






SUSTAINABLE BIOENERGY IN KENYA

A Roadmap Developed by a Cluster of Kenyan Bioenergy Enterprises

SEI Stockholm Environment Institute

Sweden Sverige

EXECUTIVE SUMMARY

The roadmap on Sustainable Bioenergy in Kenya, developed by a Cluster of Kenyan Enterprises focuses on scaling sustainable bioenergy in Kenya, specifically briquettes, pellets, biogas, and emerging biofuels derived from agricultural and organic waste. It is part of the Advancing Bioeconomy Development in Kenya (ABDK) project, led by SEI with Sida support, which aims to accelerate Kenya's bioeconomy through actor mapping, cluster roadmaps, and Kenya–Sweden business partnerships. The roadmap positions bioenergy as a key pillar of a low carbon, circular economy that can reduce dependence on firewood and charcoal, cut emissions, and create green jobs, while valorizing biomass residues and waste.

The cluster of Kenyan bioenergy enterprises, comprising of 13 Kenyan micro, small, medium Enterprises (MSME) already demonstrate viable solutions but face fragmented markets, finance gaps, and regulatory complexity. The roadmap sets out a shared vision of a sustainable and inclusive bioenergy sector that converts biomass and organic waste into clean energy, employment, and climate resilience. It includes a SWOT analysis, priority opportunities, and critical barriers. Three priority opportunities are highlighted: building an enabling environment through a strong industry association, expanding markets with an emphasis on exports, and strengthening capacity via technology transfer and training. Three core barriers are also identified being: (i) lack of sector specific funding mechanisms (ii) insufficient product awareness and market sensitization and (iii) complex certification and licensing requirements that constrain MSME growth. The roadmap outlines detailed scaling pathways for MSMEs across seven domains; financing, certification, markets, technology, infrastructure, stakeholder relations, and policy, each with targeted actions and responsible institutions. It proposes milestone targets for 2030 and 2040, including increasing bioenergy's contribution to the national energy mix, cutting unsustainable charcoal use, creating thousands of green jobs, and establishing bioenergy hubs in every county. The document concludes with an enabler matrix and milestone plan, intended to steer coordinated interventions by government, financial institutions, development partners, and private actors toward a just and inclusive bioenergy transition.

1. An Overview of the ABDK Project

The Advancing Bioeconomy Development in Kenya (ABDK) project, implemented by the Stockholm Environment Institute (SEI) with support from the Swedish International Development Cooperation Agency (Sida), aims to accelerate the industrialization, modernization and scaling of Kenya's bioeconomy while generating lessons for the broader East Africa region. The project focuses on three core interventions: mapping bioeconomy private-sector actors and agripreneurs in Kenya and Sweden, developing bioeconomy roadmaps for different Kenyan bioeconomy actor clusters, and promoting collaboration and technology exchange between Swedish and Kenyan bioeconomy practitioners.

A central component of ABDK is the co-creation of roadmaps with selected bioeconomy clusters and the use of these cluster platforms to catalyse business-to-business partnerships between Kenyan MSME bioeconomy enterprises and Swedish bioeconomy companies. Through these partnerships, the project seeks to unlock investment, technology transfer and market access for high-potential bio-based solutions.

Within this framework, the ABDK initiative supports four distinct clusters. The Bioenergy Cluster focuses on enterprises producing biomass-based energy solutions, including briquettes, pellets and biogas from agricultural and organic waste feedstocks. The roadmap for this cluster outlines priority actions to scale sustainable bioenergy value chains that enhance climate resilience, advance circular economy practices and contribute to Kenya's just and inclusive low-carbon transition.

1.1 Sustainable Bioenergy in Kenya's Emerging Bioeconomy

> A bioeconomy approach means using biological resources and waste as valuable economic assets, not by products, to replace fossil fuels and create green, low carbon growth

Bioenergy is a largely untapped but high potential pillar for Kenya's low carbon, circular economy, using crops, crop residues and organic waste to cut emissions, reduce pressure on forests and create green jobs. It can be expanded through briquettes and pellets from agricultural and forestry residues, biogas from organic waste for households and larger waste to energy systems, and longer term development of advanced biofuels from non food biomass and algae as technologies mature.

