



nema
mazingira yetu | uhai wetu | wajibu wetu

ENVIRONMENTAL BEST PRACTICES IN WASTE MANAGEMENT



Foreword

Waste management is a major challenge in Kenya, especially in rapidly growing urban metropolises and coastal areas. Nairobi for example, produces around 2,400 tons of waste every day, of which only 38 per cent is collected and less than 10 per cent recycled.

The remaining 62 per cent is disposed of at the dumpsites, illegally dumped on roadsides and waterways, or burned and this releases toxic air emissions and particulate matter. Dumping and burning is particularly common in low-income areas of urban areas, which are home to over 2.5 million people. There is need to take advantage of income generating opportunities from waste, such as recycling and composting. According to the Kenya National Climate Change Action Plan 2018-2022, “the volume of solid waste generated across Kenyan urban centers increased from 4,950 tonnes per day in 2011 to 5,990 tonnes per day in 2014;” a rate faster than the country’s urbanization rate. The need for integrated sustainable waste management is accentuated by growing industrialization of the economy, and inappropriate disposal of solid waste.

The country has intervened through the development of the National sustainable waste management policy and sustainable



waste management bill, National Waste management regulation 2006 and strategy as well as waste guidelines.

The Authority recognizes the efforts of the private sector, community based organizations, industries, learning institutions and individuals who have made a great contribution in addressing different streams of waste by recycling, reuse and reducing.

This booklet features a few of the techniques and technologies that have been developed. This booklet adds to the many publications that the Authority has published to enhance awareness creation on waste management in Kenya.

I call on all stakeholders to replicate the initiatives highlighted in this booklet and develop such more innovations in order to reduce the amount of the waste that goes to the disposal sites and into our environment.

A handwritten signature in blue ink, appearing to read 'Mamo B. Mamo'. The signature is fluid and cursive.

**Mamo B. Mamo, EBS
Director General**

Introduction

Each year, people around the world dump a staggering 2.12 billion tons of waste. One of the biggest reasons for this astounding amount of waste is that human beings trash approximately 99% of everything they purchase within six months.

Every Kenyan generates about half ($\frac{1}{2}$) kilogram of waste daily which translates into 22 metric tons of waste generated per day, 8 million tons annually while only 70% of that waste is collected and dumped'. In Nairobi, an estimated 2400 tonnes of solid waste is generated every day. While most of the waste generated is biodegradable, plastic waste account for about 20%, and only 45 % of the plastic waste is recycled.

Waste can be classified based on where it is collected. . This may include industrial waste, domestic waste, agricultural waste and Municipal waste. Waste can further be classified as Liquid Waste (commonly found both in households as well as in industries), Solid waste (which include Plastic waste, Paper/card waste, Tins and metals, Ceramics and glass), Organic Waste (food waste, garden waste, manure, rotten meat and agricultural waste), Recyclable waste (paper, metals, furniture and organic waste) and Hazardous Waste (all types of waste that are flammable, toxic, corrosive and reactive).

Accumulated waste deposits are an indication of societal lifestyles, waste management practices and production technology in place. Some societies at the peak of their development have stagnated due to inadequate management of their waste leading to proliferation of diseases, environmental degradation and ultimate adverse impact on livelihoods.

Improper management of waste poses a threat to Climate Change and eventually to the achievement of sustainable development. Waste being one of the

contributors of greenhouse gases, affects climate change and it is for this reason that as a country, we should embrace sustainable waste management technologies and initiatives to curb this growing global challenge.

Efficient and sustainable waste management systems are required as the country develops into a newly industrialized state by the year 2030. National Environment Management Authority (NEMA) aspires to assist the public and institutions in Kenya to be **7R** oriented by **Reducing; Rethinking; Refusing; Recycling; Reusing; Repairing and Refilling** their waste.

Waste management is the responsibility of everyone (individuals, communities, businesses, industries and government). Several individuals and organizations have taken it upon themselves to ensure that the waste generated by them and others is used as a resource that can be put into meaningful use eventually enhancing their livelihoods as they save the environment.

The Objectives of this booklet are;

1. To document and showcase some of the waste management best practices in Kenya.
2. To promote adoption of best practices in waste management so as to improve environmental management and enhance livelihoods.
3. To educate and create awareness to the public on waste as a resource.
4. To influence behavior change amongst the public towards sustainable waste management.
5. To link the public to organizations that promote best waste management practices.
6. To catalyze the public to explore other best practices in waste management that exist in Kenya.

Best Practices In Waste Management In Kenya.

