arXiv*. https://arxiv.org/abs/2401.02445
11. Bogdan-Martin, D. (2022, March 25). *How Africa is leading the way in dealing with "e-waste."* *World Economic Forum*. https://www.weforum.org/stories/2022/03/how-to-solve-the-global-e-waste-issue-4-lessons-from-africa/

 doi:10.20944/preprints202509.0962.v1

12. Carabajal, A. T., Orsot, A., Elimbi Moudio, M. P., Haggai, T., Okonkwo, C. J., Jarrard III, G. T., & Selby, N. S. (2024). *Social and economic impact analysis of solar mini-grids in rural Africa: A cohort study from Kenya and Nigeria* [Preprint]. *arXiv*. https://arxiv.org/abs/2401.02445
13. DatacenterDynamics. (2024, April 9). *Africa Data Centres and DPA break ground on South Africa solar farm*. *DatacenterDynamics*. https://www.datacenterdynamics.com/en/news/africa-data-centres-and-dpa-break-ground-on-south-africa-solar-farm
14. Ecotutu. (2023). *Cold storage innovation for African farmers*. Retrieved from https://en.wikipedia.org/wiki/Ecotutu
15. Ecofin Agency. (2025). *Africa's Africa50 Targets $10 Billion in Climate Investment With $118 Million First Close*. *Ecofin Agency*. https://www.ecofinagency.com/news-finances/1808-48079-africa-s-africa50-targets-10-billion-in-climate-investment-with-118-million-first-close
16. Ericsson. (2022, March 2). *Ericsson supports MTN in Road to Zero pledge*. *Ericsson.com*. https://www.ericsson.com/en/news/1/2022/ericsson-supports-mtns-road-to-zero-pledge
17. Global Sustainability Magazine. (2023). *Sustainability in the New Age: Shaping a Greener Future*.
18. GSMA. (2023). *European Green Digital Coalition (EGDC)*. GSMA. https://www.gsma.com/solutions-and-impact/connectivity-for-good/external-affairs/egdc/
19. GSMA. (2023). *The Mobile Economy: Sub-Saharan Africa 2023*. GSM Association. Retrieved from https://www.gsma.com
20. GSMA. (2024). *The Mobile Economy Report 2024*. GSM Association. Retrieved from https://www.gsma.com
21. International Energy Agency. (2022). *Africa energy outlook 2022*. OECD/IEA. https://www.iea.org/reports/africa-energy-outlook-2022
22. International Finance Corporation & Google. (2020). *e-Conomy Africa 2020: Africa's $180 billion internet economy future*. IFC. https://www.ifc.org
23. International Telecommunication Union. (2022). *Green Digital Transformation in Africa*. ITU. Retrieved from https://www.itu.int
24. International Telecommunication Union & United Nations Institute for Training and Research. (2024). *Global E-Waste Monitor 2024*. ITU & UNITAR. https://ewastemonitor.info/the-global-e-waste-monitor-2024/
25. International Telecommunication Union & World Bank. (2023). *Green data centers: Towards a sustainable digital transformation — A practitioner's guide*. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099112923171023760
26. Mastercard Foundation. (2024). *Partnership for Digital Access in Africa*. Mastercard Foundation. https://mastercardfdn.org/en/partners/partnership-for-digital-access-in-africa/
27. Miriri, D. (2023, September 4). *Hundreds of millions pledged for African carbon credits at inaugural climate summit*. *Reuters*. https://www.reuters.com/business/environment/africa-climate-summit-opens-with-focus-financing-continental-unity-2023-09-04/
28. Moncada, A. C. (2025, July 23). *Africa is harnessing technology to leapfrog towards growth*. *World Economic Forum*. https://www.weforum.org/stories/2025/07/africa-leapfrog-moment-harnessing-technology-green-growth-and-regional-integration-for-global-value-chains/
29. MTN Group. (2024). *FY23 climate report*. https://www.mtn.com/wp-content/uploads/2024/04/MTN_FY23_Climate_Report.pdf
30. Muya, C. (2023, August 28). *Africa needs stronger collaboration towards greener digital transformation—Green Web Foundation*. Green Web Foundation. https://www.thegreenwebfoundation.org/news/africa-needs-stronger-collaboration-towards-greener-digital-transformation/
31. Native Media. (2024). *Africa's tech renaissance*. Retrieved from https://www.nativemedia.africa
32. Oke Akinkugbe, A. O. (2025). *A review of tax incentives for renewable energy projects in Nigeria*. AO2LAW. Retrieved from https://ao2law.com/a-review-of-tax-incentives-for-renewable-energy-projects-in-nigeria/
33. OECD. (2022). *Measuring the environmental impacts of AI compute and applications: The AI footprint*. OECD Digital Economy Papers.
34. PEG Africa. (2023). *Company profile*. Retrieved from https://en.wikipedia.org/wiki/PEG_Africa
35. Pulse. (2025, March 19). *Nigeria launches Africa's 1st AI tool to track carbon emissions*. Pulse Nigeria.