Kenya's heavy reliance on firewood and charcoal makes sustainable biomass briquettes and pellets a key alternative for households and industry, though scaling them requires investment in technology, supply chains and clean cookstoves. Biogas has growing use but is constrained by cost and maintenance challenges, while second and third generation biofuels remain nascent yet promising for future rural industrialization and employment.

A bioeconomy approach means using biological resources and waste as valuable economic assets, not by products, to replace fossil fuels and create green, low carbon growth. It links sustainable biomass management, innovation and coordinated policy so Kenya can build integrated value chains from waste collection to energy generation, improve energy security and generate green jobs.

In practice, this involves investing in efficient biomass value chains, R&D and supportive policies and finance so that modern bioenergy such as biogas, bio briquettes and bioethanol can scale. Biogas systems, briquettes from residues and ethanol from crops like sugarcane and cassava are already key options that can cut emissions, reduce charcoal use and fossil fuel imports, and stimulate rural enterprise and agro industrial development.

2.

The Kenyan Enterprise Cluster Roadmap on Sustainable Bioenergy

The Kenyan Sustainable Bioenergy enterprise cluster roadmap details priorities and solutions for scaling modern bioenergy briquettes, pellets, biogas and advanced biofuels using Kenya's abundant agricultural and organic waste resources. It includes the cluster vision, SWOT analysis, key opportunities for expansion, critical barriers, an implementation structure and milestone targets. The roadmap provides actionable steps, clear enablers and detailed policy recommendations for Kenya's transition to a circular, low-carbon bioeconomy

2.1 The Cluster Vision

A sustainable and inclusive bioenergy sector that transforms Kenya's biomass and organic waste into clean energy, green jobs and climate resilience, driving the country's transition to a circular, low-carbon economy.

Cluster 4 members and enterprises are listed in the annex.

2.2 Scaling Opportunities for Cluster Enterprises (MSMEs)

Micro, Small and Medium Enterprises (MSMEs) within Kenya's bio-based sector engaged in bionergy production hold strong potential for growth, market expansion and environmental impact. To unlock this potential, a coordinated set of actions is needed to strengthen access to finance, technology, certification and policy support in the following areas:

Financing

» **Reduce upfront and ongoing costs for bioenergy businesses by leveraging tailored loans, tax incentives and carbon or impact market grants.**

- Co design "briquette loans" with partner banks where machinery serves as collateral and repayments follow production cycles.
- Secure tax holidays, capital allowances and import duty/VAT exemptions for bioenergy equipment and inputs.
- Support eligible enterprises to register and participate in carbon and impact finance mechanisms linked to verified emission reductions.

Certification & Compliance

» **Ensure standardized product quality and efficient regulatory compliance through coordinated research, testing and streamlined processes.**

- Establish clear briquette and bioenergy standards with KEBS and develop simple guidance for MSMEs on how to comply.
- Form a multi agency task team (KEBS, NEMA, KFS, EPRA, counties) to harmonize requirements and reduce duplication.
- Provide shared testing services and cluster based certification to lower individual costs and speed up approvals.

Markets

» **Expand market reach and consumer demand by collaborating on awareness campaigns, shared logistics and demonstrating positive impact.**

- Run coordinated awareness and demonstration campaigns targeting households, schools, hospitals and businesses on clean cooking benefits.
- Use shared distribution hubs and pooled transport to reliably serve large and scattered customers at lower cost.
- Document and communicate social, economic and environmental impacts (jobs, forest saved, emissions reduced) to buyers and investors.

Technology

» **Improve productivity and competitiveness by investing in advanced equipment, process innovation and digital tools.**

- Facilitate access to higher efficiency presses, dryers and modern carbonisation systems through leasing, incubation or joint investments.
- Support MSMEs with training on process optimisation, maintenance and quality control to reduce waste and improve consistency.
- Promote use of basic digital tools for tracking production, costs and sales to strengthen business and operational decisions.