The case studies of waste management in Kenya reflect on waste segregation and recycling to make new products which are useful and long lasting. Separation of waste at source will aid in extracting recyclable materials with ease because cleaning of recyclables commingled with other waste is expensive. The following are a few best practices in Kenya.

A) WASTE TO ENERGY

Waste to Energy refers to technologies that treat waste to recover energy in the form of heat, electricity or alternative fuels such as biogas. The scope is wide, encompassing a range of technologies of different scales and complexity. These technologies may include **(a) anaerobic digestion**, the production of cooking gas in household digesters from organic waste, **(b) landfill gas**, collection of methane gas from landfills, **(c) incineration**, thermal treatment of waste in utility size incineration plants, **(d) co-processing**, co-processing of Refuse Derived Fuel (RDF) in cement plants and **(e) alternative technologies (pyrolysis/gasification)** or gasification. These technologies apply to different waste streams and have different functions and characteristics, therefore their applicability must be assessed independently based on the local context and waste stream in question. The most highly used waste to energy technology in Kenya is Biogas Production both at home, schools and community level.

Biogas Production Technology:

This is the anaerobic digestion (AD) decomposition of organic matter through microorganisms in the absence of free oxygen. A gas-tight reactor, the so-called anaerobic digester, is used to provide favourable conditions for microorganisms to turn organic matter, the input feedstock, into biogas and a solid-liquid residue called digestate. The digestate can be used as organic fertiliser when the feedstock is source separated and non-contaminated organic waste. Biogas is a mixture of both methane and carbon dioxide –and serves as a high-energy renewable fuel that can be used as a substitute for fossil fuels and which can be converted into thermal and/or electrical energy.

Biogas production is a highly sustainable energy option as it aims at phasing out households' dependence on fuelwood and charcoal. This is a great boost towards improving household health and sanitation (biogas is a clean, smokeless fuel) and provides on-demand energy for cooking and boiling water.

Benefits harnessed from Biogas production include: Reduction in carbon emissions by 73,623 tonnes, mainly by reducing the use of firewood and charcoal, cleaner energy technology is expected to benefit a huge number of citizens as time wasted in collecting firewood will be used for alternative chores. This will greatly improve quality of life, creating jobs in the new market of biogas-related services.



