BRIDGING THE ESTONIAN AND KENYAN DIGITAL-CLEANTECH ECOSYSTEMS

"Understanding Kenya's Digital-cleantech Ecosystem Driving a Twin Transition"

December 2023

This project is supported by ESTDEV- Estonian Centre for International Development

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Abbreviations & Acronyms

AI	Artificial Intelligence
ATM	Automated Teller Machine
EPR	Extended Producer Responsibility
FGD	Focused Group Discussions
GAPs	Good Agricultural Practices
GSM	Global System for Mobile Communication
GPS	Global Positioning System
ICTA	Information Communication & Technology Authority
IOT	Internet of Things
KAM	Kenya Association of Manufacturers
KCIC	Kenya Climate Innovation Center
KCV	Kenya Climate Ventures
KEBS	Kenya Bureau of Standards
KENIA	Kenya National Innovation Agency
KEPSA	Kenya Private Sector Alliance
KIPI	Kenya Industrial Property Institute
KIRDI	Kenya Industrial Research and Development Institute
KRA	Kenya Revenue Authority
NACOSTI	National Commission on Science Technology and Innovation
NEMA	National Environmental Management Agency
OCCP	Open Charge Point Protocol
OSCP	Open Smart Charging Protocol
PAAS	Pumping As A Service
PAYG	Pay-As-You-Go
STI	Science, Technology and innovation

Introduction and Background to the Study

This study is a part of the project "Estonia-Kenya Twin Transition Ecosystem Building", a collaboration project between Cleantech Estonia and Kenya Climate Innovation Center. The project is supported by ESTDEV- Estonian Centre for International Development.

With support from EstDev, Cleantech Estonia (CE) is partnering with Kenya Climate Innovation Center (KCIC) on an initiative centered on technologies that drive twin transition, namely, clean technologies that incorporate data and digital solutions. The objective of this collaboration is to chart the landscape of Kenya's digital clean technology sector and to develop a synergistic communication network that connects the Kenyan ecosystem with that of Estonia.

Since 2016, Cleantech Estonia has pioneered cleantech sector development in the Baltics. Adapting to the needs of a maturing sector, CE has gradually broadened its scope of activities to support cleantech innovation development, deployment, investment and regulatory framework adaptation. CE is uniting sector leaders and building the strongest, most collaborative cleantech ecosystem. They amplify the voice of the sector by providing policymakers with insights on cleantech. With the "Estonia - Kenya twin transition ecosystem building" project, Cleantech Estonia is settled to connect the Kenyan and Estonian digital-cleantech ecosystems in order to create synergies and collaboration opportunities.

Since its inception in 2012, KCIC has been at the forefront of fostering innovation among Kenyan entrepreneurs and startups, specifically on the development of solutions to combat climate change, with a special focus on digitally-enabled clean technologies. KCIC provides comprehensive support through business incubation programs, capacity building, and financial assistance. Additionally, KCIC leverages its private sector expertise to advocate for government policies that facilitate climate action, aiming to create an enabling environment for sustainable ventures.

The scoping study on Kenya's digital-cleantech ecosystem, as one of the key deliverables of the project on ***Estonia-Kenya Twin Transition Ecosystem Building***, aims to give a better understanding of the sector by examining Kenya's digital-cleantech ecosystem - its history, overview of the current status, enablers as well as the opportunities and challenges to Kenya's cleantech development.

The study aligns with interest by Cleantech Estonia and KCIC to promote knowledge exchange, creation of direct business partnership and investment opportunities among ecosystem players in Estonia and Kenya. For CE, this holds the potential to serve as a pilot project to potentially create and foster similar relationships between Estonia and other African countries.

The **objectives** of the research project on ***Understanding Kenya's Digital-cleantech Ecosystem*** are to:

- Fill a critical knowledge gap by developing and publishing an overview of Kenya's digital-cleantech ecosystem, with a focus on its history, approaches, enablers, emerging opportunities as well as challenges;
- Inform Cleantech Estonia and KCIC with regard to key players in the digital-cleantech ecosystem in Kenya;
- Establish an enduring network of experts, startups and practitioners in the digital- cleantech ecosystem in Kenya for cooperation with peers from Estonia.

To strengthen the relationship between the Estonian and Kenyan ecosystems, a collaborative communication system was created on LinkedIn under the name of "Estonia-Kenya Cleantech Hub". This platform offers stakeholders the means to access information, discover market opportunities, and foster relationships with representatives from partner countries.

Introduction and Background to the Study

Kenya Climate Innovation Center, in collaboration with Cleantech Estonia, has undertaken a comprehensive assessment of Kenya's digital-cleantech landscape, examining the sector's history, public awareness, enabling factors, challenges, opportunities, and roles played by the diverse stakeholders involved, with the ultimate goal of cultivating sustainable partnerships among Kenyan and Estonian entities in the digital-cleantech field.

The assessment employed a mixed-methods approach, utilizing both secondary and primary data sources. Primary data was gathered from a variety of ecosystem players, including startups, government agencies, support institutions, financiers, as well as academic and research institutions.

The findings indicate that Kenya's digital-cleantech sector, though nascent, ranks among Africa's leading startup ecosystems such as Egypt, Nigeria, and South Africa. The country is also a notable player in climate action, especially in renewable energy sectors like wind and solar. Public awareness of digital clean technologies is notably high among youth and urban residents.

Digitization in Kenya is closely tied to the country's mobile money revolution, particularly M-Pesa. This platform has been pivotal in launching various digital-cleantech initiatives, significantly enhancing access to clean energy and water, and shaping the fintech landscape. Other key innovations include remote-locking systems and advanced mobile payment solutions, impacting sectors beyond energy and water, and transcending other sectors such as agriculture, education and health, thus promoting rural development and livelihoods.

The heightened public awareness of digital-cleantech solutions in Kenya is significantly influenced by the country's innovation landscape and its dedicated emphasis on addressing climate change issues. A substantial majority of the 187 respondents, more than two-thirds, express a discernible level of awareness regarding digital-cleantech solutions. This increased awareness is primarily attributed to the government's commitment to digitization and its strong focus on environmental sustainability. The alignment of Kenya's innovation initiatives with climate change concerns has played a pivotal role in fostering public understanding and recognition of digital-cleantech solutions.

In the public psyche, popular digital solutions include MKOPA- a pay-as-you-go system for underbanked customers which allows access to mobile credit that is linked to solar lighting, smartphones, fridges, TVs, etc.; Pima Power for remote monitoring and control of electricity consumption; Twiga which creates a platform for manufacturers to access efficient supply chain solutions by improving speed, reliability and reducing warehousing and distribution costs; T-Bin for solar powered smart waste bins and M-Gas as well as BBox for digital clean cooking solutions.

Digital-cleantech solutions are largely concentrated into urban areas in Kenya. Of the startups which took part in the study, two out of three are based in urban setups. The study however reveals that in rural Kenya, some of the digital-cleantech solutions which are making a difference include Satellite Imaging for Climate and Agricultural Management; 3D Printing for Farming and Medical Equipment; Mobile Phones for Market Access and On-Demand Products; and, Tablets for Education and Research.

The Kenyan digital-cleantech ecosystem comprises a network of innovators, government bodies, private sector entities, incubators, educational and financial institutions, development partners, and businesses. Each plays a crucial role in the sector's growth.

Despite its potential, challenges like high costs, practicality concerns, user interface issues, skills requirements, skepticism towards new technologies, and technological risks hinder wider adoption. Strategic focus areas include enhancing informational outreach, skills development, innovation incentives, knowledge exchange, inclusive data sharing, and market competitiveness, all aimed at scaling up digital clean technology adoption.

Kenya's digital-cleantech sector, integral to its startup ecosystem, shows immense potential for growth. By addressing current challenges and harnessing innovations, Kenya is poised to maintain its leadership in digital clean technology in the region, significantly impacting both urban and rural communities. Key sectors to watch out for going into the future include agri-tech and solar technologies, renewable energy and waste management**.**

Research Methodology

This study was structured as an exploratory inquiry within a mixed methods context, leveraging both primary and secondary sources to gather information from a wide range of participants. These included the general population, digital-cleantech startups, established companies, investors in the digital-cleantech sector, government bodies, associations, as well as educational and research organizations, encompassing both qualitative and quantitative perspectives.

Through the online public survey, 187 respondents were reached, interviews were conducted with 25 startups and 36 ecosystem representatives in and out of government.

The selection of respondents for this study aimed to ensure a comprehensive understanding of Kenya's Digital-cleantech Ecosystem by encompassing diverse perspectives. The general population respondents were randomly sampled to capture a broad cross-section of opinions and attitudes. Digital-cleantech startups were purposely selected based on their active engagement in the sector, while established companies were chosen for their experience and influence. Investors were targeted for their financial insights, and government bodies were included to incorporate regulatory perspectives. Associations, educational institutions, and research organizations were selected to represent the collaborative and knowledge-sharing aspects of the ecosystem. The diverse pool of respondents, comprising 187 from the online public survey, 25 from startup interviews, and 36 from ecosystem representative interviews, was strategically chosen to provide a holistic view, ensuring that both emerging and established voices within Kenya's digital-cleantech sector were adequately represented. This approach facilitated a nuanced exploration of the ecosystem, blending qualitative depth with quantitative breadth.

Secondary data was meticulously sourced from authoritative government documents and reports (***detailed in Annex 1***), along with existing literature pertinent to Kenya. For primary data collection, a variety of adaptable approaches were employed, such as in-person interviews at various institutions and businesses, online interviews, a Focus Group Discussion (FGDs) involving seven startups, and a survey instrument made available through the kobo open data toolkit (ODK) which was disseminated via the KCIC's website and social media channels. This comprehensive strategy was devised to engage all relevant stakeholders, providing a panoramic view of the national ecosystem.

Situational Analysis

Country Context

Kenya, the largest economy in East Africa, is classified as a lower middle-income nation. The country's national governance structure comprises an Executive branch led by the President, and Parliament which is composed of the Senate and the National Assembly. Kenya is implementing a devolved framework, in which it is divided into 47 counties. An elected governor oversees each county government, while a county's legislative function is performed by the County Assembly, which is comprised of representatives from electoral wards.

Over the past decade, the country's GDP has consistently grown at a rate exceeding 5.6% annually, surpassing the average population growth of around 2.5%, leading to an increase in per capita GDP according to the African Development Bank 2022 report.

The United Nations Population Fund (UNFPA) estimates[1] that Kenya's population currently stands at 55.1 million, ranking 26th in the world and 7th in Africa.

Kenya is dominated by a relatively young population with about 60% of the current population falling between the 18-35 years old age bracket.

Between 2015 and 2019, Kenya's economy experienced comprehensive growth, averaging 4.8% annually. This growth notably reduced the poverty rate from 36.5% in 2005 to 27.2% in 2019, based on the $2.15/day poverty threshold.

Since 2021, Kenya's economic landscape has been navigating its way out of various challenges, including the 2022 General Election shivers, the COVID-19 pandemic and the Russia-Ukraine war. Experiencing a GDP growth of 4.8 percent in 2022, Kenya's economic momentum moderated, following a robust 7.5 percent recovery from the COVID-19 setbacks in 2021.

Innovation Context: Kenya is Safeguarding a Leading Role in Africa

Often touted as Africa's "Silicon Savannah", Kenya is teeming with innovation. The country is ranked 88th globally and third in Sub-Saharan Africa by the World Intellectual Property Organisation in its Global Innovation Index 2022 report[2]. The country has consistently over the past 12 years outperformed on levels of innovation relative to the GDP, which is at par with other lower-middle-income economies such as India, the Republic of Moldavia and Vietnam.

In the Kenyan Startup Ecosystem Report 2022, Disrupt Africa found that 308 tech startups were active in Kenya as of November 2022, placing the country as one of Africa's "big four" startup ecosystems in Africa, alongside Egypt, Nigeria and South Africa.

Moreover, Kenya's heart of commerce and innovation is its capital city, Nairobi, which stands as a central pillar in the country's burgeoning startup landscape. Nairobi ranks among the foremost urban centers for new business ventures in Africa, sharing the spotlight with other African heavyweights such as Cairo, Cape Town, Lagos, and Johannesburg.

Among the leading subsectors of Kenya's fledgling startup ecosystem are fintech, agritech, e-health, e-commerce, mobility and energy[3].

The young population has been identified as a major opportunity for spurring innovation and digital transformation due to their vibrancy and readiness to learn new ideas, and to adopt new technologies[4].

1 https://www.unfpa.org/data/world-population/KE
2 https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023/ke.pdf
3 Kenyan Startup Ecosystem Report 2022
4 (Kenya Innovation Outlook, KeNIA 2022)

Climate Innovation: A Regional Powerhouse in Climate Action

A country with a diverse array of landscapes ranging from coastal beaches to the Great Rift Valley's mountains and savannas, as well as a network of lakes and rivers, Kenya is emerging as a vanguard in Africa for climate action.