Infrastructure

» **Support scale and reliability with upgraded production plants and strong distribution systems.**

- Upgrade production sites to meet safety, storage and throughput needs, including reliable power and water where required.
- Advocate for improved access roads and coordinated last mile logistics in key producing and consuming counties.
- Explore co location in industrial or bioenergy parks to share utilities, warehouses and common services.

Stakeholder Relations & Influence

» **Strengthen advocacy, resource sharing and sector voice through industry associations and proactive government engagement.**

- Formalize a bioenergy or briquette producers' association to coordinate members, set voluntary standards and speak with one voice.
- Create cluster platforms and working groups for joint problem solving, training and information exchange across regions.
- Engage regularly with chambers, private sector alliances and civil society to build alliances around clean energy and MSME support.

Policy & Government Engagement

» **Drive constructive policy reforms and reduce regulatory barriers via lobbying, transparency and strategic partnerships.**

- Work with national and county governments to implement clean cooking and bioenergy strategies in procurement, subsidies and enforcement.
- Advocate for harmonized county by laws, simplified licensing and predictable fee structures for briquette and bioenergy enterprises.
- Build long term partnerships with relevant ministries, regulators and development partners to align policies, pilots and funding with MSME needs.

2.2. SWOT Analysis

Strengths

- Very strong community impact potential, with the cluster now targeting about 1 million direct jobs and 3 million indirect jobs by 2030, and restoring around 500,000 acres of degraded or invasive species infested land per year.
- Abundant and affordable biomass feedstocks (charcoal dust, sawdust, rice husks, bagasse), plus available land and growing demand for clean energy and circular economy solutions.
- Diverse product portfolio (carbonized and non carbonized briquettes, biochar, biogas, smudging fuel) and intellectual property in development.

Opportunities

- Sector specific funding mechanisms (briquette/biogas loan products, consumer financing, tax incentives, carbon and impact market grants) that can unlock capital for machinery, working capital, and expansion.
- Formation of a strong industry association to lobby, aggregate large and export orders, coordinate market linkages, and support self regulation and best practice sharing (without illegal price fixing).
- Capacity building and technology transfer through expanded incubation (KIRI type hubs), training, knowledge platforms, and structured access to export markets such as Dubai, Saudi Arabia, Yemen, and Germany.

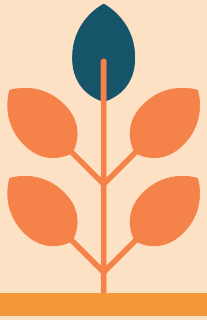
Weaknesses

- Complex and costly certification and licensing, involving multiple agencies (KEBS, NEMA, KFS, NCA) with unclear processes and a recognition gap for biogas technicians.
- Lack of awareness among consumers and even police about briquettes' advantages and proper use, leading to low adoption and confusion with charcoal.
- Lack of ideal machinery and drying technology (reliance on screw presses, absence of airflow dryers, limited access to higher tier biochar kilns), which, together with seasonal feedstock variation and poor infrastructure, keeps production low and unreliable.

Threats

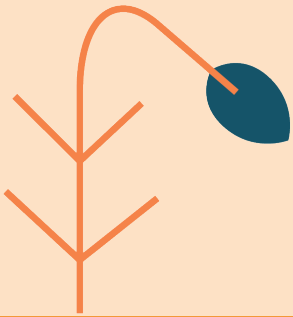
- Lack of sector specific funding, insufficient product awareness, and complex certification/licensing were identified as the three main barriers to growth.
- Strong competition and policy influence from LPG suppliers, the lifting of the charcoal ban (reducing briquettes' comparative advantage), and exposure to "cartel like" control of export channels.
- High and rising operating costs (electricity, transport, multiple county fees), non uniform county regulations, and weak enforcement of existing clean cooking

2.3 Key Opportunities for Expansion



- **Enabling environment (industry association)**
  Create or strengthen a dedicated industry association that can lobby for supportive policies, simpler licensing and VAT/ tax exemptions, while also promoting self regulation on quality and safety instead of relying only on fragmented individual efforts.
- **Markets (export focus)**
  The cluster can significantly expand by systematically exploring and entering export markets, especially in regions already demanding sustainable solid fuels, using collective branding, shared logistics and compliance with international standards.
- **Capacity building (technology transfer and training)**
  Targeted capacity building through technology transfer, hands on training and business support can upgrade MSMEs' skills and equipment, improving product quality and reliability and enabling them to access larger domestic and international markets more competitively.