A Floating Drum Biogas

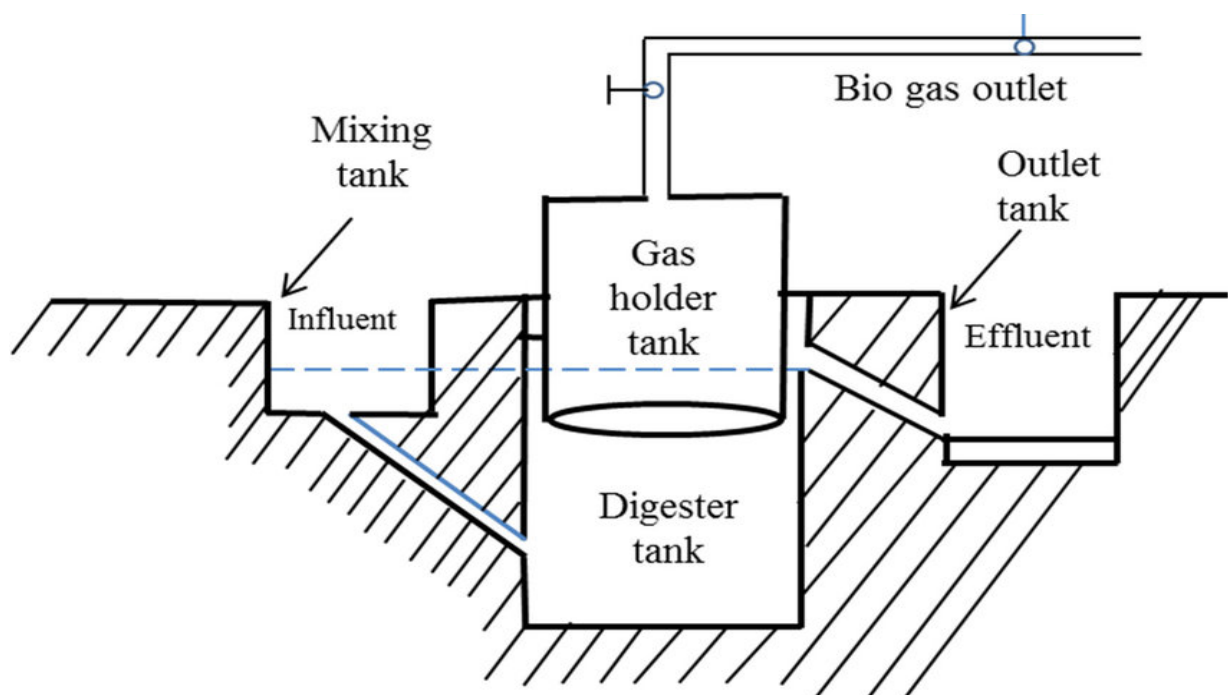


Fig 1. Illustration of a biogas plant

EXAMPLES OF BIOGAS PRODUCTION PROJECTS

I. KEEKONYOKIE SLAUGHTER HOUSE

Keekonyokie slaughter house is located in Kiserian, north of Nairobi. It provides slaughter services to livestock traders, meat brokers and butchers. It is an integrated business incorporating meat processing, cold storage, hides and skins and intestinal meats that is popular with

the bottom market segment.

In 2005, the company constructed a fixed dome biogas plant to convert the liquid animal waste into useful new products. This was part of an effort to fulfil National Environmental Management Authority (NEMA) requirements for slaughterhouses to stop the discharge of waste water in rivers causing environmental degradation.



ACHIEVEMENTS:

- Supply of biogas to local communities as cheap cooking gas to replace the charcoal obtained from cutting of trees. The new product prototype consists of a gas cylinder that can be refilled after use.
- The biogas is being used to generate electrical power for the meat cold room, meat processing equipment and hot water for sterilizing and washing the abattoir.
- The bio slurry obtained from the biogas production plant is used as fertilizer by the farmers thus replacing chemical fertilizers which are more expensive and environmental unfriendly.

II. GORGE FARM ENERGY PARK IN NAIVASHA.



Gorge Farm operates according to the principle of “no waste is waste”, therefore all the green waste generated from the field and vegetable packing houses from the surroundings is used to generate 5 megawatts of electricity through the Biojoule plant on location. The power generated is partly used on the farm and partly sold to the national grid. The Bio-

joule plant has greatly improved waste management, as waste was formerly simply dumped anywhere, thus polluting the waters of lake Naivasha.

This is Africa’s first grid connect Anaerobic Digester plant. The electricity generated is enough to cultivate its many hectares of vegetables and flowers and enough to power up to 5,000- 6,000 rural homes. For \$0.10/kWh, the firm signed an agreement to sell electricity to the country’s power distributor, Kenya Power.

The firm’s achievements include; creation of employment opportunities, production of both electricity and heat in a process called cogeneration. Heat produced is used in the farm’s greenhouses, direct supply of electricity to the national grid and sustainable, alternative energy source to electricity.

B) PLASTIC RECYCLING

Plastic recycling is the reprocessing of plastic waste into new products. When performed correctly, this can reduce dependence on landfill, conserve resources and protect the environment from plastic pollution and greenhouse gas emissions. Although recycling rates are increasing, they lag behind those of other recoverable materials, such as aluminium, glass and paper. The global recycling rate in 2015 was 19.5%, while 25.5% was incinerated and the remaining 55% disposed of to landfill. Recycling is necessary because almost all plastic is non-biodegradable and thus builds-up in the environment, where it can cause harm to both plants and animals including humans.

There are several plastic recycling technologies which are:

Mechanical recycling which refers to the processing of plastic waste into secondary raw materials or products without significantly changing the material’s chemical structure. In principle all

types of thermoplastics (plastics that can be softened through heating and re-shaped many times) can be mechanically recycled with little or no impact on quality and is the most widespread form of recycling.

Thermoplastics



Chemical Recycling covers a set of technologies (pyrolysis, gasification, hydro-cracking, depolymerisation) that change the chemical structure of plastic waste. Long hydrocarbon chains constituting plastics are broken down into shorter hydrocarbon fractions using chemical, thermal, or catalytic processes. These shorter molecules are ready to be used as feedstock for new chemical reactions to produce new recycled plastics and other chemicals. Pyrolysis is a common technique used to convert plastic waste in the absence of oxygen into energy, in the form of solid, liquid and gaseous fuels and into liquid oil.

Dissolution Recycling is a purification process through which the polymer in a mixed plastics waste is selectively dissolved in a solvent, allowing it to be separated from the waste and recovered in a pure form without changing its chemical nature.

Organic recycling is defined as the controlled microbiological treatment of biodegradable plastics waste under aerobic conditions (composting) or anaerobic

conditions. It applies to specific polymers that can be converted, under the actions of microorganisms, into stabilized organic residues, carbon dioxide, methane and water.