Despite its minimal contribution to global greenhouse gas emissions, Kenya has recognized the disproportionate impact climate change has on its economy, ecosystems, and population. The country has demonstrated leadership through innovative policies, renewable energy adoption, and international advocacy. Greenhouse gas emissions for 2020 were 80188 kilotonnes of CO_{2eq} meanwhile CO2 emissions per capita were 0,37 metric tons.[6]

Kenya is a leader in Africa for renewable energy, especially geothermal and wind energy. Policies that encourage investment in clean energy directly support the infrastructure needed for a green digital economy. The country's boasts of Africa's largest wind farm, a privately-owned 360 MW power plant developed at the remote Lake Turkana in the north. Additionally, Garissa Solar Plant is the largest grid connected solar power plant in East & Central Africa. Total generation of power is now 3 149,7 MW (FY 2021/22). Renewable energy share is 78% of installed capacity and 93% of total power dispatched.

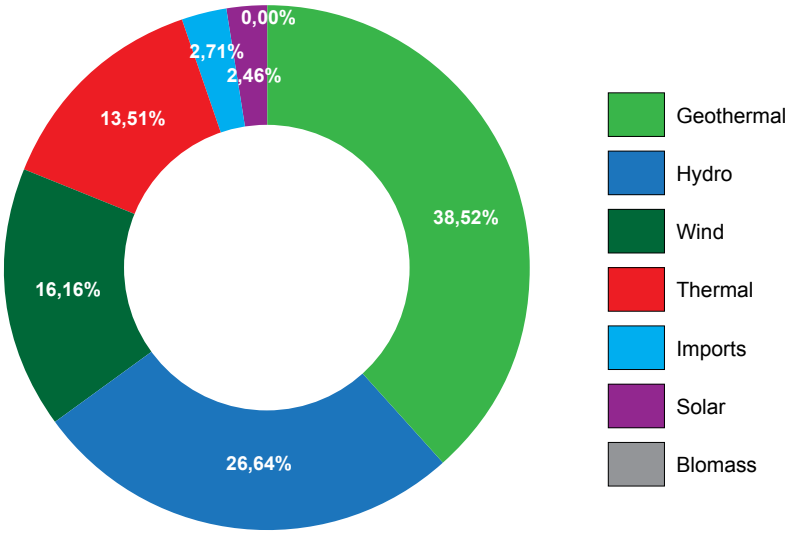


Figure 1. Kenya's Energy Generation Mix FY 2021/22

The country hosted the Africa Climate Summit (ACS) in Nairobi in September 2023 with the African Leaders Nairobi Declaration on Climate Change and Call to Action [6] being the outcome document of the summit and which will form the basis for Africa's position during the Conference of the Parties (COP28) of the United Nations Framework Convention on Climate Change in Dubai in November.

Policy, Legal and Regulatory Context for Digital Clean Technologies

As signatory to the UN Sustainable Development Goals (SDGs), Kenya actively develops and updates its national policies to resonate with these global commitments. Central to these efforts is the Kenya Vision 2030, the nation's long-term development plan, which emphasizes sustainable, low-emission, and climate-resilient economic progress. This vision is reinforced by the constitutional mandates for environmental protection as well as sustainable development. Together, these provisions create a robust foundational policy backdrop for green growth.

Digitally, Kenya's strategy is shaped by the Digital Masterplan 2022-2032, which aims to harness the full potential of the digital economy by embedding digital processes across all sectors of society and the economy. This plan envisions a collaborative ecosystem involving government, citizens, and the private sector.

5 https://www.afdb.org/sites/default/files/documents/africa_climate_summit_commitments_and_announcement_compilation_final_sept_7_2023.docx.pdf
6 https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2020&locations=KE&start=1990&view=chart https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE?end=2020&locations=KE&start=1990&view=chart)

The legal and regulatory fabric that underpins Kenya's response to climate change is anchored in the Climate Change Act of 2016. This Act lays out the framework for implementing strategies for low-carbon development, as stated in a series of government documents. These include the National Climate Change Framework Policy (2016), National Policy on Climate Finance (2018), various national climate change action plans, and the Green Economy Strategy and Implementation Plan (2016-2030).

These policies highlight the importance of fiscal and other incentives to catalyze a green transition, emphasizing the role of the private sector in this evolution.

The draft National Green Fiscal Incentives Policy Framework particularly illustrates the government's strategy to direct the economy towards a low-carbon, climate-resilient green pathway using an array of fiscal and economic tools. This comprehensive policy and regulatory instrument is pivotal for advancing digital clean technologies in Kenya, reflecting a concerted effort to align economic advancement with environmental stewardship.

Although Kenya contributes less than 0.1 percent of global greenhouse gas (GHG) emission annually, Kenya submitted an updated, more ambitious Nationally Determined Contribution (NDC)[7] on December 24, 2020, with a commitment to reduce emissions by 32 percent by 2030 relative to the business-as-usual scenario and in line with its sustainable development agenda and national circumstances.

Green Incentives

In Kenya, various green incentives and policies have been implemented to promote sustainability and encourage innovations in the digital-cleantech sector. These incentives play a significant role in fostering the digital-cleantech innovation ecosystem by providing support, financial benefits, and a conducive environment for businesses operating in this space. Some notable green incentives in Kenya and their impact on the innovation ecosystem include:

1. Renewable Energy Feed-in Tariff (REFiT):

- **Impact:** The REFiT program provides a guaranteed payment for electricity generated from renewable sources, such as solar and wind. This incentivizes the development and implementation of digital-cleantech solutions in the energy sector, promoting innovation in renewable energy technologies.

2. Tax Incentives:

- **Impact:** The government offers various tax incentives for businesses involved in environmental conservation and sustainability. This includes tax breaks for investments in renewable energy projects and technologies. These incentives reduce the financial burden on digital-cleantech startups, encouraging them to invest in research, development, and scaling of innovative solutions.

3. Carbon Offsetting and Clean Development Mechanism (CDM):

- **Impact:** Kenya participates in carbon offsetting initiatives, allowing businesses to earn carbon credits for implementing projects that reduce greenhouse gas emissions. This incentivizes the development of digital-cleantech solutions aimed at addressing environmental challenges and mitigating climate change.

4. Green Innovation Hubs:

- **Impact:** The establishment of green innovation hubs and centers in Kenya provides a collaborative space for entrepreneurs, researchers, and startups working on digital-cleantech solutions. These hubs offer support, mentorship, and access to resources, fostering an environment conducive to innovation and knowledge exchange. The Green Digital Innovation Hubs (gDIHs) are supported by GIZ in partnership with the Kenyan Ministry of ICT. It will be operated by a consortium led by the African Centre for Technology Studies

7 https://unfccc.int/sites/default/files/NDC/2022-06/Kenya%27s%20First%20%20NDC%20%28updated%20version%29.pdf

(ACTS). Other entities part of the consortium include Jomo Kenyatta University of Agriculture and Technology, Kenya Industrial Research and Development Institute, the Kenya Agricultural and Livestock Research Organization, Kenya National Innovation Agency and Konza Technopolis. Notably, the gDIH will be located in Nairobi but accessible to all MSMEs in Kenya, regardless of their location

5. **Government Procurement Preferences:**

- **Impact:** The Kenyan government gives preferences to environmentally friendly products and services in its procurement processes. This incentivizes digital-cleantech startups to develop sustainable and eco-friendly solutions, creating a market for their innovations.

6. **Research and Development Grants:**

- **Impact:** Various grants and funding opportunities are available for research and development activities in the cleantech sector. These grants support digital-cleantech startups in conducting innovative research, testing new technologies, and bringing sustainable solutions to market.

7. **Energy Efficiency Standards and Labels:**

- **Impact:** The government has implemented standards and labels for energy-efficient appliances and products. This incentivizes digital-cleantech startups to design and produce energy-efficient technologies, fostering innovation in the pursuit of sustainability.

The impact of these green incentives on the digital-cleantech innovation ecosystem in Kenya is substantial. They create a supportive environment that not only reduces the financial risks associated with innovation but also actively encourages startups to focus on developing and implementing sustainable solutions. Additionally, these incentives attract investment, talent, and collaboration, contributing to the overall growth and success of the digital-cleantech sector in Kenya.

History of Kenya's Digital Transformation Journey

Historical Context

Key strides in Kenya's digital transformation dates back to the emergence of internet service providers in the early 1990s, the network building for mutual traffic exchange in the early 2000s, the launch of the M-Pesa mobile payment platform in 2007, the laying of submarine cables in 2009, and the formation of a technology cluster in the capital city of Nairobi.

In 2004 eGovernment strategy[8] was launched, detailing the administrative structure, training requirements and the standardization framework for digitalization. It had four main objectives namely to: i) Improve collaboration between government agencies through reduction in the duplication of efforts, and enhance efficiency and effectiveness of resource utilization; (ii) Improve Kenya's competitiveness by providing timely information and delivery of government services; (iii) Reduce transaction costs for the government, citizens and the private sector through the provision of products and services electronically; and (iv) Provide a forum for citizens' participation in Government activities.

Since then, many developments have taken place in Kenya, ranging from new products like the revolutionary M-pesa[9] services, legislative provisions to regulate new developments and existing ones, and the very comprehensive Vision 2030 which had the clearest framework on digitization as of that time. The journey can be represented by Figure 1 below, highlighting some key developments:

8 https://www.ict.go.ke/wp-content/uploads/2019/05/KENYA-E-GOVERNMENT-STRATEGY-2004.pdf

9 Mobile money transfer service and the largest fintech platform in Africa

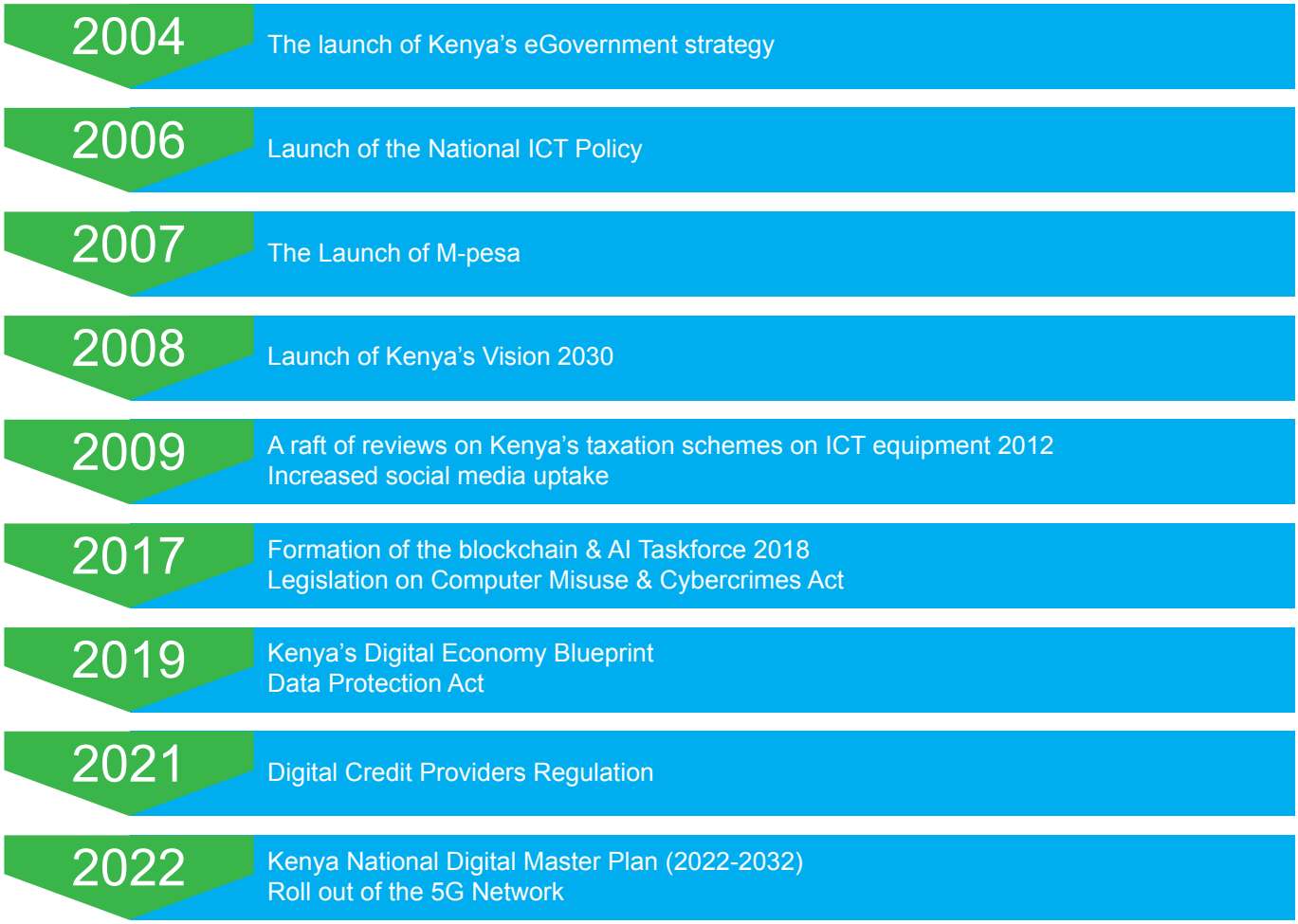


Figure 2: Kenya's Digital Transformation Milestones

Current Scenario

Currently, the government is committed to upscale digitalization via 19 initiatives and flagship programs shown in Figure 2 under the digital master plan (2022-2032). These initiatives are categorized into 5 main pillars: i) Digital infrastructure; ii) Digital services, products and Data management; iii) Digital skills; iv) Digital enterprises, innovations and businesses; and v) Policy, legal and regulatory frameworks