2.4 Key Barriers for Growth



- **Lack of sector specific funding mechanisms**
  There are no dedicated financial products for briquette/ bioenergy MSMEs, leading to high upfront capital burdens (equipment, licenses, facilities) and no consumer or institutional financing options.
- **Insufficient product awareness and market sensitization**
  Most consumers and even authorities do not understand briquettes' benefits or how to use them properly, leading to low adoption, confusion with charcoal and weak, fragmented market linkages.
- **Complex certification and licensing requirements**
  Enterprises face multiple agencies (KEBS, NEMA, KFS, NCA), unclear processes, high compliance and pre operation costs, county by county variations and a recognition gap for biogas technicians, all of which slow or block formalization and scaling.

2.5. Ideal Situation for the businesses

Cluster members aspire to mainstream bioenergy use in households, institutions, and industrial processes, supported by strong cluster platforms, shared infrastructure, coherent policy frameworks, and technical support. The ultimate goal is a climate-smart bioenergy sector recognized for green jobs, circularity, and its contribution to national energy security.

2.6. Enablers, Lead Institutions, and Policy Actions

ISSUE	INSTITUTIONS	POLICY ACTIONS
Trade license (costly, fragmented county processes that slow or discourage formalization of SMEs)	County governments, KNCCI	• Develop a harmonized digital one stop licensing platform across counties; • Introduce reduced or tiered license fees and targeted tax incentives for bioenergy MSMEs; • Train county officials on bioenergy business models and timelines.
Finance (high upfront capital needs and lack of tailored financial products for bioenergy MSMEs)	KFS, KEPSA, NCA, EPRA, NEMA, NACOSTI/ NRF, banks, SACCOs, DFIs	• Create dedicated innovation funds for bioenergy (grants and R&D), blended finance windows, • Asset financing products using equipment as collateral; • Align tax incentives (holidays, capital allowances, duty/VAT relief) with these financial products.
Market access (weak links to buyers and high distribution/ logistics barriers, especially for MSMEs)	NGAAF, Women/ Youth funds, SACCOs, logistics firms, county investment portals	• Support pooled logistics and shared warehouses/depots in key towns; • Roll out standardized producer stickers/ passes to reduce roadside harassment; • Use women/youth funds and SACCOs to co finance last mile distribution and institutional supply networks.
Brokers / extortion (informal middlemen and rent seeking increasing costs and undermining trust)	KNCCI, KENInvest, media, enforcement agencies	• Strengthen formal B2B channels (trade fairs, digital marketplaces, investment portals); • Use chambers and associations to document and escalate extortion cases; • Publish clear fee/cess schedules and run media campaigns on legal vs. illegal charges.
Certification (complex, costly, multi agency compliance requirements that overwhelm small producers)	KEBS, NEMA, universities, TVETs	• Fast track development and revision of briquette, biochar, and biogas standards; • Provide subsidized/shared testing facilities and mobile labs; • Define clear pathways and local expertise for carbon certification and MRV support.
Policy (fragmented or weakly implemented policies and incentives for modern bioenergy)	Ministry of Energy, KPLC, KAM, KFS, EPRA, related agencies	• Embed explicit bioenergy and clean cooking, and biofuel blending targets in national and county energy policies and procurement; • Harmonize incentives across agencies (tariffs, taxes, grants); • Integrate briquettes, biogas, and biochar into public procurement frameworks.