Due to costs limitations mechanical recycling technology of plastics recycling is the most commonly used in Kenya.

Plastic polymers recycling is often more challenging because of low density and low value. Almost all plastics are non-biodegradable and hence builds up on the environment. This waste ends up harming the natural earth biodiversity and when it ends up in water bodies, is a huge threat to the aquatic ecosystem. Until 2015, the world has produced some 6.3 billion tonnes of plastic waste, while only 9% of which has been recycled, and only 1% has been recycled more than once.

Mechanical recycling and feedstock recycling are the two main methods used. Mechanically, the plastic waste is sorted by colour and polymer before being reprocessed while in feedstock recycling, the plastics are converted back to its original chemicals.

There are seven main categories of plastic material namely;

- Polyethylene terephthalate (PET)- used mainly for packaging e.g. water bottles
- High density polyethylene (HDPE) which is used to make plastic bottles, corrosion resistant piping.
- PVC used to manufacture plastic pipes and cards such as bank cards.
- Low density polyethylene (LDPE) mainly used to manufacture plastic parts for computer components.
- Polypropylene (PP) used to manufacture high purity piping system e.g. laboratory equipment.
- Polystyrene (PS) used as packaging materials and for making foam cups, tumblers and disposable cutlery.
- Other.

Examples of Plastic Recycling Companies

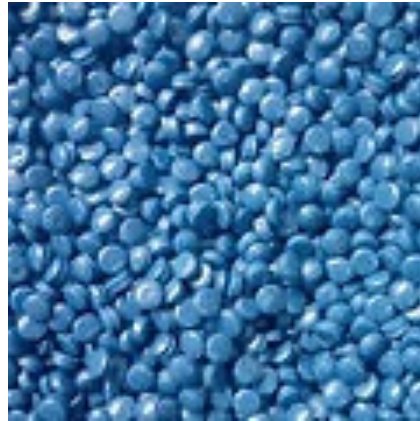
i. Mr. Green Africa



Mr. Green Africa is a Nairobi-based recycling company whose vision is to change people's perceptions towards waste. Mr. Green Africa aims to close the loop from consumer to plastics manufacturer through its supply network and high value recycled plastics.

The company incorporates the concept of shared value—creating economic value while addressing social and environmental challenges—into its core, by harnessing the untapped potential of an existing informal waste management industry. It has a processing equipment that allows them to convert locally collected plastic waste in to high quality Post Consumer Recyclates (PCR) which is sold as a usable raw material for manufacturing at very competitive rates.

The company has improved the livelihoods of waste pickers, who play a vital role in the reclamation of recyclable materials; they mainly pick the plastics from homes and dumpsites. The waste pickers are paid for the plastic they pick and deliver to the company.



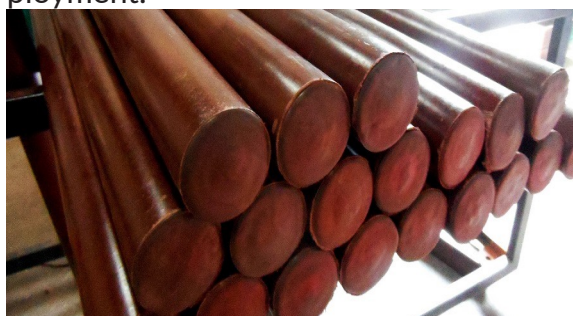
Plastic Pellets

ii. EcoPost Limited

EcoPost uses 100% recycled plastics to make aesthetic, durable and environmental friendly plastic lumber for use in applications ranging from fencing to landscaping and other beautification items.

EcoPost obtains their raw materials from a number of sources including, garbage collection companies, furniture manufacturers (timber yards, saw mills), youth and women groups involved in collecting plastic waste recyclables, waste collection yards in all the major towns of Kenya, county officials dealing with waste management, private individuals able to source more than 1 tonne of plastic waste every week and any other companies which generate plastic waste and would like a safe and secure means of disposing it.

EcoPost prides itself in the ability to address the challenges of urban waste management (plastic pollution), deforestation and climate change, while at the same time tackling chronic youth unemployment.



Plastic Fencing Posts

C) E-WASTE RECYCLING



E-waste is short for electronic waste, that is trash generated from broken, obsolete, and surplus electronic devices sometimes people refer to it as e-scrap. These electronics often contain toxic chemicals and hazardous materials and when not disposed properly they can cause the release of toxic substances into our environment. E-waste recycling then refers to the reprocessing and re-use of these electronic wastes. It is a process that seeks to recover material from electronic waste and use them in new electronic products.