MASTERPLAN FLAGSHIP PROGRAMMES

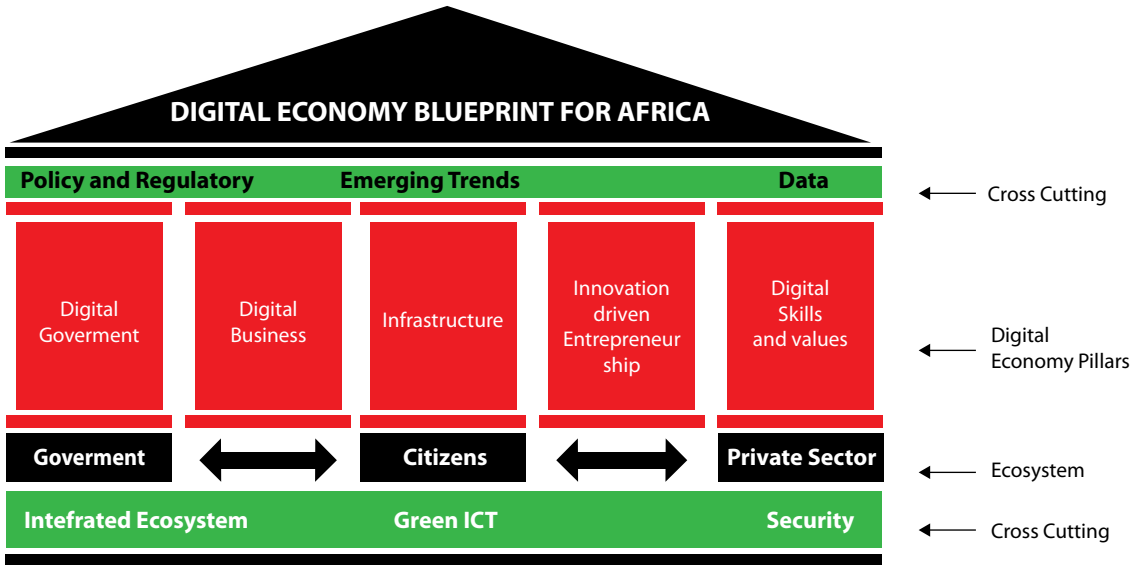
PILLAR	FLAGSHIP PROGRAMMES	ACTORS
DIGITAL INFRASTRUCTURE	1. **Installation of 100,000km of high speed fiber optic infrastructure** to provide internet to all Schools, government institutions/offices, Metro-cities, health facilities, rural businesses, homes and public spaces	MIIYA, ICTA., CA,KONZA, KURA, KeNHA, KeRRA, NMS, MOH, NT,MED, CoG, Development partners and Private Sector
	2. **Establishment of 25,000 internet-hotspots** across the country to provide internet services to innovators, youth and entrepreneurs	MIIYA, NT,CoG, ICTA, Private Sector
	3. **Establishment of Cloud Services** for government and private sector	MIIYA, ICTA.,NT, KONZA,ODP Private Sector
	4. **Establishment of 1450 Village digital hubs** for citizen digital literacy training, film production and public access to government services	MIIYA, ICTA., MIIYA, ICTA.NT, KFC,KFCB, MEDIA, ODP, CoG, Private Sector
	5. **National Physical Addressing System** to accelerate e-commerce initiative	MIIYA, ICTA.,PCK, ODP, CA,CoG,MOI,MOL, private sector, NT
	6. **National Spatial Data Infrastructure** to provide trusted geospatial data for businesses and government	MIIYA, ICTA., MOL,CoG, ODP,NT, MOL, ODP,Private Sector, Development partners, NT
	7. **Regional Submarine Cable Maintenance Depot** to ensure effective maintenance support for submarine cables serving the Africa Region	MIIYA, ICTA.,EAC,Private sector,NT, Development Partners, MOT
	8. **Regional Smart ICT Hub**- to provide faster IP exchange and data storage for the Africa Region.	MIIYA, ICTA.,Private Sector, EAC, Konza, ODP
	9. **Kenya eWaste Programme** to manage e-waste electronic products in the country	MIIYA, ICTA., NEMA, KONZA, County Government, CoG, MCDAs, NT,Private Sector, Development Partners, ODP, KONZA
DIGITAL SERVICES, PRODUCTS AND DATA MANAGEMENT.	10. **Digital one-stop-shop for all Government** common services through automation of all government core processes and digitization of manual records, interoperability and unified communication platforms.	MIIYA, ICTA., KONZA, MCDAs, NT, CoG, Private Sector, Development Partners
	11. **National Public Key Infrastructure** for digital signatures	MIIYA, ICTA., CA, MCDAs, Private Sector, NT, ODP
DIGITAL SKILLS	12. **Digital Literacy Capacity Building for 20million citizens 10,000 ICT professionals** on high-end skills, **300,000 public servants and 350,000 teachers** to given them necessary IT proficiency to be able to deliver services effectively to the citizen to be able to utilize technology in their businesses and access to government e-services	MIIYA, ICTA., MCDAs, CoG, MOI,MODEV,MOED, TSC,
	13. **Smart ID card** to provide person unique identifier.	MIIYA, ICTA., MOI, Dept Civil Reg, Private Sector, NT
	14. **Digital Literacy Programme** to accelerate integration of technology in teaching and learning in all learning institutions	MIIYA, ICTA.,, MOED, TSC, KNEC,KICD, Private Sector, Development partners, NT
DIGITAL ENTERPRISES, INNOVATION AND BUSINESSES	15. **Kenya Software and Electronic Industry** – establishment of 2 software manufacturing industries and two electronic manufacturing plants with 100,000 software engineers and production of over 1.2 million electronic devices	MIIYA, ICTA.,MOIED,CoG, Private Sector, Development Partners
	16. **Annual International ICT Expo** to show case on existing products and services for entrepreneurs and businesses	MIIYA, ICTA., KENIA, KEPSA, Private Sector, MOFA
POLICY, LEGAL AND REGULATORY	17. **Harmonization/enactment of policies, legislations** to enable ease of doing ICT businesses in the country. 18. **Enactment of e-government legislation** to support resource mobilization to fund the Masterplan Programmes. 19. **Enactment of Critical Infrastructure** protection legislations to protect all critical infrastructure installations across the country	AG, MIIYA, ICTA, Parliament, NT

Figure 3: Flagship programmes and initiatives by the Kenyan government

On the digital front, the government is currently working on universal broadband availability throughout the country within five years. The aim is to enhance government service delivery through digitization and automation of government processes and make 80% of government services available online.

Promoting eGovernment is seen as a measure to reduce carbon footprint associated with public service delivery.

To promote e-commerce, the government has also launched a Free Wi-Fi project, meant to enhance connectivity in markets as well as County Industrial Parks across the 47 counties in Kenya.



Adopted from Kenya's Digital Economy Blueprint 2019

Figure 4: The Digital Economy Blueprint

Public Perceptions on Digital Clean Technologies

This study delves into the public perceptions of Kenya's burgeoning clean digital technologies, a vibrant and evolving sector at the intersection of innovation, environmental stewardship, and economic growth. As the nation stands at the forefront of the digital revolution, with notable advances such as M-Pesa reshaping economic interactions, there is a compelling need to gauge the collective sentiment and engagement of the Kenyan people with these green technologies.

Understanding how these technologies are perceived by the population will not only reflect the current state of acceptance and utilization but also inform policymakers, investors, and innovators about the potential pathways for sustainable development and inclusion in the digital age.

This assessment therefore aims to shed light on awareness levels, expectations, and reservations among Kenyans, thereby offering a foundation for strategic advancements in Kenya's digital-cleantech landscape.

A virtual survey was disseminated, eliciting feedback from 187 participants across Kenya.

Level of Public Awareness

The survey indicates that 67.4% (n=126) of respondents have some level of understanding of what constitutes digital clean technologies, represented in Figure 4 below. However, it is observed that there is a conflation between the concepts of "digital" and "cleantech" in the public consciousness. The notion of cleantech is more dominant, and often takes precedence in the public's mind, even in instances where digital attributes are integrated.

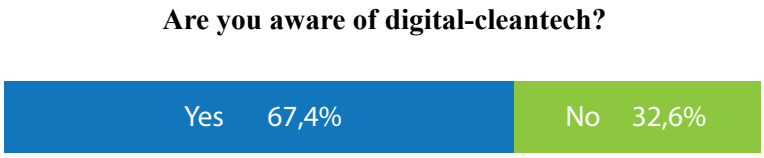


Figure 5: Public's awareness of digital-cleantech

Sources of Information on Digital-cleantech

Of the proportion of respondents who register a modest level of awareness of digital clean technologies, close to half of them say they first heard and have continued to learn about cleantech from social media platforms, about a third in workshops and seminars, one in ten say they learnt of cleantech from television, while the rest from their places of work, friends and family, as well as support institutions such as KCIC.

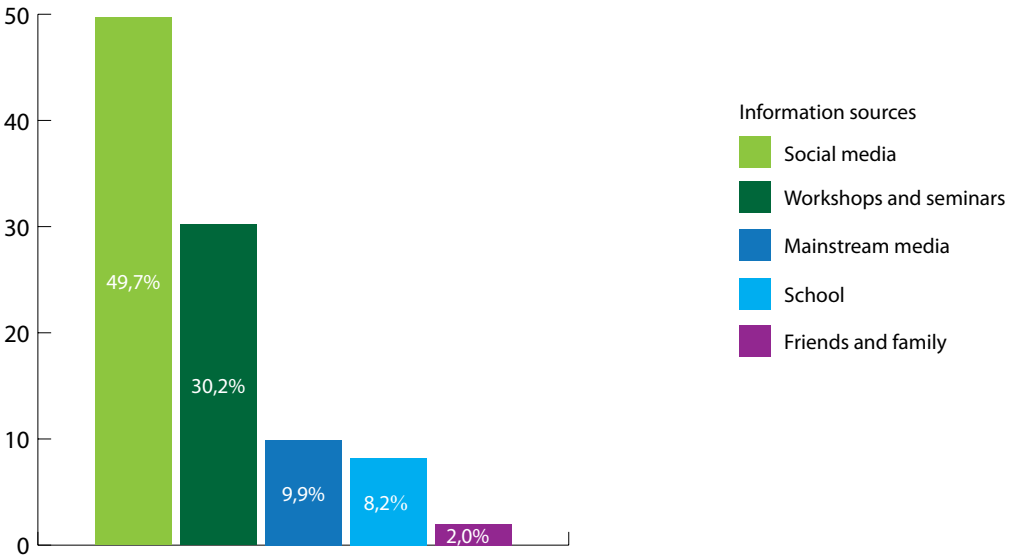


Figure 6: The distribution of information sources on digital-cleantech

Local Institutional Support for Digital-cleantech

Of those surveyed, knowledge of local initiatives supporting digital clean technologies is even. Some of the initiatives and institutions mentioned include: Green Energy Africa, Nairobi Tech Lab (NaiLab), Sustainable Energy for All (SEforALL) Kenya Hub and Africa Digital Media Institute (ADMI) Cleantech Programme.

Generational Sentiments on Digital-cleantech

The majority of Kenyans who are knowledgeable about cleantech are young adults, primarily between the ages of 18-25 and 26-40 years. This trend can be attributed to several factors: firstly, these age groups represent the largest portion of the country's demographic dividend; secondly, young people tend to be more open to adopting new technologies; and thirdly, the contemporary education system in Kenya increasingly highlights digital technologies. These are among the key reasons for the heightened awareness of cleantech within the youthful demographic cohort.

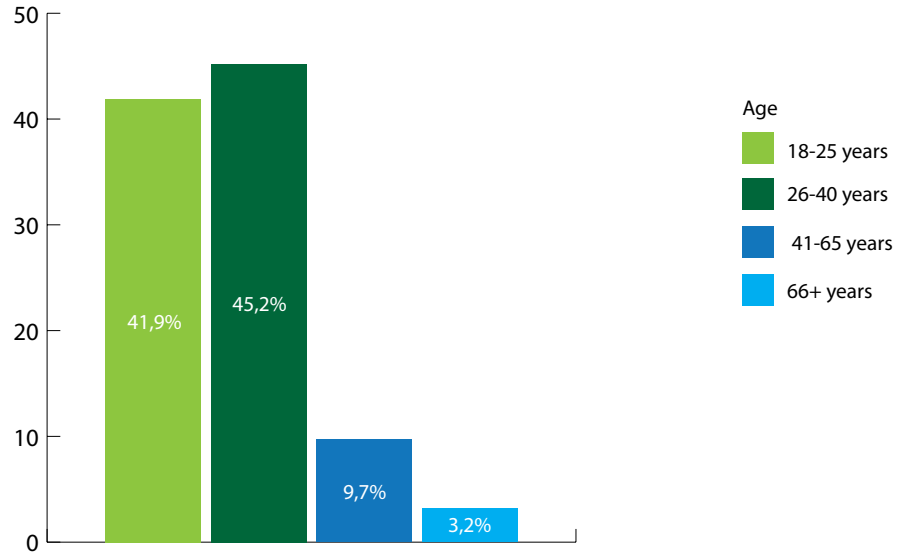


Figure 7: Distribution of knowledge of digital-cleantech ecosystem by age

Popular digital-cleantech solutions in the public domain

In the assessment of Kenya's digital-cleantech ecosystem, several enterprises have emerged as pivotal in leveraging data-driven digital innovations across various sectors. This section provides an overview of some popular brands and their contributions, as revealed by the public assessment.

