

Circularity and Waste Minimisation in Nyanza

*Investment Recommendations
Informed by Global Best Practices
in 4R Philosophy and Green
Initiatives*

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Nashon J. Adero – nashon.adero@gmail.com

Department of Mining and Mineral Processing Engineering
(MMPE)

Taita Taveta University (TTU)



Circularity and Waste Minimisation



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The Challenge: *Why Circular Economy?*

Circular Economy (CE) is **regenerative**, unlike the take-make-waste model or the **cradle-grave model** of a **linear** economy.

❑ **4R Philosophy:** Reduce, Reuse, Recycle, Recover/Regenerate

❑ **SDGs:** mainly 12, 13, 15

McKinsey Global Institute:

❑ Some sectors are harder to **decarbonise** than others, e.g., **plastics, cement, steel**, captive coal, shipping, road freight, railway electrification, and electricity generation

❑ **Plastics:** Only **10%** of plastics is **recycled**, 7% incinerated. **Micro- & nano- plastics** a threat to aquatic life & humans thro' **bioaccumulation** and **biological magnification**

Purpose and Context



Purpose:

Demonstrate why Nyanza's waste streams—covering **agricultural** residues, **plastic**, **e-waste**, and **invasive species**—present **significant investment potential**

Position circular economy practices as a path towards **sustainable development**, aligning with wider African innovations and Agenda 2063



Global Waste Generation:

Globally, approx. **2 billion tonnes** of **municipal solid waste** produced each year – excludes industrial waste, hazardous waste, or construction and demolition debris (World Bank).

Average municipal solid waste generation was estimated in 2018 at **0.74 kg per capita per day** worldwide but set to rise substantially by 2050 with urban growth (World Bank), current estimate (2024) **0.80 kg/capita/day**.

Global recycling rate stands at around **14%**, highlighting the scope for improvement (World Bank).

Africa's Situation

Africa generated about **174 million metric tonnes** of municipal solid waste in 2016, to triple by 2050 (World Bank; Mbutia, 2025).

Current estimate (2020s): **250 million metric tonnes** per year and rising with population and urbanisation.

Average per-capita waste generation in Africa about **0.54 kg per day** in 2023—lower than the global average but increasing rapidly due to urbanisation.

Waste collection rate of **55%**, below global average (**74%**) (Mbutia, 2025).

The continent's overall waste recycling rate remains **below 10%** (UNEP, 2020); **4%** though **70-80%** is recyclable (Mbutia, 2025).

Innovations—such as recycling kiosks and automated deposit schemes—are emerging (Mbutia, 2025).

Kenya's Context

Kenya produces around **8 million metric tonnes** of solid waste annually, with only **8–10%** recycled or recovered (Muthia, 2023).

Nairobi alone generates over **2,400 tonnes** of solid waste daily, half of which remains uncollected (UN-Habitat, 2022; Mbutia, 2025).

Waste-to-energy projects are starting to gain traction, including plans for a facility that can process **1,400 tonnes** of refuse daily to generate **15 megawatts** (MW) of electricity.

Nyanza Region Overview

- As a **sugarcane** and **cereals** belt, Nyanza produces substantial **agricultural residues** (bagasse, husks) and faces a rising stream of **plastic**, **e-waste**, plus invasive **water hyacinth** in Lake Victoria.
- Recycling rates remain **under 10%** in most Nyanza counties (Kisumu County, 2018; Migori County, 2019).
- This **untapped potential** for recovery, recycling, and energy generation makes a strong **business case** for investors.

08/02/2025

Circularity and Waste Minimisation - Nashon Adero



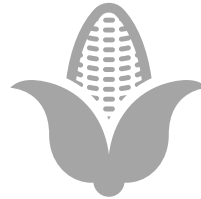
Key Waste Streams in Nyanza



1. Sugarcane Residues (Bagasse & Tops)

Over **1.3 million metric tonnes** of sugarcane annually in counties like Kisumu, Migori, and Homa Bay (KNBS, 2019).

Bagasse is a **bioenergy feedstock**, capable of powering combined heat and power systems.



2. Cereal Husks and Crop Residues

Maize, sorghum, and millet cultivation leads to **20–30%** of harvest mass as agricultural waste (Homa Bay County, 2018).

Potential for **composting**, **animal feed**, and **biofuel** production.



3. Water Hyacinth

Over **10,000 hectares** of Lake Victoria has been infested (Migori County, 2019).

Jaramogi Oginga Odinga University – Enactus Club: **briquette production** from hyacinth, providing **clean cooking fuel**.

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4. Plastic Waste

- Plastic accounts for roughly **12%** of municipal solid waste in Kisumu (KNBS, 2019).
- Recycling innovations—such as “**reverse vending**” kiosks that give refunds for returned bottles—are gaining attention in African cities.