These electronic wastes may be in the form of home appliances like air conditioners, televisions, electric cookers, heater, DVDs, fans, microwaves, and radios. They may also be in the form of information tech equipment like your computers, laptops, mobile phones, batteries, hard disks, circuit boards, monitors.

Kenya generates an average of 3,000 tons of e-waste each year from computers, monitors, printers, mobile phones, fridges, batteries and other electronic devices. Waste of electrical and electronic equipment can be classified as solid waste if they have reached the end of their user life whether it is a household item or non-household item and cannot be put into any more use.

Lack of e-waste awareness creation, along with poor separation and disposal systems, has led to e-waste being mixed with ordinary waste in dumpsites. According to the UN's Global E-waste Monitor 2020, the world generated 53.6 million tons of electronic waste in 2019 alone,

with Africa recycling less than 0.1% of its electronic waste annually.

Recycling of e-waste is a growing trend and was initiated to protect human and environmental pollution impacts of e-waste.

Recycling electronics is an often challenging activity, because e-scrap are typically sophisticated and manufactured from diverse elements such as metals, batteries, plastics, and glass. While this process often varies, there is a general process:

Step 1: Collecting and Transporting

This is the first stage of recycling e-waste. Here, recyclers place take-back booths or collection bins in specific places. When these bins get filled, the recyclers then transport the e-wastes to recycling facilities and plants.

Step 2: Shredding and Sorting

The next step is to shred and sort the e-waste. The success of subsequent separation relies on shredding. Shredding involves breaking e-waste into smaller pieces for proper sorting. With the use of hands, these tiny pieces get sorted and then manually dismantled. This is typically labor-intensive as waste items are, at this stage, separated to retrieve different parts.

Step 3: Dust Extraction

The tiny waste particles get smoothly spread via a shaking process on the conveyor belt. At this point, the dust gets extracted and discarded in an environmentally compliant manner. This way, there is no environmental degradation.

Step 4: Magnetic Separation

A strong overhead magnet helps to separate steel and iron from other wastes. However, some mechanical processes may sometimes be required to separate circuit board, copper, and aluminum from

other wastes particles. And this is especially where they are mostly plastic.

Step 5: Water Separation

Water separation technology becomes relevant to separate the glass from the plastic.

Leads that contain glass are then sent to smelters to use in the production of batteries, x-ray tubes, and new CRTs.

Step 6: Purification of Waste Stream

Locating and extracting leftover metals from plastics is done to purify the waste stream further.

Step 7: Preparing Recycled Materials for Sale

The final stage is preparing recycled materials for sale. Here, the materials separated and prepared for sale as raw materials to produce new electronics and other products.

There are very few institutions in Kenya that are registered to recycle E-waste.

Examples of e-waste management entities

i. WEEE Centre



The Waste Electrical and Electronic Equipment Centre (WEEE Centre) is an e-waste recycling company based in Nairobi. It offers the services of awareness creation (training) and safe disposal of electrical and electronic waste (e-Waste); in accordance with NEMA waste regulations and

WEEE regulations that are protective to both the environment and public health.

As a fundamental core value, The WEEE Centre runs an environmental friendly operation. It provides e-waste collection, dismantling and automated processing services in Nairobi and several other major cities in Kenya. It primarily sources e-waste from the private and public sector as well as through collection campaigns targeting individual households. It takes lead in managing e-waste and awareness creation.

Achievement:

- Safe disposal of unrecyclable parts of e-waste
- Safe e-waste recycling
- Training on the safe e-waste handling, storage and disposal methods and their adverse effects on the public health and environment if not properly disposed.

ii. E-waste Initiative Kenya (E-WIK)

E-WIK is a non-governmental organization in Nairobi whose core value is to offer proper e-waste management by providing a safe disposal option across the country through their intensive network. They also promote private-public partnership with the purpose of achieving overall environmental stewardship.

E-WIK creates an enabling environment for the informal sector involvement in the segregation, recycling, collection, transfer, treatment, and disposal of e-waste, and prioritizing the involvement of lower-income and disadvantaged recycle groups wherever possible. Valuable recycled materials are recovered. They ensure zero pollution on all fractions of e-waste through different partnerships handling different material fractions.

Their waste collection and transfer system provides a collection point for every waste generated in the country. These include direct vehicle collection, door to door, and community collection

methods. E-WIK occasionally has collection events and their distance collection occurs where the user sends the e-waste through a special courier to the collector.