Energy Sector:

- **M-KOPA**: Recognized in the 2019 Global Cleantech 100, M-KOPA has revolutionized asset financing for underbanked customers in Africa. Based in Nairobi, Kenya, it provides access to essential products including solar lighting, televisions, fridges, and smartphones, through a pay-as-you-go system. MKOPA has been instrumental in integrating solar power, information technology, and financial solutions, enhancing the lives of hundreds of thousands of households in Kenya, Uganda, Ghana and Nigeria.

- **Pima Power:** (*Pima, Swahili word for Measure*) enables consumers to monitor, control and reduce consumption of both electricity and gas.

- **Nishati Prime**: (*Nishati*, Swahili word for *Energy*) This enterprise offers off-grid energy solutions integrating Productive Use Leveraging Solar Energy (PULSE) for systems such as cold storage, water pumps, and milling solutions for smallholder farmers.

- **Renewvia Energy Kenya**: Facilitates energy access in remote areas through solar mini-grids, utilizing mobile money for electricity access.

- **Baridi:** (Baridi, *Swahili* word for *Cold*) Specializes in linking communal markets, agribusiness processors, and cold chain stakeholders with solar-powered cooling solutions. They employ IoT for remote monitoring and sensor technology.

- **SOLARGEN**: A leading provider in energy, water, and irrigation solutions in Kenya and the East Africa region.

The energy sector's advancement in digital solutions, especially through mobile money, has significantly improved accessibility in remote areas. Other key players include D-light solar and Sanergy.

Agriculture Sector

- **iProcure:** Based in Nairobi, iProcure stands as the largest agricultural supply chain platform in rural Africa, offering comprehensive procurement, last-mile distribution services, business intelligence, and data-driven stock management.

- **Twiga:** Enables manufacturers to access efficient supply chain solutions through Soko Solution, improving speed, reliability, and reducing warehousing and distribution costs.

- **Rhea Africa:** Develops IoT sensor applications for precision agriculture, aiding smallholder farmers in sustainable and profitable growth.

Waste Management

- **T-Bin:** The T-Bin is a smart intelligent solar powered segregated waste bin fitted with twin smart screens, IOT devices, Wi-Fi and street lighting.

eMobility

- **Mazi Mobility:** Specializes in electric motorbikes and ***tuktuks (three-wheeled vehicles)***, gaining popularity in Kenyan cities like Mombasa and Kisumu**.**

Clean Cooking:

- **M-Gas Kenya:** Offers smart metering solutions for informal settlements, enabling LPG purchases via mobile money (M-Pesa).

- **Bboxx Kenya:** Combines pay-as-you-go solar energy services with cooking solutions, using PayGo energy's smart metering technology.

These enterprises exemplify the impactful use of digital innovations in Kenya and Africa at large, significantly advancing the digital-cleantech ecosystem and improving the quality of life for millions.

Education and Awareness of Digital-cleantech

The bulk of individuals with an awareness of digital-cleantech possess at least an undergraduate degree, as shown in the data. There appears to be a direct correlation between educational attainment and the likelihood of being informed about digital-cleantech, suggesting that education plays a significant role in increasing awareness. However, this trend does not proportionately extend to those with postgraduate degrees, who do not represent as large a segment as might be expected.

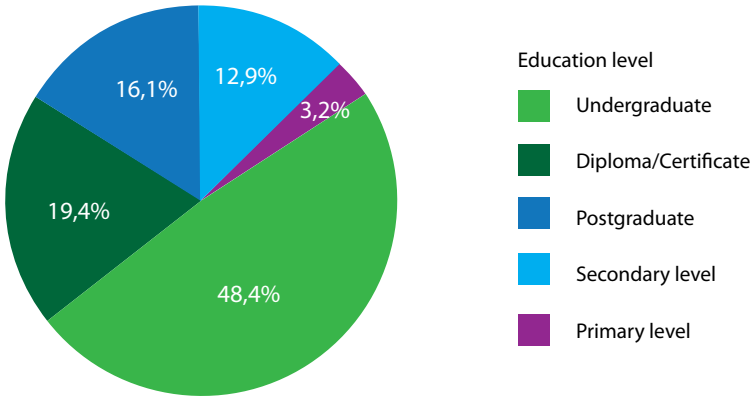


Figure 8. Awareness of digital-cleantech by level of education

Zonal Distribution

Knowledge and adoption of digital-cleantech are primarily concentrated in Kenya's urban centers, particularly the four main cities of Nairobi, Mombasa, Kisumu and Nakuru as well as other major towns. Interestingly, more than a third of the rural population are aware of digital-cleantech compared to just one in ten for the peri-urban population.

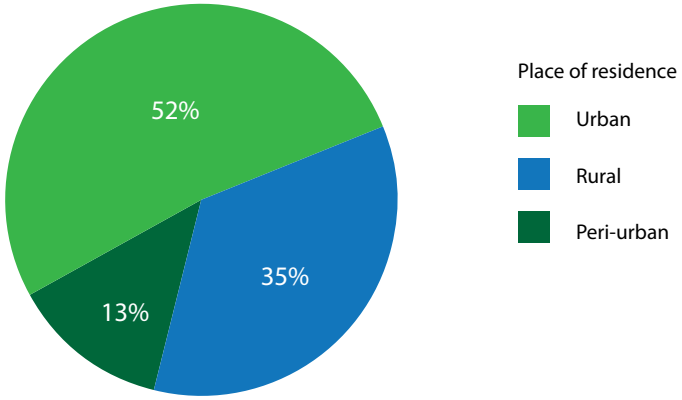


Figure 9. Awareness of digital-cleantech by place of residence

Digital-cleantech in Rural Kenya: Five Key Innovations

Digital-cleantech innovations are making significant impact in rural areas of Kenya, a manifestation that digital-cleantech is not just confined to urban settings but are reaching far into the countryside, addressing everyday challenges faced by rural communities. Here are some of the key digital innovations making a difference:

- **Satellite Imaging for Climate and Agricultural Management**: Satellite technology is used for weather mapping and monitoring crops and livestock. The Kenya Livestock Insurance Programme (KLIP) utilizes satellite data to measure vegetation "greenness" and predict pasture availability for grazing livestock, providing crucial support in regions affected by erratic weather.

- **3D Printing for Farming and Medical Equipment**: 3D printing is being employed to create efficient, low-cost planting scoops, which helps in the precise application of fertilizer, thus protecting the environment. Additionally, rural medical facilities benefit from 3D printed parts for medical equipment, making healthcare more accessible and affordable.

- **Mobile Phones for Market Access and On-Demand Products**: Platforms like Digifarm and M-Farm use text-based prompts to provide market information, micro-loans, and access to agricultural inputs. This innovation is pivotal in farming, allowing farmers to receive updates on prices, weather, and interact with various stakeholders.

- **Tablets for Education and Research**: Tablets are increasingly used in rural areas for educational purposes and data collection. They are cheaper and more user-friendly than laptops, especially for primary school students in marginalized areas. Tablets are also employed by organizations like One Acre Fund for registering clients, marketing products, and collecting survey data, enhancing the efficiency of agricultural practices and boosting community standing.

Startups in the Digital-cleantech Space

The study considered 25 startups in the digital-cleantech space (individual details in Annex 2). The findings illustrate that most digital clean technology startups are located in urban areas, making up 58.3% of the total. A trend is noticed where many startups move to peri-urban areas (which host 33.3% of the startups) during growth or diversification. Only a small number start in peri-urban areas, and rural areas have just 8.3% of startups.

Agritech and solar technologies are the leading sectors in Kenya for digital clean technologies. These include climate-smart agriculture with digital tools, IoT-equipped silos/warehouses, solar-powered equipment with IoT, digital soil testing, and solar-powered vacciboxes for medical transport to remote areas. Other sectors include e-mobility, e-waste management (in line with Extended Producer Responsibility policies), aquaculture with smart devices for water monitoring, smart energy metering, smart logistics, and fintech integration.

Most business owners in this field are aged 25-39, reflecting the large population in this age group and their readiness to embrace digital clean technologies. Interestingly, 71% of these businesses rate their use of digital solutions as moderate, while only 29% see their use as extensive.

The founders' decision to pursue clean digital innovations is often influenced by their educational background, mainly in engineering, biotechnology, or IT. This highlights the role of technical knowledge in advancing digital solutions in the cleantech startup sector.

Motivation to Venture into Digital-cleantech Space

Kenyan startups were asked about their motivation to venture into the digital-cleantech space:

- '**Necessit**y as the mother of invention'
- **Upbringing**: for example, the case of one who was brought up in Dandora, a neighborhood that hosts one of the largest dumpsite in Kenya thus seeing an opportunity for circularity
- **Exposure**: visits to countries embracing digital clean technologies sparked the interest.
- **Problem Solving**- Some startups were motivated by the desire to find solutions to existing problems. This is particularly true for those with an engineering background, who consider themselves as problem solvers.
- **The urge to fill a gap in the Market** - Some startups identified a gap, with very few offering practical solutions to existing or glaring problems.
- **Local Challenges**- The motivation for some startups comes from the need to provide solutions to local challenges, such as lack of grid power for farmers and the need to improve the socio-economic standing of farming communities.
- **Environmental Concerns**- For some, the motivation came from environmental concerns, for instance sustainable food production.
- **Soil Health**- The ambition to do research centered on soil health also motivated some startups. They found that the health of the soil was very poor and needed a lot of restoration efforts.
- **Efficiency**- The desire for cost and time management, risk mitigation, and efficiency also motivated some startups.
- **Welfare to Societies-** Some startups were motivated by their experiences with international organizations and their desire to bring welfare to societies.

Primary Focus Sectors in Kenya

Table 1: Examples of outstanding digital technologies for selected sectors of focus

Sector	Digital Technologies in the sector
Renewable energy & Energy efficiency	• Smart solar powered operations which integrate advanced technologies like IoT, AI, and data analytics with solar energy systems to optimize energy production, usage, and management, enhancing efficiency and adaptability to varying conditions. • Energy optimization, online monitoring and management applications (increasingly important for predictive analytics of energy consumption levels, patterns and challenges – energy audit). Also notifies user when the level is low e.g., for e-bikes • Temperature control systems that are automated, including compressors, fans, and speed controllers. • Hardwares and softwares synchronized with the OCPP (Open Charge Point Protocol) and OSCP (Open Smart Charging Protocol)
Sustainable Agriculture	• IoT fitted devices that measure soil moisture content, humidity, temperature, presence of bacteria and other parameters • Smart warehouses fitted with IoT devices that measure the conditions necessary for good storage of agricultural produce
Waste management	• Machines for shredding and recycling of plastic waste, which use sensors and semi-automatic technology for material identification and temperature control. • Applications for collecting and aggregating waste products • Technologies for sorting solid waste materials in line with the Extended Producer Responsibility (EPR) requirement that is being implemented under the Solid Waste Management Act 2022
Aquaculture	• Smart devices for measuring the quality and condition of water that is ideal for the fish • Solar-powered cooling boxes and cold rooms for preservation as well as in transportation to the market
Water management	• Smart meters • Real-time monitoring of water usage • Automated water systems (Pumping As A Service, PAAS) and smart sockets that go off once the desired level is attained or for irrigation stop dispatching water • Uber model for solar-powered irrigation in agriculture
Sustainable livelihoods	• Milk ATM, which is GSM[10] controlled and programmed to measure quantities. • Household utilities and devices that are smart in nature

10 Global Systems for Mobile Communications

Cross-cutting/other	• Applications (Games) designed for capacity building and cultivating a culture of good energy management practices, while also earning points • Smart logistics within the supply chain that involves GPS tracking of location of trucks in distribution of produce for instance. Also, in the e-mobility sector. • Integrated mobile payment systems like M-Pesa. • Cloud computing for data storage and processing. • Sensor technology, IoT, and machine learning for data collection and analysis. • Modbus card for communication with software and data collection for automation of operations. • Digital solutions in the health sector e.g., virtual doctors, treatment and prescription without having to necessarily visit a facility • Ready-to-go payment systems

Youth and Gender Perspectives

A distinct focus on the youth and gender aspects highlights the significance of inclusivity and diverse perspectives within the innovation landscape.

Youth Angle: The focus on the youth in Kenya's digital-cleantech ecosystem stems from the recognition of the dynamic and innovative potential that young entrepreneurs bring to the sector. The youth demographic is often characterized by a fresh perspective, technological acumen, and a strong drive for innovation. In the context of digital-cleantech, the youth are seen as key drivers of disruptive and sustainable solutions. Their agility in adopting new technologies and their inclination towards environmental sustainability make them pivotal contributors to the ecosystem.

Enablers for Youth Involvement include education and training programs, youth-centric funding initiatives as well the role of innovation hubs and incubators with a focus on the young people especially within the digital-cleantech space.

Gender Perspective: Recognizing the importance of gender diversity, the study also explores women's crucial role in driving innovation and sustainability, and their inclusion is essential for a comprehensive and balanced ecosystem.