Safety (limited sector specific OHS guidance, creating risks for workers and enterprises)	DOSH, OSHA, NCA, county governments, industry association	• Develop tailored OHS guidelines and checklists for bioenergy plants; • Link safety audits to financing and incubation support; • Conduct joint inspections and trainings focused on practical improvements rather than punitive closures.
Infrastructure (inadequate power, roads, and industrial facilities for efficient bioenergy production and distribution)	National & county governments, KPLC, KERRA, KURA	• Prioritize upgraded processing hubs/ light industrial zones with reliable power, water, and storage; • Identify and improve key transport corridors linking biomass sources to hubs and markets; • Support grid/mini grid connections and productive use tariffs.
Foreign investment (mobilization of international capital and technology into local bioenergy MSMEs)	SEI, KEPSA, investment agencies, business councils, bilateral chambers	• Facilitate joint ventures and B2B matchmaking between local MSMEs and foreign firms; • Package and promote bankable bioenergy projects to green/climate finance and impact investors; • Structure tech transfer partnerships with clear local training and after sales support.
Abbreviations are provided in the annex		

2.7. Milestones: 2030 and 2040

By 2030

- 10% total energy mix supplied by sustainable bioenergy; 1,000 biogas systems operational; 50% reduction in unsustainable charcoal use.
- 10,000 green jobs created; 30% of waste valorized; robust bioenergy certification; regional/county integration.
- Decentralized innovation funding (NACOSTI/NRF, KIRDI).

By 2040

- 25% of national energy supplied by bioenergy; complete elimination of unsustainable charcoal; 50,000 direct/indirect green jobs.
- Bioenergy industrial park/hub in every county; major fossil import reduction; Kenya as regional innovation hub.

ANNEX

List of members and enterprises Cluster 4: Sustainable Biofuels

	NAME	ORGANIZATION
1	Karisa Chrispine Sirya	Natural Char Energy
2	Mary Wambua	Gemari Ventures
3	Emmanuel Muchule	Mama Moto
4	Grace Wahu	Ecostrides
5	David Karani	Kafas Green Energy
6	Festus Ngugi	Kings Biofuels ltd
7	Donbosco Manene	Big Organic naturals
8	Anthony Ochieng	Biogold Energy
9	Cody Danet	Riziki Nature Based Solutions-EA
10	Miriam Maina	Riziki Nature Based Solutions-EA
11	Justus Masha	Migas
12	Miral Morjaria	Riziki Nature Based Solutions-EA
13	Priscilla Adhiambo	NairoBits Trust
14	Emmanuel Muchuke	Almost waste Solutions
16	Gilbert Mato	Rangeland Reseedlings solutions

ABBREVIATION / ACRONYM LIST

ABDK	Advancing Bioeconomy Development in Kenya Bioeconomy
ABPP	Africa Biogas Partnership Programme
B2B	Business to Business
DFI	Development Finance Institution
DOSH	Directorate of Occupational Safety and Health
EPRA	Energy and Petroleum Regulatory Authority
EBK	Engineering Board of Kenya
EPZ	Export Processing Zone
KAM	Kenya Association of Manufacturers
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Research Institute
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KFS	Kenya Forest Service
KIRDI	Kenya Industrial Research and Development Institute
KNCCI	Kenya National Chamber of Commerce and Industry
KPLC	Kenya Power and Lighting Company
MSME	Micro, Small and Medium Enterprise
NACOSTI	National Commission for Science, Technology and Innovation
NCA	National Construction Authority
NEMA	National Environment Management Authority
NRF	National Research Fund
NGAAF	National Government Affirmative Action Fund
OHS / OSHA	Occupational Health and Safety / Occupational Safety and Health Act
R&D	Research and DevelopmentBioeconomy-Cluster-4-Roadmap-Final.docx
SACCO	Savings and Credit Cooperative Organization
SEI	Stockholm Environment Institute
SEZ	Special Economic Zone
Sida	Swedish International Development Cooperation Agency
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities, Threats
TVET	Technical and Vocational Education and Training
VAT	Value Added Tax