E-WIK has achieved increased employment rates, proper channel for collection and disposal of E-waste in Kenya, especially within Nairobi County, improved awareness on sustainable E-waste management and bridged the digital divide by providing refurbished ICT equipment.

D) WASTE PAPER RECYCLING

The paper recycling process involves collection of waste paper, sorting it out into categories, pulping the waste paper, which feeds back into the paper making process. The rationale behind paper recycling is to recover the valuable raw materials and recycle it to create new paper. Paper recycling can be defined as the environmentally friendly process of recovering and processing scrap and waste paper to create new paper products. Scientific research has demonstrated that manufacturing paper with recycled content has significant environmental and economic benefits.

Waste paper recycling process includes several steps, including collection, transportation, sorting, processing into usable raw materials, and finally using that raw material to produce new paper products:

- **Collection** - Waste paper is taken from collection bins and deposited in a large recycling container.
- **Transportation** - The recovered paper waste is taken to the paper recycling plant, separated into types and grades.
- **Sorting**- The paper is sorted into different grades, this is crucial because it determines the amount of fibre extracted from the pulp.
- Processing the waste paper into usable raw materials include the

following:

- **Pulping** - The sorted paper is then turned into pulp using water, hydrogen peroxide, and caustic soda with soap.
- **Pulp Screening and Cleaning**- To remove contamination from the pulp, the pulp is screened for non-paper debris such as glue, staples, and plastic.
- **De-inking** - The pulp is now all fibre and will be repeatedly de-inked. This process removes printing ink and glue residues and adhesives.
- **Refining** - The mechanical treatment process of paper pulp fibres to give the appropriate characteristics for papermaking.
- **Rolling** - Lastly, the almost dry pulp is pushed through an ironing-board-type machine that moves it into the desired paper grade. It is then dried using heated metal rollers and wound into a giant roll.

It is crucial to note that recycling paper is not comparable to other types of recycling, such as metal recycling. With metals, the metallic properties are retained after repeated recycling, but recycling paper reduces the length of fibres. The recyclable paper will ultimately reach a point where it can no longer be recycled. There are several companies in Kenya that recycle paper into many products.

i) Chandaria Industries

Thousands of tons of good quality recyclable paper go into landfills, causing a rise in greenhouse gases as the paper degrades with other waste, or incinerated, causing a massive amount of air pollution. Paper recycling saves energy, trees, water and other resources.

Chandaria Industries is at the forefront of championing the reuse, reduce, and recycle policy, by ensuring that

their products are made with recycled paper waste.

The paper recycling operations provide employment opportunities to over 20,000 Kenyans and the industry recycle up to 4,000 tons of paper waste per month into new tissue & paper raw material. Essentially, 100 tons of paper waste produces 60 tons of recycled tissue.

ii) Kamongo Waste paper

Kamongo Waste paper limited is based in Nairobi and has several collection centers in Kenya. The company recycles cardboard/paperboards, newspapers and high grade office papers. All waste paper materials are segregated into their respective sources ranging from pure Kraft paper, supermarket waste paper, office paper, old newspaper, magazine and printed paper side trim and sheets. They are then baled and shipped to respective paper mills as raw materials for the manufacturing of recycle paper board, tissue and paper products.

Cardboard is a high-quality and durable material that makes it ideal for recycling into paperboard and other paper products. Clean cardboard boxes - free from water damage, grease and other food contamination- are recyclable.



Cardboard boxes to be converted

The industry takes pride in protecting the planet by reducing the amount of waste paper that ends up in the landfills as well as providing employment to hundreds of people.

E) GLASS WASTE RECYCLING

Glass recycling is the process of turning waste glass into usable products. The glass is sorted by colour and washed to remove impurities, carefully inspected for contamination and hazardous materials, then crashed and melted and moulded into new products such as bottles and jars. The glass goes through a pre-treatment process which removes any paper or plastics using blown air. Any metal objects are removed with magnets.

Since glass does not decompose, every 1,000 kg of waste glass recycled into new items saves about 315 kilograms of CO₂ from being released into the atmosphere during the manufacture of new glass. This consequently minimizes the temperature rise associated with GHGs.