Enablers for Women's Participation include Gender-Inclusive Programs such as those run by KCIC and other ecosystem players, mentorship initiatives and access to targeted funding opportunities.

In conclusion, the youth and gender angles in the study emphasize the importance of inclusivity, recognizing the unique perspectives and contributions of both demographics in driving innovation and sustainability within Kenya's digital-cleantech ecosystem. The enablers outlined, including educational programs, funding initiatives, mentorship, and gender-inclusive strategies, collectively contribute to creating a vibrant and diverse innovation ecosystem. The example of KCIC illustrates how institutions can play a pivotal role in promoting youth and gender inclusivity in the digital-cleantech sector.

Mapping Kenya's Digital-cleantech Ecosystem

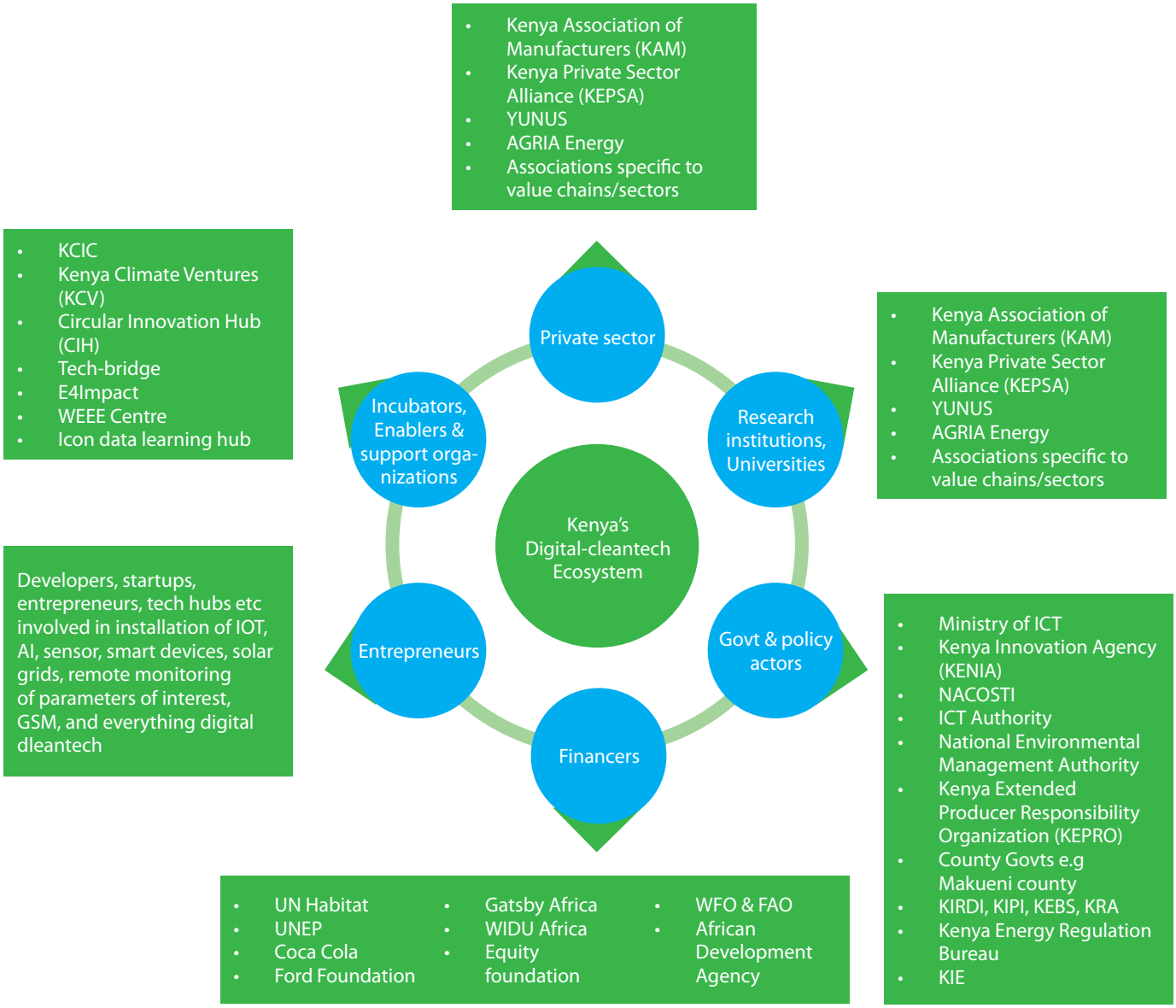


Figure 10: Representation of Kenya's Digital-cleantech Ecosystem

Fostering Digital-cleantech Innovation: Snapshot of Kenya's Startup Ecosystem

Introduction

Kenya's startup ecosystem, which is instrumental to the growth of the digital-cleantech sector, is a vibrant and dynamic network where various players come together to foster innovation and commercialization of business ideas. This interconnected web of stakeholders, ranging from private sector firms, government and policy actors, financiers, to research institutions, incubators and accelerators as well as entrepreneurs, plays a pivotal role in nurturing an environment conducive to the growth of digital clean technology solutions.

Kenyan startups have a notably higher probability to participate in incubation or acceleration programmes compared to startups in other African nations. In 2022, nearly half (45.5%) of the startups tracked by Disrupt Africa in Kenya were involved in such programmes. This high participation rate is attributed to the abundant local opportunities and the strong appeal of Kenyan startups to both pan-African and international programs.

Startups and co-working spaces

Hubs and co-working spaces in Kenya, such as iHub, Nairobi Garage, and Nailab, are more than just physical locations; they are innovation hotbeds where tech entrepreneurs gather to share ideas and resources. These spaces,

often blurred with incubation functions, offer a nurturing ground for startups to flourish. While Coworker.com lists 94 co-working spaces, and GSMA notes 48 innovation hubs, the true count is likely higher, with approximately 150 spaces including those out of the commercial capital Nairobi, including Dlab Hub in Eldoret, Lake Hub in Kisumu and SoteHub in Mombasa. This reflects a nation-wide web of innovation support.

Incubators and Accelerators

Kenya's incubators and accelerators are pivotal in steering startups through their early stages, providing mentorship, funding, and strategic connections. Notable incubators and accelerators include the KCIC, WEEE Center, ICON Data Learning Hub, and Tech Bridge, along with ASSEK and Afrilabs, which have been instrumental in scaling digital clean technologies. The presence of approximately 30 such programs, and acceptance into international accelerators like Y Combinator and Techstars, showcases Kenya's robust ecosystem for startup growth.

Government Initiatives

The Kenyan government, through agencies like ICTA and KeNIA, invests in the sector, aiming to create a thriving national innovation ecosystem. The ICTA's partnership with the Dutch government and the launch of Startup Savanna by MoITED illustrate Kenya's commitment to integrating startups into global networks. Furthermore, the Capital Markets Authority's Regulatory Sandbox allows for the live testing of innovative solutions, emphasizing the government's role in creating a conducive environment for tech innovation.

Corporate Initiatives

In the corporate arena, initiatives by firms such as Safaricom, with its Spark Venture Fund, and KCB Bank's interest-free loans for entrepreneurs, represent a growing trend of startup-corporate collaboration. This engagement is vital for startups looking to scale and commercialize their technologies, with corporate partnerships providing a platform for expansion and sustainability.

Investor initiatives

Investor engagement has become increasingly influential, with venture capital funds, angel investors, and private equity firms actively seeking opportunities within Kenya's clean tech sector. International accelerators such as Y Combinator and Techstars, as well as local investor networks like the African Business Angel Network (ABAN) and Nairobi-based Viktoria Ventures, are providing not just capital but also strategic guidance. These investors are often the catalysts that take startups to the next level, enabling them to refine their technologies, scale operations, and reach commercial viability.

The harmonious collaboration between these various support structures creates a robust environment for Kenyan startups to innovate, scale, and succeed in the burgeoning field of digital clean technologies.

Kenya's financial institutions and funders are instrumental players in propelling the growth of the Digital-cleantech sector, acting as key enablers for startups within the ecosystem. These financial entities provide critical capital that fuels innovation, research, and development initiatives in digital clean technology. The dynamic interplay among funders, financiers, and other ecosystem players, including knowledge institutions, startups, innovators, government agencies, and incubation support institutions, forms a collaborative landscape essential for sectoral advancement. Financial institutions not only inject capital into promising ventures but also forge strategic partnerships with knowledge institutions to leverage their expertise. This collaboration facilitates the seamless flow of resources, knowledge exchange, and mentorship, fostering an environment where startups and innovators can thrive. Additionally, government agencies and incubation support institutions further enhance this ecosystem by providing regulatory frameworks, incentives, and nurturing environments that attract and sustain digital-cleantech initiatives. This synergistic interplay among diverse stakeholders positions Kenya's Digital-cleantech sector for sustained growth and impactful contributions to environmental sustainability.

Examples of funding institutions include:

African Enterprise Challenge Fund (AECF):

- **Role:** AECF operates across Africa, including Kenya, and supports businesses that have a positive

impact on rural communities. It provides grant and repayable funding to cleantech startups, promoting innovation and sustainable business models.

Acumen East Africa:

- **Role:** Acumen is a non-profit impact investment fund that supports businesses addressing poverty and environmental challenges. In Kenya, Acumen invests in cleantech enterprises, offering patient capital and strategic support to help them achieve long-term impact.

KCB Foundation:

- **Role:** As a financial institution, KCB Foundation supports various initiatives, including those in the cleantech space. It provides financial services, mentorship, and capacity-building programs to startups and entrepreneurs working on sustainable solutions.

Safaricom Spark Fund:

- **Role:** Safaricom, Kenya's leading telecommunications company, has a venture fund known as Safaricom Spark. While not exclusively focused on digital-cleantech, it invests in startups and innovative businesses, contributing to the overall entrepreneurial ecosystem in Kenya, including the digital-cleantech sector.

These funders play a crucial role in providing financial resources, mentorship, and support to digital-cleantech startups, helping them overcome challenges and contribute meaningfully to the sustainable development of Kenya's digital-cleantech ecosystem.

A startup like MKOPA, known for its off-grid solar solutions utilizing digital technologies, has benefited from funding from various sources, including impact investors and development finance institutions. These finances have gone to providing capital for expanding their operations, improving technology, and reaching more underserved communities with affordable and sustainable energy solutions.

Initiatives by Knowledge Institutions

Kenya's knowledge institutions, encompassing academic institutions, higher learning establishments, and research and development institutions, play a central and instrumental role in shaping the trajectory of the country's digital-cleantech ecosystem. The synergy between these knowledge institutions and industry, particularly in fostering innovation, supplying skilled human resources, and propelling developmental efforts for dual transitions, is noteworthy. Institutions of higher learning in Kenya are at the forefront of driving digital clean technology innovations, serving as pivotal hubs for research, development, and entrepreneurial endeavors. These institutions not only offer essential infrastructure, including innovation spaces and incubators, but also create environments conducive to the collaborative efforts of students, researchers, and entrepreneurs. In this collaborative landscape, knowledge institutions serve as catalysts, working in tandem with other stakeholders such as startups, financiers, government institutions, and more, to collectively drive the development and implementation of sustainable technologies that effectively address the challenges posed by climate change.

Table 2: Initiatives by Knowledge Institutions

Institution	Programme	Description
University of Nairobi	The Maker space	A creation space equipped with digital fabrication tools and equipment for use by makers
Jomo Kenyatta University of Agriculture & Technology	An industrial and technology park	The project is being implemented in partnership with the Ministry of Industrialization with the aim of enhancing uptake of research results by industry players, by providing a location in which government, private sector and universities cooperate parks create environments that foster collaboration and innovation
Kenyatta University	Chandaria Business Innovation & Incubation Center	A centre that fosters the culture of innovation and entrepreneurship within the university through establishment of innovation and entrepreneurship programmes that have strong links with industry, underscoring collaborations as critical for skills development (education and training), the generation, acquisition, and adoption of knowledge (innovation and technology transfer), and the promotion of entrepreneurship (start-ups and spin-offs)
Zetech University	Zetech Innovation Entrepreneurship and Technology Hub (iZet)	A multi-purpose "vehicle" with the aim of being a business and technology incubator for graduates and other citizens outside the university
Riara University	Accelerating Entrepreneurship Support for Universities (AESU) program	An educational partnership between the Open University (UK), Riara University (Kenya), and Ashoka East Africa, funded by the British Council through the inaugural Innovation for African Universities (IAU) programme. The program seeks to renew and adapt the entrepreneurship and innovation curriculum with a view to producing enterprising graduates who are capable of securing employment and/or commercializing locally developed innovations that harness digital technology and contribute to addressing the climate emergency in Kenya.
Dedan Kimathi University of Technology	Centre for Innovation and Entrepreneurship Management (CIEM)	An initiative by the university to help startups apply information, imagination and skills in deriving greater or different values from resources and all processes by which new ideas are generated and converted into useful marketable goods or services
Strathmore University	@iLabAfrica Research and Innovation Centre	This is a prime example, as it serves as a nexus for the university's efforts in technology and innovation. The center collaborates with industry partners to provide students and startups with the resources and mentorship needed to bring digital-cleantech solutions to market. These partnerships are vital, as they help align academic research with commercial and societal needs, ensuring that innovations are both sustainable and economically viable.