5. Electronic Waste (E-waste)

- E-waste is on the rise; Kisumu County alone generates **800–1,000 metric tonnes** per year (Kisumu County, 2018).
- E-waste makes up **2-3%** of total solid waste but represents **70%** of the toxic waste in landfills—highlighting the dangers if left unmanaged.
- **Gold, silver, palladium, and platinum can be recovered from e-waste.**

Global Innovations Relevant to Nyanza

1. Data-Driven Waste Management

- **Real-time route planning & optimisation** can lower municipal collection costs by **15–20%, 35% in Seoul** (Mbuthia, 2025)
- **Smart IoT-sensor-based bins** and mobile apps ensure fill-level alerts and efficient pickups and disposal tracking, e.g., in Kigali, Barcelona – 30-40% efficiency improvements including cost cutting

2. Solar-Powered Composters/Compactors

- Emerging technology in parts of Africa, harnessing **solar energy** to speed up **composting** and **compress** trash
- Ideal for **organic waste streams** (food, crop residues) in rural and semi-urban areas

3. Waste Recycling Initiatives

- **Reverse logistics programmes** and deposit-refund kiosks help retrieve end-of-life devices
- **Extended Producer Responsibility (EPR)** frameworks support cost-sharing across manufacturers and importers, e.g., PETCO – South Africa
- **Chemical recycling** of complex plastics: Japan, South Africa
- **AI and robotics in waste sorting:** *Tomra Sorting Solutions* (Norway), *ZenRobotics* (Finland), *AMP Robotics* (USA)
- **UAVs** for efficiency and safety enhancement

Sweden turns 50% of household waste into energy and even imports waste! **Ethiopia's Koshe-Reppie Waste-to-Energy (WtE)** facility processes **1,400 tonnes of waste per day** to produce **25 MW** of electricity.

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4. Plastic in Road Construction (India & Nepal)

Shredded plastic mixed with bitumen results in **more durable roads** (Asian Development Bank, 2021): **2 metric tonnes** builds **1 km of paved road**.
Reduces plastic pollution and offers an **alternative asphalt binder**.

5. Industrial Ecology in Denmark

Kalundborg Symbiosis: Companies exchange by-products (heat, water, materials) to reduce waste (Ehrenfeld & Gertler, 1997).
Adaptable to **sugar-processing, brewing, or packaging** industries in Nyanza.

6. Waste-to-Energy (WtE) Facilities

WtE plant can process **1,400 metric tonnes** of waste daily to generate **25 – 30 MW** of electricity.
Scalable in Nyanza, leveraging **bagasse, water hyacinth, and municipal waste**.

Innovative Reuse of Plastic by Enactus Club, Taita Taveta University (TTU)



PROJECT TITLE: Reducing the environmental footprint of plastic waste by making Ottomans from used plastic bottles

PROJECT NAME: TUNZA MAZINGIRA

UNIVERSITY: TAITA TAVETA UNIVERSITY (TTU)

PRESENTERS:

DENNIS NGASI
PAUL NJINU
LACENA AMANDA

Patron & Faculty Advisor:
Nashon Adero
Lecturer, Taita Taveta University

The winning
project for
the 2022
National BIC
Education
Challenge

Investment Opportunities in Nyanza



Waste-to-Energy (WtE) Plants

1. Biogas & Biomass: Convert sugarcane bagasse, cereal husks, and water hyacinth into electricity or heat for local communities.

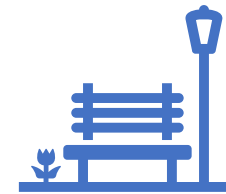
Potential to replicate Ethiopia's **25 MW** success story at scale.



Plastic Road Surfacing

2. Collaborate with county public works to pilot and scale **plastic-bitumen road projects** in rural areas.

Reduces plastic litter while improving road lifespan.



Industrial Ecology Parks

3. Co-locate industries to **share resources: sugar mills, breweries, packaging plants.**

Emulate Denmark's Kalundborg to reduce costs and environmental impact.

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4. Briquette Production

- Partner with **Jaramogi Oginga Odinga University** to industrialise **water hyacinth** briquettes.
- Reduces deforestation, offers alternative livelihood for local communities.

5. Data-Driven Management & Solar Composting

- Introduce sensor-equipped collection bins and route-optimisation software to cut operational costs.
- Set up **solar-powered composters** for food and agricultural waste, especially in rural markets.

6. E-waste Recovery & Recycling

- Establish specialised centres for refurbished electronics, safe extraction of precious metals, and responsible disposal.

Implement deposit-refund schemes to incentivise collection

Implementation Roadmap

Short-Term (0–2 years)

- Conduct feasibility studies on WtE, plastic roads, and industrial ecology clusters.
- Pilot **solar composters** in smallholder farming communities.
- Initiate deposit-refund schemes for e-waste and plastic packaging

Medium-Term (3–5 years)

- Scale up pilot successes to multiple sub-counties; build local expertise.
- Formalise EPR legislation at county level for plastics and e-waste.
- Deploy AI and data-driven monitoring to streamline waste collection and resource recovery.