Recycled glass can be used to manufacture fiberglass insulation products, ceramic sanitary ware, as a flux in brick manufacture, manufacturing concrete, agriculture and landscape applications such as top dressing, root zone material or golf bunker sand, recycled glass countertops, water filtration media and abrasives among many other uses. In Kenya there are several companies that recycle glass to make a variety of products:

i) Eco Blocks and Tiles Company

The Eco Blocks and Tiles Company was founded in 2016 and it has improved waste management in Kenya by recycling glass waste into eco-friendly, cost-effective, durable, mold-resistant and beautiful roofing tiles, which are 100% recyclable at their end life. The company consciously works to reduce environmental pollution caused by plastic and glass waste by recycling these into distinct building ma-

materials that are aesthetically appealing, longer lasting and affordable.



House roofed with Eco-blocks tiles

ii) Kitengela Hot Glass



Kitengela Hot Glass recycles and transforms scrap material into objects & designs that have a future, addresses a need and fulfils a function or desire. The glass is collected from suppliers to the building industry, melting 150kg of old glass a day. The company has converted over 200 tons of scrap window and bottle glass into useful and decorative items over the years. The products made from recycled glass are harder and have a longer lifespan.

This translates to over 330 tons of Carbon dioxide saved so far. (1 ton of carbon dioxide is reduced for every 6 tons of recycled glass used)

Products made from recycled glass are; drinking glasses and bottles, chandeliers, lamps, furniture, beads and sculptures.

F) DUMPING SITES TO GREEN SPACES

Urban green space is open-space areas reserved for parks and other “green spaces”, including plant life, water features -also referred to as blue spaces - and other kinds of natural environment. Most urban open spaces are green spaces, but occasionally include other kinds of open areas. Urban Green spaces are defined as areas largely covered with vegetation in an urban setting. These spaces have proven to generate environmental, social and health benefits directly and indirectly acquired by the residents.

Green spaces in cities mitigate the effects of pollution and can reduce a phenomenon known as the urban heat island effect, which refers to heat trapped in built-up areas.

Establishment of green spaces is also in line with target 7 of the UN Sustainable Development Goal Number 11 which aims at providing universal access to safe, inclusive and accessible green and open spaces for all. Greenspaces can be located within forests, parks, schoolyards, vacant lots, gardens and along riparian and transport corridors.

There are several dumping sites that have recently been converted into Green spaces such as Michuki Memorial Park and Kibarani Dumpsites in Nairobi and Mombasa Counties respectively.

i. Komb Green Solutions, Korogocho



Komb Green Solutions is a community

based organization formed in 2017 and it's located at the Nairobi River riparian land, a few meters to Nairobi's official dumping site; the Dandora dumping site. The organization has transformed an area along Nairobi River in Korogocho which was initially a dumpsite and a den for thieves into a green and safe space.

They have been able to restore the riverbanks along Nairobi River that entailed removing solid waste that had piled up for many years. They have also engaged in various forms of urban farming where they grow vegetables including kale, spinach and cabbages which they distributed to some vulnerable families in the slums during the Covid-19 pandemic. Komb Green Solutions won the 2019-2020 Changing Faces Competition – an initiative mobilizing citizens to transform neglected public open spaces across Nairobi into clean, green, and safe community spaces organized by Green Space Network.

Their main achievements are; establishment of green, clean and safe spaces as well as environmental restoration and rehabilitation efforts.

iii) Michuki Memorial Park

The park was established in 2008 through concerted efforts geared towards creating a public recreation area at a site previously used as dumpsite and a criminal hideout; which came about as a result of the rehabilitation and restoration of the Nairobi River. Before rehabilitation, the area was an illegal dumpsite with an awful stench emanating from the polluted river. It was characterized by high levels of insecurity and was occupied by hawkers and garages with the river sections choking with solid waste.

As a result of the rehabilitation program, accumulated solid waste totaling to 20,000 tons was removed, illegal structures were cleared, the riparian zone was leveled and construction of a pathway

along the river was done to mark a clear boundary of the riparian land. Indigenous trees were planted all over the park creating a green space as a way of helping to mitigate against air pollution and provide relaxation and recreational sites for city residents. The park has a 500 sitter amphitheater and events' grounds for use by the public.

iii) Kibarani Dump site - Mombasa

The County Government of Mombasa with her partners have repurposed the infamous Kibarani Dump site into a Green Recreational Park. Kibarani is the gateway to Kenya's oldest city, Mombasa and for five decades, has been characterized by the sprawling dumpsite beside the Indian Ocean. The dump site was not only an eyesore, but also a public health concern for locals as well as the cause of marine pollution. Today the government and private stakeholders reclaimed the lost glory of Mombasa tourist city, with different varieties of trees planted in places once given over to rotting trash. Kibarani is now a Greener Recreational Park.