Role of Intellectual Property

Intellectual property (IP) plays a crucial role in fostering innovation and protecting the rights of inventors within the digital-cleantech ecosystem in Kenya. Adequate protections for innovators are vital to encourage investment and ensure the sustainable growth of the sector.

It's essential for innovators in the digital-cleantech sector in Kenya to work closely with intellectual property organizations such as the Kenya Industrial Property Institute (KIPI) to navigate the registration processes and ensure adequate protection for their innovations. Keeping up with IP regulations and leveraging these protections can significantly contribute to the growth and success of the digital-cleantech ecosystem in Kenya.

Various types of intellectual property are relevant to digital-cleantech innovation, including patents, trademarks, and copyrights.

Patents

- **Role:** Patents are crucial for protecting technological innovations. They grant innovators exclusive rights to their inventions for a certain period, encouraging them to disclose their inventions to the public in exchange for legal protection.

- **Innovations and Protection:** Digital-cleantech startups in Kenya seek patents for innovations such as advanced solar technologies, energy storage solutions, or efficient waste management systems, among others. Specific patent information (registration numbers and territories) would need to be obtained from the Kenyan Industrial Property Institute (KIPI) or other relevant authorities.

Trademarks:

- **Role:** Trademarks are essential for branding and protecting the identity of products and services. In the digital-cleantech sector, trademarks help companies distinguish their offerings and build a reputation for quality and innovation.

- **Innovations and Protection:** Startups may register trademarks for their company names, product names, or logos. Information on specific trademark registrations would be available through the Kenya Industrial Property Institute (KIPI).

Copyrights:

- **Role:** Copyrights protect original works of authorship, including software, literature, and artistic creations. In the digital-cleantech sector, copyrights are relevant for protecting software used in cleantech solutions.

- **Innovations and Protection:** Digital-cleantech startups seek copyright protection for their software codes, user interfaces, or other creative works associated with their digital solutions.

Impact of Intellectual Property:

- Intellectual property protections provide innovators with a competitive edge, attracting investment and fostering a culture of innovation within the digital-cleantech ecosystem.

- By securing exclusive rights, innovators confidently disclose their technologies, knowing that they are protected from unauthorized use.

- IP protections enhance the value of innovations, making it easier for startups to commercialize their products and attract partnerships and collaborations.

- Investors are more likely to fund cleantech startups that have robust intellectual property portfolios, as this indicates a commitment to protecting and monetizing innovations.

Challenges Faced by Digital-cleantech Startups

- **Technical Capacity**: - Insufficient personnel with technical expertise on installation and operation of cleantech solutions, and knowledge in designing digital products.

- **Low Adoption Rates**: - Albeit the adoption rates being on the rise, the public has been slow to adopt new technologies, often preferring existing technologies. This is probably due to skepticism, low purchasing power especially by the youth as well as lack of awareness and understanding of the benefits of these technologies. A paradox exists, where the youth who are more receptive to digital solutions lack the purchasing power while the older population that is relatively rigid to such solutions have the purchasing power.

- **Ever evolving technologies**: - Many startups identify that a technology might be new today but shortly after another comes up, before one is able to establish themselves, leaving them lagging behind. One has to always be very agile and flexible while also thinking outside the box.

- **High initial costs**: - The initial installation costs for some technologies, such as solar-powered technologies are quite high and are a barrier to adoption.

- **Low public awareness**: - There is inadequate public awareness on clean technologies. This is particularly true in the agricultural sector, where many smallholder farmers are unaware of the benefits of these technologies beyond just the commercial aspects such as climate mitigation (environmentally good practices).

- **Issues of standards for innovations**: - No existing standards to match innovations or inventions, which makes it difficult for startups to have their devices/innovations certified and export-ready.

- **Access to Funding**: - Young entrepreneurs in particular often struggle to access funding, which renders them less competitive and struggling to catch up with larger companies in the market.

- **Insufficient supportive incentives**: - Insufficient fiscal and other incentives from the government to support startups and encourage innovation in the cleantech sector.

- **Market Infiltration by counterfeit products**: - The market is often infiltrated by many fake products, which are cheaper options therefore offering unfair competition to genuine cleantech solutions.

- **High cost of production and renewable components**: - The cost of components for renewable energy solutions is very high. This can be a barrier to adoption.

- **Policies and regulations not at par with rapid pace of innovations:** - Authorities would sometimes demand for permits and licenses yet there are none being offered by the mandated bodies. Also, there are no policies towards the adoption of renewable energy that favour all the actors. Many do not know their roles in the ecosystem.

- **Massive research demands in Kenya:** - innovators face a significant challenge due to a disparity between the substantial demands for research and the limited availability of information in certain fields. The process of innovation heavily relies on thorough research, but the existing pool of information within the country is notably inadequate in emerging fields, creating a challenging environment for those seeking to innovate.

- **Gaps in data privacy and management:** - Digital transformation massively involves capturing data from users, but the privacy regulation and management in Kenya has loopholes that pose the danger of what someone with the data can do.

- **Protectionist tendencies** by innovators for fear of theft of property rights or innovations, thus fragmentation in the ecosystem

- **Public distrust** for local innovations to imported technologies.

- **Market challenges that affect the quality of products**: - Startups source materials from different markets for different components, one risk is of incompatibility or poor quality. Relatedly, locally there are insufficient machineries for example machines that print circuit boards, thus no option but to import.
- **Commercial/cash flow problems**: - Startups operating as B2B with a turnaround time of not less than 2 months, thus debts and cash flow inertia.

In **s**ummary, the key challenges can be clustered into four main categories represented in the diagram below:

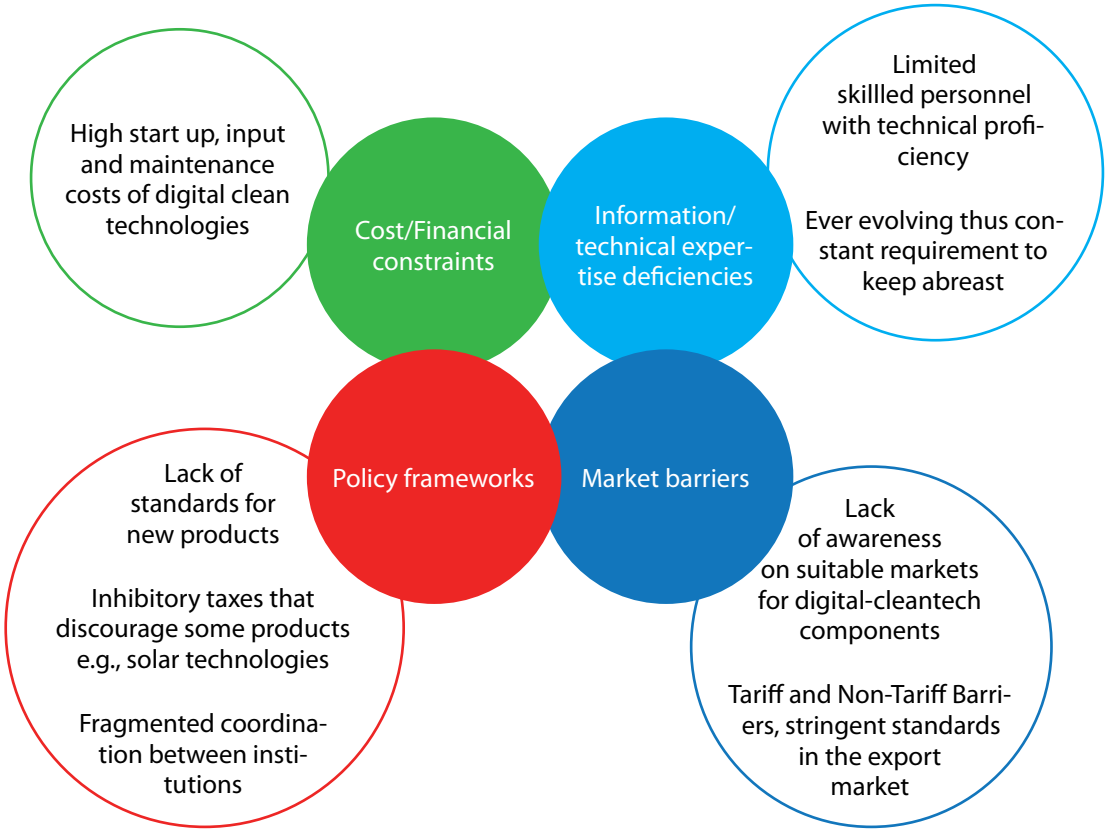


Figure 11: Key challenges for the digital-cleantech sector

Prospects Within Kenya's Digital-cleantech space

- **Precision Agriculture and Regenerative Agricultural Technologies** - Smart regenerative agricultural technologies being used to restore and increase soil biodiversity. Digital platforms for farmer training on climate mitigation, Good agricultural practices (GAPs), smart irrigation, and water management using solar-powered devices. Generally, digitalisation can be expected to reduce the 'distance' between farmers, input providers and final consumers. Any digital innovation in the agriculture sector has higher potentials of adoption and quick reception because it carries the masses in Kenya in terms of economic activity. The agriculture value chain still presents substantial opportunities for adopting digital-cleantech solutions in value addition of produce.

- **Renewable Energy Solutions** - The customer base available to take up renewable energy solutions in their businesses and homes in all locations presents a significant opportunity. Innovations in terms of energy storage, hybrid inverters for multiple sources, small wind turbines, and smart monitoring solutions are promising areas.

- **Smart Cities** - A myriad of investments exist in these cities. The most potent example is the Konza Technopolis [11], a project that is currently under development in a semi-arid region and is set to host Kenya's first wholly smart city. It hosts the Open University of Kenya, the country's first public university that is wholly virtual.

- **The carbon trading market (carbon capture technologies) -** With the recent change in law to provide for carbon trading, AI is increasingly being touted as a gamechanger in the sector. Already, in a pioneering move, Boomitra has partnered with the Farm to Market Alliance (FtMA) to launch a carbon farming project under the UN World Food Programme's Innovation Accelerator. Leveraging Boomitra's remote sensing and AI technologies, this initiative will empower East African farmers by monitoring soil carbon and nutrient levels remotely, enhancing soil health, and facilitating new economic opportunities through carbon credits.

- **Robotics (AI) for use in** sectors such as waste segregation, capacity building initiatives and industrial operations.

- **'White-labelling' of digital solutions**: the integration and tapping of other smart meters to be able to offer broader utility analytics. This is applicable across all sectors.

- **Opportunities to involve IoT in beekeeping,** in a way that monitors the conditions of the hives and other parameters.

- **The Dairy Industry** - The dairy sector is growing with many cooperatives venturing into value addition to get more profits, presenting an opportunity for cleantech solutions in this sector.

- **Food Preservation** - through cooling and drying technologies given the increasing focus on food security.

- **eMobility** - electric vehicles present an opportunity for both environmental impact and cost management. Implementing tracking systems to monitor the amounts of carbon emissions as well as locations contribute to crime reduction and additional savings for the consumers.

- **Policy Perspective** - For instance, the new energy act that makes it mandatory for heavy consumers of power to have a power manager presents opportunities for job creation and improved efficiency.

- **eWaste** - the implementation of the newly adopted Extended Producer Responsibility (EPR) under the 2022 solid waste management act outlines that waste producers will have to segregate at source. This promises enhanced adoption of e-waste thus more opportunities in the sector.

11 https://konza.go.ke/

Revolutionizing Tomorrow: Top Sectors Set to Transform with Digital-cleantech Innovations

- **Water Management:** Utilizing solar power for pumping, irrigation, and institutional use. Digital upgrades to monitor and maintain community pumps efficiently.
- **Agriculture:** Advanced cooling technology to curb post-harvest losses, comprehensive automation in agro-processing across value chains, and remote crop monitoring. Embracing soil testing and IoT for enhanced post-harvest management.
- **Health Sector:** Innovative cooling and storage solutions for vaccines, and the integration of smart devices for efficient appointment scheduling.
- **Energy Sector:** Embracing a shift to renewable sources like solar and wind energy, with the potential to export surplus energy to national grids through advanced technology.
- **Waste Management:** Transformative waste-to-energy solutions, including electricity-generating incinerators and production of organic fertilizers.
- **Transport Sector:** Green logistics revolution through the use of smart IDs, enhancing efficiency and sustainability in transportation.
- **Manufacturing:** Implementing eco-friendly production processes and smart automation to reduce environmental impact and increase efficiency.
- **Urban Development:** Smart city technologies for sustainable urban planning, energy-efficient buildings, and improved public transportation systems.
- **Education:** Integrating digital tools for resource-efficient and sustainable learning environments.
- **Retail and Commerce:** Adopting green practices in supply chain management and utilizing digital platforms for eco-friendly consumer engagement.