 doi:10.20944/preprints202509.0962.v1

36. Reclaim Africa. (2024). *How African startups are solving local problems with global impact*. Retrieved from https://reclaimafrica.org/blog/africa-rising
37. Reuters. (2024, April 8). *Africa Data Centres, DPA break ground on 12 MW solar farm in South Africa*. *Reuters*. https://www.reuters.com/business/energy/africa-data-centres-dpa-break-ground-12-mw-solar-farm-south-africa-2024-04-08/
38. Reuters. (2024, May 9). *How homegrown startups are boosting e-mobility in Africa*. *Reuters*.
39. Reuters. (2025, March 10). *Nigeria strikes $200 million deal to power rural areas with renewable mini grids*. *Reuters*. https://www.reuters.com/world/africa/nigeria-strikes-200-million-deal-power-rural-areas-with-renewable-mini-grids-2025-03-10/
40. Safaricom PLC. (2023). *Sustainable business report 2023*. https://www.safaricom.co.ke/images/Downloads/Safaricom-2023-Sustainable-Business-Report.pdf
41. Solar Electric Light Fund. (2023). *Solar market gardens in Benin*. Retrieved from https://en.wikipedia.org/wiki/Solar_Electric_Light_Fund
42. TAGI Africa. (2024). *AI for good: Top African innovations*. Retrieved from https://www.tagi.africa
43. The Africa Report. (2024). *Three African green tech startups to watch*. Retrieved from https://www.theafricareport.com
44. United Nations Environment Programme. (2023). *Africa's green business opportunities are abundant*. https://www.unep.org/news-and-stories/press-release/africas-green-business-opportunities-are-abundant-unep-study-shows
45. United Nations Environment Programme. (2023). *Greening Africa's Digital Transformation: ICT for sustainability*. UNEP. Retrieved from https://www.unep.org
46. Vota, W. (2025, July 21). *Apply Now: 250,000 EUR for African Climate Mitigation Technology—ICTworks*. ICTworks. https://www.ictworks.org/apply-now-250000-eur-for-african-climate-mitigation-technology/
47. White House. (2024, May 24). *Fact sheet: Vice President Harris announces public and private sector commitments to advancing digital inclusion in Africa*. The White House. https://www.whitehouse.gov/briefing-room/statements-releases/2024/05/24/fact-sheet-vice-president-harris-announces-public-and-private-sector-commitments-to-advancing-digital-inclusion-in-africa/
48. Wikipedia contributors. (2025). *Agbogbloshie* [Wikipedia page]. Retrieved from https://en.wikipedia.org/wiki/Agbogbloshie
49. Wikipedia. (2025, updated). *BasiGo*. Retrieved from https://en.wikipedia.org/wiki/BasiGo
50. Wikipedia. (2025, updated). *Konza Technopolis*. Retrieved from https://en.wikipedia.org/wiki/Konza_Technopolis
51. Wikipedia. (2025, updated). *Spiro (company)*. Retrieved from https://en.wikipedia.org/wiki/Spiro_%28company%29