Kibarani Recreational Park

G) MUNICIPAL WASTE TO COMPOST

One method of treating municipal solid waste is composting, a biological process in which the organic portion of refuse is allowed to decompose under carefully controlled conditions. Microbes metabolize the organic waste material and reduce its volume by as much as 50 percent. Things such as eggshells, fruits,

and vegetables, flowers and plants, rice and beans, dairy products, meat, poultry and seafood, bones, paper products, milk cartons, tea bags, coffee grounds, tea/coffee filters, garden waste, etc. Four tasks are central to the design of a modern Municipal Solid Waste composting system: collection, contaminant separation, sizing and mixing, and biological decomposition. Municipal Solid Waste (MSW) composting is a rapidly growing method of solid waste management globally, in most of Africa, municipal solid waste disposal by open dumping is still under practice and in Kenya.



Organic waste

i) Takataka Solutions

Every day Takataka solutions collects waste from hundreds of residential, commercial and industrial clients across the Nairobi Metropolitan area. The collected waste is sorted after which they make compost from organic waste; and work with recycling partners for other materials.

At their composting plant they process organic and garden waste into high quality compost, a natural soil amendment. The compost is then used by urban households and farmers across Kenya to improve their soil fertility. Compost helps replenish soil fertility by increasing the soil organic matter. Its nutrient composition is high and its benefits include not only increased crop growth but also water retention, reduced need for chemical fertilizers and suppression of soil-borne diseases and pests.

ii) Dajopen Waste Management Project

The Dajopen Waste Management (DWM) group is a community-based organization based in Kitale, Kenya. It aims at tackling the economic, social and environmental conditions of vulnerable communities through a community-based waste management strategy, including the collection of waste, the production of recycled items, and the training of other self-help groups and actors regarding alternative livelihood opportunities, waste management and organic farming. More than 21,000 people have been trained in waste management and organic farming while eight community groups have been trained by DWM in producing a range of recycled products.

Their mission is to help clean the town environment through reuse and recycling of municipal solid waste for the benefit of its slum dwellers and small scale farmers, as well as enhancing food security by making and supplying value added organic fertilizer to farmers.

Dajopen's products include organic biodegradable waste, briquettes from dry tea leaves and pulp papers and simple maize shellers made from scrap metals.

H) WASTE TO HANDCRAFTS

Art from waste is an interesting way to recycle and reuse items that may end up in a dumpsite. Here are some ideas on how to make art and craft pieces from waste material lying around at home.

Reuse or recycle plastic bottles can be converted into craft art in the following ways:

- **In gardening:** The lower half of a plastic bottle can be cut out and used to sow seeds and grow saplings until they are ready for transfer into the soil. They can also be used as large perforated bottle to water garden plants.
- **As toys:** Collected and painted

similar-sized bottles in bright colors can make a set of colorful skittles for rounds of bowling.

- **As artwork:** Cut and paint plastic bottles using glass colors make flower vases, wall hangings and paintings at home.



Artwork made from discarded materials

Since Kenya implemented the plastic carrier bag ban in 2017, a lot of citizens especially the youths are coming up with creative ways to earn an income, combat the effects of a changing climate while abiding to the said laws. Kenyans are on the forefront, expressing their contribution towards environmental conservation and sustainability through art.

i. Funkidz Furniture

It’s a children’s furniture company, located in Kikuyu town. The company uses waste to make ecofriendly furniture using circular economy model that relies on minimizing waste and ensuring outputs of the economy are reduced, reused and recycled.

The company uses waste from farmlands, schools, offices and homes to manufacture a range of furniture products. Using leftovers like rice husks, mixing it with other fibrous properties of agricultural waste and then compressing and compacting them to create boards that can be used in making furniture, classroom partitions or even ceiling boards.



Beds made out of discarded blockboards

ii. Ali Lamu



Ali, a local fisherman started making bags and art from old sailcloth locally known as “tanga”. Involving a group of about 30 women working in Kashmir in Lamu, the group is involved in patterning, shaping and painting the bags. Some of the thoughtful and uplifting messages printed include; “Wake Up and Love” “The Only Way to Save the World Is with My Heart” and “Heart That Loves Never Gets Old” .

They travel all the way to other islands like Zanzibar and Pemba, and even Somalia collecting sail cloths for their production.

Ali Lamu has successfully recycled old sail cloths into bags and through this action, he has cleaned up the Kenyan coast ridding it of dumped sail cloths which would otherwise end up in the oceans, harming the marine ecosystems. He has also created employment, especially targeting women and youth.



Malibu bag made by Ali.

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