Annexes

Annex 1: Key Documents

KENYA DIGITAL MASTERPLAN 2022-2032

KENYA DIGITAL ECONOMY BLUEPRINT 2019.pdf

Annex 2: Sampled cleantech start-ups

Business Name	Brief Description of Business	Website
Clean Energy 4 Food Security	Development of compressed air energy, free air battery (FAB) storage technologies, Compared to lithium-ion systems (Panasonic, Sanyo, LG Chem, CATL, BYD, Samsung & AESC) & Redox Vanadium batteries (Infinity Energy Systems, Rongke, Power Development, CellCube, VIONX & Volstorage) FAB is cost-effective and robust, made from mature industrial components, that can hold & discharge energy over extended periods (10 hrs +) can operate in extreme conditions without performance loss. FAB is non-polluting, designed for the circular economy, made of 95% metal components, easily recycled after a 30-year operating life. There are two outputs from a FAB, first clean, affordable & reliable electricity, second cool clean air 2-9'C, which is integrated into Clean Energy for Cold Storage (CE4CS) assembles a consists of a Micro Grid with Storage (MGS) and an Off-Grid Cold Store (OGCS). The MGS part of the system is made up of a solar PV array 20kWp and a Free Air Battery (FAB) 20kW for 10 hours or 200 kWh.	
Drop Access	Efficient Cooling (E-Cool) is the local manufacturing of portable solar-powered fridges for use in the healthcare industry as well as food storage. Besides production, Drop Access has coupled the fridges with an online application for remote monitoring and sensing, online troubleshooting and data collection. Our business model is committed to provide a practical and affordable cold chain to low-income communities coupled with a comprehensive and reliable after-sale battery storage support system.	https://dropaccess.org/
Froid Refrigeration & cooling Services	They have invented an Air conditioner that uses 3/4 less energy than the counterpart, and also have invented gadgets to help with your Refrigeration units, (Commerciall) They bring energy efficiency up to 65% through savings only using the above mentioned. Cutting energy costs, and saving the environment by reduced energy intake and demands.	froid-refrigeration-and-cooling-services.business.site/
Silo Africa	They prevent post-harvest crop losses by leveraging technology and providing digitized household silos to smallholder farmers on-farm to transform grain storage with IOT and Solar power. They cushion smallholder farmers from the pressure of selling at low prices.	https://www.linkedin.com/in/silo-africa-6b4b0a279/?originalSubdomain=ke
SowPrecise Africa	They utilize a farm management system called Weaver bird. Weaver bird enables us to identify, analyze, and manage variability in farms. It advises us on crop production practices at the right time in the right way for optimum productivity, sustainability, and protection of the land resources. Weaver bird is tailored for the African environment and customized to work within the infrastructure context in Africa characterized by poor internet connections, inconsistent power supply, and low purchasing power by farmers. Advancements in agricultural technologies such as Variable Rate Technologies (VRT), Remote Sensing, GIS and Global Positioning System (GPS), in addition to the developments in modelling and simulation of crop production, provide numerous opportunities for the development of Precision Agriculture.	https://climatelaunchpad.org/finalists/sowprecise-africa/
Circularity Space	They are introducing Solar Powered Smart bins in Africa that use Artificial Intelligence to identify and sort trash, creating value that allows consumers to earn from their waste. The bin educates users on what is recyclable and what is not, incentivizing waste management by rewarding users with redeemable points.	https://circularityspace.com/
Creos Holdings Limited	The sun canopy Vehicle Integrated Photovoltaics (VIPV) is a photovoltaic system that is installed on refrigerator trucks and public transport mini buses in Kenya known as matatus. With the technology, these trucks and buses become mobile solar parks, reducing fuel consumption and emissions costs more than solar panels connected to the grid. There is a clear business case to implement the SunCanopy in a vehicle fleet: the breakeven period is less than three years and offers a solution to significantly reduce fuel consumption.	https://creosltd.com/

Drip Masters East Africa	Mimea Agtech is a water irrigation platform we are working on at Drip Masters east africa. after two years on installing modern irrigations systems for farmers in east africa, they realised a lot of water and energy is been wasted by farmers because of lack of data on actual crop needs, when is the optimum time to irrigate , how many litres of water is required and for how long to irrigate. www.mimeagtech.com uses data from soil monitors placed in the farm, crop and agronomy data that is stored and climate and weather data to give the farmers precise irrigation timing guides daily, for how long to irrigate and with how many litres of water. We shall save water, energy and time and make the farmers more productive and the environment better.	https://dripmasters.co.ke/
Vesser Afrique	Vesser Afrique's mission is to increase access to water for domestic and agricultural use cases. We actualise this by partnering with water utilities and irrigation operators, and through our Pumping As A Service (P.A.A.S) business model we supply them with our cutting-edge and innovative pump that is completely green and smart. Our pump does not require electricity or fossil fuel to pump water, it has a capacity to pump up to 2000m3 of water per day, lift it about 150m and deliver it up to 15 km away.	https://vesserafrique.com/
Carbon Zero Mobilities Limited	Carbon Zero Mobilities is an e-transport company promoting adoption of clean technology in the transport sector. The company has partnered with an American energy storage technology manufacturer, Alternate Systems Inc, to introduce electric powered 2 and 3 wheelers in Kenya. In partnership with a local micro credit company (Nikodigi Ltd) Carbon Zero has developed a lease to own business model targeting the corporate companies dealing with delivery and courier services to switch to clean technology. The company will also establish a charging infrastructure around Supermarkets which will also serve as overnight holding points for individual bike owners plying a certain region. This shall enable the bike users to get access to charging points and secure places for overnight parking. The charging points shall be business generating points for the individual two and 3-wheeler transport providers. The company seeks to support mitigation of Greenhouse gases in the transport sector	https://dominion-ev.com/about/
M-taka waste solutions Limited	M-taka is a tech-integrated waste management social enterprise based in Kisumu, Kenya. Its main goal is to educate communities on better waste management practices, connect actors in the waste value chain, and improve the livelihoods of waste actors. M-taka uses a social incentive-based approach to address the challenge of plastic waste management. By educating the community on the impacts of plastic waste and the benefits of recycling, as well as providing incentives for positive behavior change, M-taka aims to instill knowledge and encourage a shift in attitudes towards plastic waste management. The enterprise aggregates plastic waste recyclables to community buy-back centers through verified agents and then crushes the plastics for sale to end-of-chain recyclers. Additionally, M-taka empowers women in the waste sector by involving them in the collection and recycling process, providing them with an opportunity to earn an income while also contributing to the solution to the plastic waste problem. M-taka has achieved significant success in increasing plastic recycling culture and reducing plastic waste pollution in Kisumu. The enterprise has attracted a multisectoral approach, providing access to resources such as technical know-how, financial resources, and policy development support. Through the use of innovative technology and social incentives, M-taka aims to create a long-term commitment to proper waste management in the community.	https://m-taka.co.ke/
T-Bin	The T-Bin is a smart intelligent solar powered segregated waste bin fitted with twin smart screens, IOT devices, Wi-Fi and street lighting that educates the public on waste separation at source to create more decent jobs in the recycling sector.	https://nowaste.whatdesigncando.com/projects/t-bin/

Voltstone Group Limited	Our Solar Pumping systems make use of renewable energy to deliver water and this reduces emission of green-house gases and in turn mitigate Climate Change. ADAPTATION around water wastage .Our device will give real-time information for farmers on their water levels and water usage. Farmers will have improved water management. When we incorporate moisture sensors to the soil, water will only be delivered when needed, this will reduce over-watering of crops(water wastage) or underwatering. This will eventually increase quantity and quality food production by optimizing water usage. This increase in produce will lead to creation of many job opportunities in the farms. The water level sensor will give consumption data which can be used to identify leakages in pipes if consumption was to drastically increase. It will also help with planning by giving customers water level data. Our control panel monitoring system will enhance Energy efficiency by relaying pump health data and monitoring Voltage and Current within the system. Our System will also be connected to Solar Pumping Systems which will monitor energy usage and ensure maximum usage of sun hours. The major challenge with solar systems is dust, when we have a system that monitors power output of panels, we will be able to observe the decline in power production informing the client that it is time for solar panel cleaning. This regular cleaning of panels will also increase energy output. Our solution can be extended to detect total dissolved solids(TDS) in water using a TDS sensor and with that, can monitor mineral traces in water to ensure its safe consumption for a population.	https://voltstone.co.ke/
CHAJI SERVICES LIMITED	The African continent is on the verge of a significant e-mobility growth push, with a unique context that demands tailored solutions. CHAJI recognizes this need and is developing integrated energy solutions that cater to all e-mobility asset classes, utilizing a smart cloud-based platform and building hardware locally in Africa. Our solutions are OCPP enabled and easily integrated with a wide range of network solutions, promoting seamless communication and interoperability between different EV charging stations and management systems. CHAJI provides a comprehensive cloud-based platform for managing electric vehicle charging Infrastructure that includes remote management and maintenance capabilities, energy management, pricing and billing, aggregated network and roaming, security, dashboard analytics, and user management. The platform supports multiple hardware vendors and is OCPP 1.6 compliant for future readiness. CHAJI's focus on interoperability with e-Roaming ensures increased charge point access to users. The system is secure, with end-to-end encryption, and offers full visibility and transparency for operations via CHAJI's admin dashboard. Additionally, CHAJI enables simultaneous EV charging, avoids grid overload, and accepts various forms of payment. HardwareWe are locally designing and manufacturing the following EV charging hardware: - 3.3KW smart IoT 3 pin plug charging device for charging 2-wheeler (electric motorcycles) and 3-Wheeler (electric rickshaw/tuk tuks). - 7KW and 22KW wall box which is a level 2 AC charging device for charging 3-wheelers and 4 wheelers for commercial installations and private/home use. Software (Platform) In addition to the hardware, we are; - Integrating an open-source communication protocol, OCPP, which enables our partners to easily connect to their own systems with ease. - *Developing a custom charge point management system with a focus on local payment methods e.g. M-Pesa, load balancing and offer charging analytics e.g. Kilowatts used, device status and diagnostics etc.	https://ke.linkedin.com/company/chaji-energy

Dronecrops Limited	They offer mapping and crop spraying services using drones. This enables farmers to make more informed decisions, allowing for a more integrated approach to crop protection and farm management. Still, our high-level accuracy spraying drones makes the operation faster, efficient and more cost effective. Agricultural activities contribute approximately 30 percent of total greenhouse gas emissions, mainly due to the use of chemical fertilizers, pesticides and animal wastes. This rate is bound to further rise as a result of an increase in the demand for food by a growing global population. GHGs contribute to climate change and global warming and thereby have a profound impact on the sustainability of agricultural production systems. Our solution involves the use of drones to map farmlands and in the process identify problematic areas that require attention. These could be areas infested by pest and diseases, nitrogen deficient regions or areas with water logging/scarcity. This allows us to perform spot chemical application using drones, eliminating the need to unnecessarily apply chemicals to the entire farm. Aside from saving on input cost and reduced emissions, farms are able to record much higher farm productivity	https://vc4a.com/ventures/dronecrops-ventures/
NOLAN CLARK EA LIMITED	Nolan Solar specializes in consulting and aggregating SOLAR PV systems. With an experience of over 2MW of hands-on installations across Kenya; we work relentlessly to deliver sustainable, innovative and cost effective solutions with the best industry practices at competitive prices.With a diverse portfolio of services ranging from Captive Solar Power farms, Off-grid and Grid-tied solar energy systems suited for both domestic and commercial use. We provide solutions for Residential, Commercial, Industries, Schools, Hospitals and Government buildings.	https://www.nolan-clark.co.ke/
Torque Controller Kenya Ltd	Torqco Controller Limite is a registered limited company in Kenya having 2 shareholders with Dennis having majority of shares in the business. The business is an Energy Management Program (EMP) offering Commercial, Processing and Manufacturing Industries who wants to reduce their costs of production by reducing their energy and maintenance costs by rolling out their Energy Management Program (EMP) which entails: Process Optimization, Plant Automation and Provision of alternative renewable sources of energy thus increasing their profits and business sustenance. In 2020 added their comprehensive Energy Management Program (EMP) and iIn 2022 they have generated over 8M Kenyan Shillings in sales and going for more	
Hydragravity Energy	Hydragravity energy is a brand new technology that harnesses the force of gravity and hydraulics to spin a turbine thus generating clean affordable energy. This is made possible by leveraging the force of hydraulic through a hydraulic engine that converts the linear motion of hydraulic actuators into rotary motion. This engine has an extremely high torque which makes it possible to lift heavy weights with an input of only 3 Kwt from a battery pack connected via an inverter. A vertical lifting system raises 8 cast iron balls to a height of 8 meters and then releases them one at a time. The balls roll by force of gravity and they spin a 7 meters diameter turbine thus harvesting their kinetic energy as they fall. The turbine is attached to a 20kw alternator that generates clean, extremely cheap and efficient energy.	http://www.hydragravityenergy.com/
Rhea soil health management ltd	We have developed a soil testing device that uses sensors and is linked to a dashboard using IOT. We plan to build a fertiliser recommendation system and link it to the device ensuring farmers receive soil analysis data and report in real time	https://www.rhea.africa/
GECSS INVESTMENT LIMITED	At GECSS Investments Ltd, we trade in Electric Motorcycles and mainly target the boda-boda riders who are the two wheeler taxis as our main clients. We also service their motorcycles since these bikes require special skills to maintain motors and batteries. We have also created swap stations where riders would swap a depleted battery with a fully charged one. We are looking into investing into solar energy to charge these batteries. We also conduct retrofitting of the petrol-powered motorcycles and change them to electric powered ones. There is a broad base of these clients since riders are finding it more convenient to retrofit motorcycles on the roads than buying new electric ones. The aim of introducing this technology to the Kenyan community is to create jobs and help our clients save a lot of money, noting that Kenya's petrol pump price is exorbitant, and continues to increase at an exponential rate. Also, it is one way of putting Kenya on the front line in the battle against global warming which has negatively affected the lives of many Kenyans.	https://www.gecss-ke.com/