Long-Term (5+ years)

- Develop industrial ecology parks across Nyanza.
- Integrate circular economy objectives into **County Integrated Development Plans (CIDPs)**.
- Position Nyanza as a **national hub** for green manufacturing, renewable energy, and ecological innovation.

Business Case for Investment

High Waste Generation, Low Recycling Rate

- Nyanza's waste volumes, combined with under-10% recovery (Kisumu County), reveal **substantial room** for profitable interventions.

Energy and Environmental Returns

- WtE facilities can provide **clean energy** (25+ MW in some examples), while solar composting cuts methane emissions.
- Plastic roads reduce maintenance costs and demand for virgin asphalt.

Social and Economic Impact

- New ventures can create **green jobs**, enhance sanitation, and improve public health.
- Grassroots solutions (hyacinth briquettes, deposit kiosks) empower local communities economically and environmentally.

Supportive Policy Environment

- Growing recognition of EPR, data-driven management, and circular economy in Kenyan law.
- Kenya's success with plastic bag bans signals **political will** for broader waste reforms.

R&D: Decision Support Model for Green Public Procurement

DECIDE ON THE CRITERIA
FOR MULTI-STAKEHOLDER
ENGAGEMENT AND
ARRIVING AT RATIONAL
OUTCOMES

(GREENING) POLICY MUST
ENSURE DIRECTION,
COHERENCE, AND
CONTINUITY

EXAMPLE ON PROCURING
GREEN PRODUCTS – ALSO
SEE NEXT SLIDE FOR
PARAMETERS

Example of weighted criteria for procurement of green products

Social/human rights 30%

- i. abuse of child labour in production processes,
- ii. abuse of gender rights in production processes,
- iii. abuse of labour rights of employees,
- iv. corporate social responsibility/community services,
- v. visual intrusion and noise pollution levels,
- vi. public health and safety considerations in design and production,
- vii. upholding of ethical values/professionalism/honest communication,
- viii. cultural heritage values,
- ix. care for vulnerable groups – PWDs/senior citizens/children/women,
- x. extended producer responsibility/warranty reputation,
- xi. reputation for quality on the market,
- xii. space requirements for operation.

Environmental 30%

- i. energy star/consumption rating,
- ii. energy consumed per unit of production,
- iii. carbon dioxide emissions per unit of product or service,
- iv. water used per unit of production,
- v. fibre used per unit of production,
- vi. avoidance of use of polluting/harmful reagents/chemicals,
- vii. land use efficiency with minimal degradation or fragmentation,
- viii. potential to reduce heat emissions/global warming,
- ix. impact on air quality,
- x. distance travelled to reach the consumer/farm-to-fork,
- xi. sensitivity to biodiversity conservation.

Techno-economic 40%

- i. frugality/affordability/cost-saving qualities,
- ii. use of local materials,
- iii. application of indigenous knowledge and local capacity,
- iv. age of the technology used,
- v. labour productivity costs,
- vi. service life/durability,
- vii. support for a sharing digital economy model,
- viii. business model innovation,
- ix. product innovation level,
- x. organisational culture,
- xi. taxes.

Transport

Diesel Prado (2014), j_2

i= 1 2 3 4 5 6 7 8 9 10 11 12

24.55

7.27

3 3 3 2 2 3 2 3 3 1 2

27.88

19.39

2 1 1 3 2 2 2 3 3 3 1

20.00

15.00

2 2 1 1 2 3 2 1 2 3 2 3

72.42

41.67

0 1 1 1 1 1 1 0 0 2 0

$$G_j = \frac{W_e}{33} \sum_{i=1}^n e_i + \frac{W_t}{33} \sum_{i=1}^n t_i + \frac{W_s}{36} \sum_{i=1}^n s_i$$

Green office block (water, energy, natural lighting, waste separation and implementing the Rs), j_3

Conventional concrete office block (using groundwater, mains electricity from oil, light all day, no waste separation or recycling, imported materials), j₄

i= 1 2 3 4 5 6 7 8 9 10 11 12

24.55

9.09

3 3 2 2 2 3 2 3 3 2 2

30.30

19.39

1 3 2 3 2 3 2 3 3 2 1

25.00

17.50

2 2 2 2 3 3 2 3 3 2 3 3

79.85

45.98

Brown

Red

Conclusion and Implication for Stakeholders

Integrated Approach: Harnessing Nyanza's sugarcane/cereals residue, water hyacinth, plastic, and e-waste streams through 4R strategies can **transform waste into wealth**.



Innovations Underway: From reverse vending kiosks to solar-powered composters and data analytics, Africa-wide breakthroughs can inform Nyanza's next steps.



Call to Action

Expand feasibility studies, secure investor engagement, and leverage pilot programmes.

Institutionalise circular principles for lasting environmental, social, and economic benefits in Nyanza.