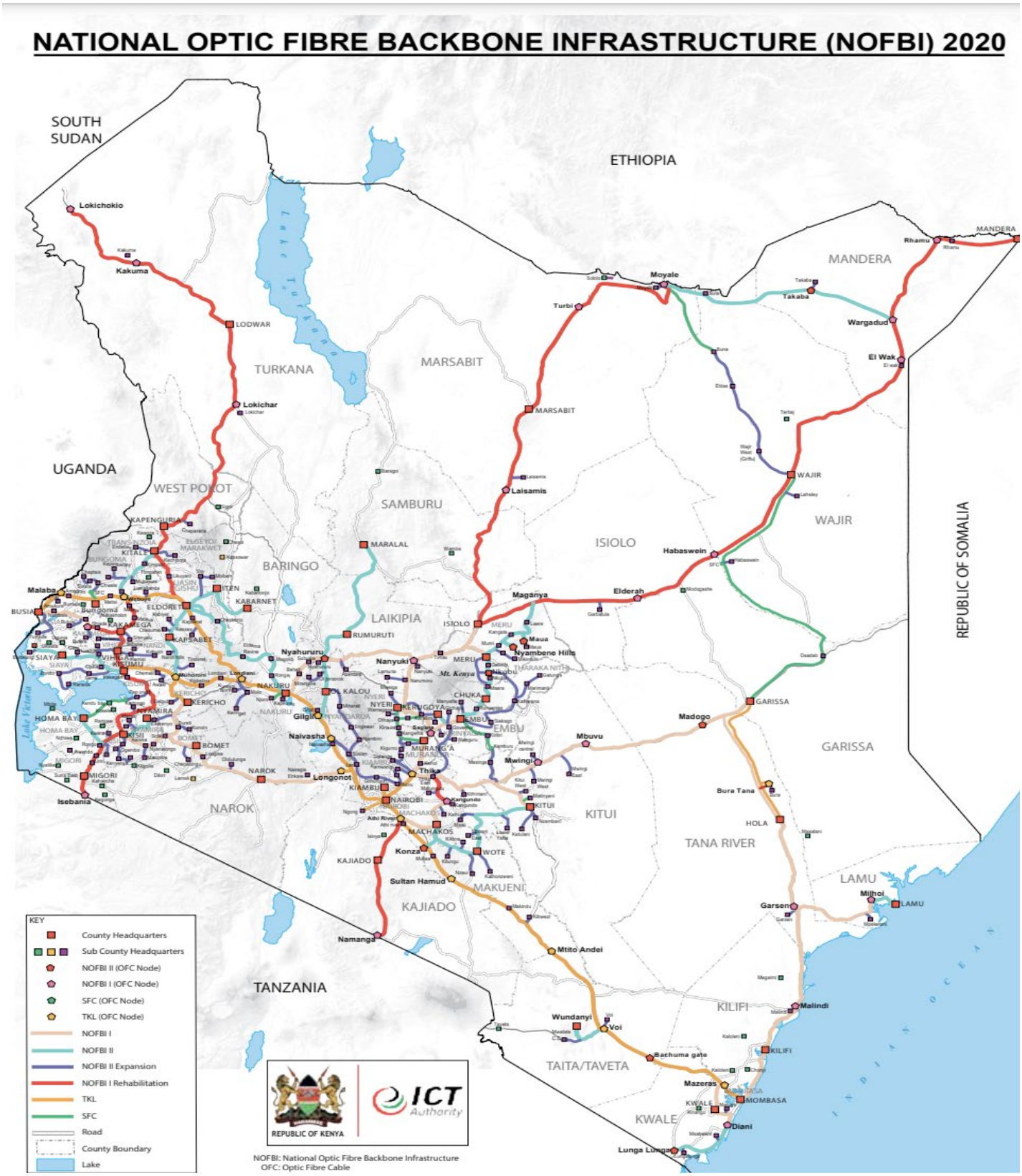
TOTOSCI Holdings Ltd	Totosci Holdings Ltd is the only startup in Africa that locally manufactures mobile phone USB chargers using Recycled HDPE and PVC plastics. Their products are KEBS certified and Brand Kenya Approved. The company works with youths in Muranga county who collect HDPE plastics, bring them to the companys collection centre, the materials are then sorted and cut into smaller pieeces which are then shredded. By using HDPE plastics collected, the company is able to save up to 60% of production cost compared to him buying the HDPE from a supplier's shop. According to Global Market Statistics, Kenya has 10 million smartphone mobile users. All these users use a USB cable to charge their devices and to transfer data. Because of the big number of the users of the cables, the market has been flooded with fake usb cables that are not up to the standards. This causes every smartphone user to have 2 or 3 damaged usb cables in their houses. Most of the problems associated with this breakage at the end point due to stress of folding and others breakage of internal wires.	https://www.totosci.net/
Lake View Fisheries Limited	Lake View Fisheries Ltd (LVF) is a vertically integrated fish farm operating from Mfangano Island, Lake Victoria, Kenya. The company seeks to improve the sustainable production and availability of fish farmed through modern aquaculture technologies(all systems automated); ultimately, it aims to increase per capita fish consumption and boost the economy for small scale fish producers as well as other actors along the value chain. The company operates 14 floating fish cages, anchored approximately 1 km offshore. Each cage has the capacity to produce 35,000 fish to maturity (~300 grams/piece) per production cycle. LVF produces tilapia for a range of different income segments on the Kenyan market.	https://agrifichallengefund.org/lake-view-fisheries/
Tecsols Limited	Techsols Limited focuses on Design and Developments of Digitalized Innovative Engineering Technological Solutions in the Agricultural Sector (Production, Post-Harvest and Storage Technologies); Renewable Energy Sector (Use of solar energy in cooling(Automated Solar cooling tanks). Use of solar, biomass and Geothermal for drying, eggs incubation and chick brooding) and Water Sector (Solar Water Desalination, Pumping and Purification). client give them design brief/product requirements and their design, develop, make, install and commission the product. For already developed products, they deliver as required(sometimes with upscaling or downscaling as appropriate)	https://tecsolslimited-kenya.business.site/
Techwin Limited	Techwin Limited is a leading manufacturer of stainless steel equipment within various industries. Equipped with modern technology and workshop machinery, the company is able to design, manufacture, supply, install, and maintain a wide range of customized engineering equipment including solar powered dairy processing equipment.They supply solar powered dairy processing equipment for individual agribusiness entrepreneurs, dairy cooperatives and welfare groups mostly in the rural areas of Kenya. Their products are custom made to fill the gap created by the unavailability of electricity in the rural regions and high cost of power that makes food processing costly to small and medium business enterprises.	https://www.techwin.co.ke/
Agrotech Plus	Agrotech Plus is providing solar-powered refrigerated storage that it says extends the shelf life of perishable crops from about 5 days to 21 days. Agrotech Plus enables agribusinesses, communities and smallholders to rent cold storage facilities. Farmers can rent a space in the cold store for a daily fee of $0.30 per 20 kilogram crate of produce, or take up a weekly subscription. They can also pay for the cold storage with crops instead of cash. To help farmers reduce food losses and sell their produce at competitive prices, the solar powered cold storage service also includes a mobile app that connects them to food aggregators; organizations that consolidate and distribute agricultural products. Agrotech Plus is expected to break-even in year 3 (post pilot) with 100 cold storages linked. In year 5, revenues are expected to be $8,000,000.	https://agrotekplus.com/

Annex 3: Public actors and authorities in the cleantech space

Some authorities involved in Kenya's cleantech space include:

Institution	Mandate
Kenya National Innovation Agency (KENIA)	The Kenya National Innovation Agency (KeNIA) is a State Corporation established under the Science, Technology and Innovation (STI) Act, No. 28 of 2013 under the Ministry of Education. The core mandate of the Agency is to develop and manage the National Innovation System. The Agency is therefore responsible for coordination, promotion and regulation of the National Innovation System through linkage of institutions, creation of science and innovation parks, continuous benchmarking of standards
ICT Authority (under the Ministry of ICT)	The Authority is tasked with rationalizing and streamlining the management of all Government of Kenya ICT functions. Their broad mandate entails enforcing ICT standards in Government and enhancing the supervision of its electronic communication, while also promoting ICT literacy, capacity, innovation and enterprise.
National Commission for Science, Technology & Innovation (NACOSTI)	Regulation and quality assurance in the science, technology and innovation sector, and advisory to the Government in matters related thereto. This entails coordination of agencies to implement sound policies and budgets, stakeholder consultations, accreditation, awareness and knowledge creation, private sector involvement etc.
Kenya National Cleaner Production Centre:	Established in 2000, the center works towards building capacity in resource efficiency and pollution prevention for enterprises through information, training, in-plant production process assessment, projects implementation and policy advice.
The Centre for Green Growth and Climate Change (CGGCC) at the **Kenya Association of Manufacturers (KAM)**	The center seeks to deepen industries' level interventions to become a one-stop solution center promoting circular economy, import-substitution, climate change actions, and financial linkages. The center prioritizes people, planet, and profit to improve the manufacturers' bottom-line while preserving the environment for future generations. Programmes being run in the center include: Certified Energy Manager (CEM); Certified Measurement and Verification Protocol (CMVP); Energy Auditing; Solar T3; Performance Improvement of Boilers and Steam Systems; and ESCO Model Training
Kenya copyright board (KECOBO)	KECOBO is mandated with the overall administration and enforcement of copyright and related rights. The Board carries out public awareness, enforcement, registration of copyright, licensing of collective management organisation and education on matters of copyright and related rights. It coordinates the activities of the copyright industries
Kenya Accreditation Service (KENAS)	KENAS is mandated with a myriad of roles that revolve around conformity to standards, accreditation and public awareness. The body's mission is to provide greater confidence in accredited conformity assessment services to businesses, government, regulators, consumers and the public

Annex 4: Kenya's National Optic Fibre Backbone Infrastructure (NOFBI)



Annex 5: Implementation of SDGs in Kenyan Ministries and the use of ICT

Table 4 Implementation of SDGs in ministries and the use of ICTs

Ministries	SDGs	Implementation	Use of ICTs
Ministry of Education	GOAL 4: Quality Education	Yes	Yes
Ministry of Energy	GOAL 7: Affordable and Clean Energy	Yes	Yes
Ministry of Health	GOAL 3: Good Health and Well-being	Yes	Yes
Ministry of Water	GOAL 6: Clean Water and Sanitation	Yes	Yes
Ministry of Lands	Goal 15: Life on Land	Yes	Yes
Ministry of Devolution and Arid and Semi-Arid Lands (ASALs)	GOAL 1: No Poverty GOAL 2: Zero Hunger	Yes	Yes
Ministry of Information, Communication, and Technology	GOAL 9: GOAL 9: Industry, Innovation, and Infrastructure	Yes	Yes

Adopted from: (Onyango & Ondiek, 2021)

Acknowledgements

This report was prepared by the Kenya Climate Innovation Center. The CEO, Joseph Murabula provided oversight while the following contributed to the study: *Ernest Chitechi, Vincent Ogaya, Emmanuel Yahuma* and *John Musyoka.*

The report benefitted from insights and review of our partners from Cleantech Estonia, specifically *Kädi Ristkok (the CEO), Veigo Kell* and *Heili Hiis.*

Special thanks to all stakeholders, including entrepreneurs, startups, academic and research institutions, startup funders as well government agencies who, as informants, willingly agreed to participate in the study and lent information that make up the contents of this report.

About Kenya Climate Innovation Center

The Kenya Climate Innovation Center (KCIC) was launched on the 26th September 2012 as part of the World Bank's infoDev initiative and was the first in a global network of Climate Innovation Centers (CICs) launched by infoDev's Climate Technology Program (CTP) to support the development and scale up of locally relevant climate technologies.

KCIC provides incubation, acceleration, capacity-building, and innovative financing to Kenyan entrepreneurs developing innovative solutions in five thematic sectors namely: renewable energy and energy efficiency; water management; agribusiness; waste management; and commercial forestry in a bid to address climate change challenges.

KCIC has over the years supported over 4,000 Small and medium sized enterprises (SMEs) with a keen focus on women and youth-led climate smart enterprises in Kenya and beyond, subsequently creating over 39,500 direct and indirect jobs and the commercialization rate of supported enterprises stands at 67%.

About Cleantech Estonia

Cleantech Estonia is an organization that unites, supports and represents cleantech sector development in Estonia and the Baltic region. They bring together technologies and solutions with the best experts, investors and corporations, building a pan-Baltic network of cleantech actors. They help policymakers create supportive regulations, raise awareness, and foster collaboration. Export and global collaboration are part of their core mission. By uniting the green economy actors, Cleantech Estonia promotes accelerated sector development. With an established cleantech sector in Estonia and the Baltics, they aim to lead the transition to a clean economy. Collaboration, innovation, and sustainability as their core values are rooted in their strategy and activities.

About ESTDEV

The Estonian Centre for International Development (ESTDEV) is a government-funded foundation responsible for managing and implementing Estonia's international development cooperation and humanitarian assistance projects. Supported projects are focused on areas where Estonia has strong added value to offer: supporting educational innovation, boosting digital and green revolutions, and business development.