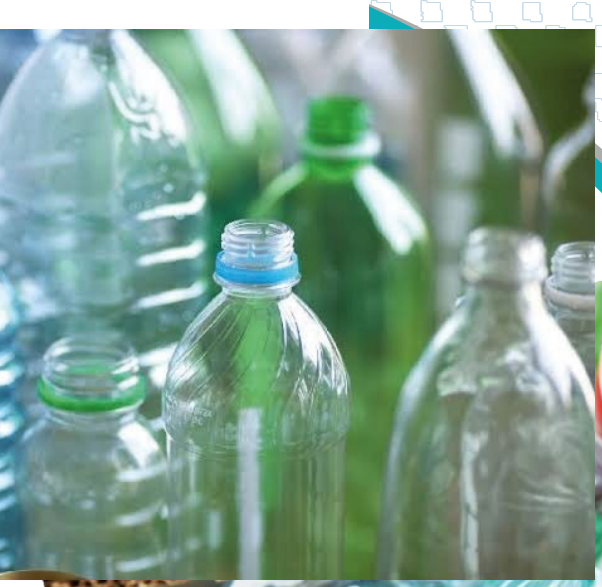
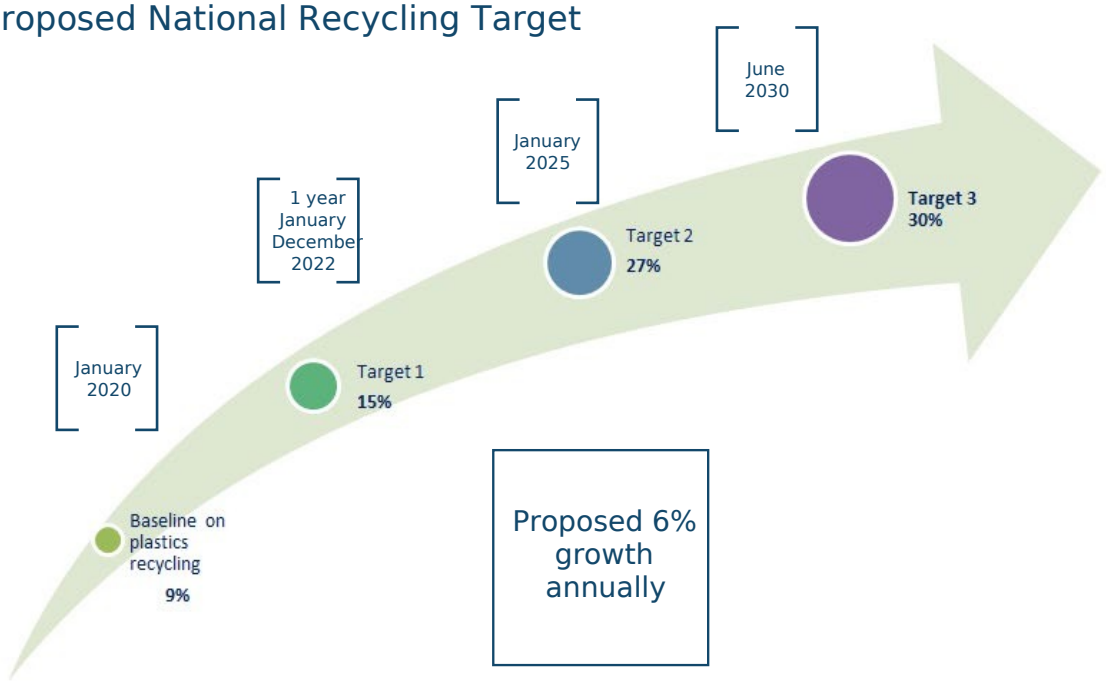


Accelerating a Circular Economy in Kenya

November 2019

a) Proposed National Recycling Target



b) Three Year Plan to operationalize producer responsibility organizations for all plastics stream

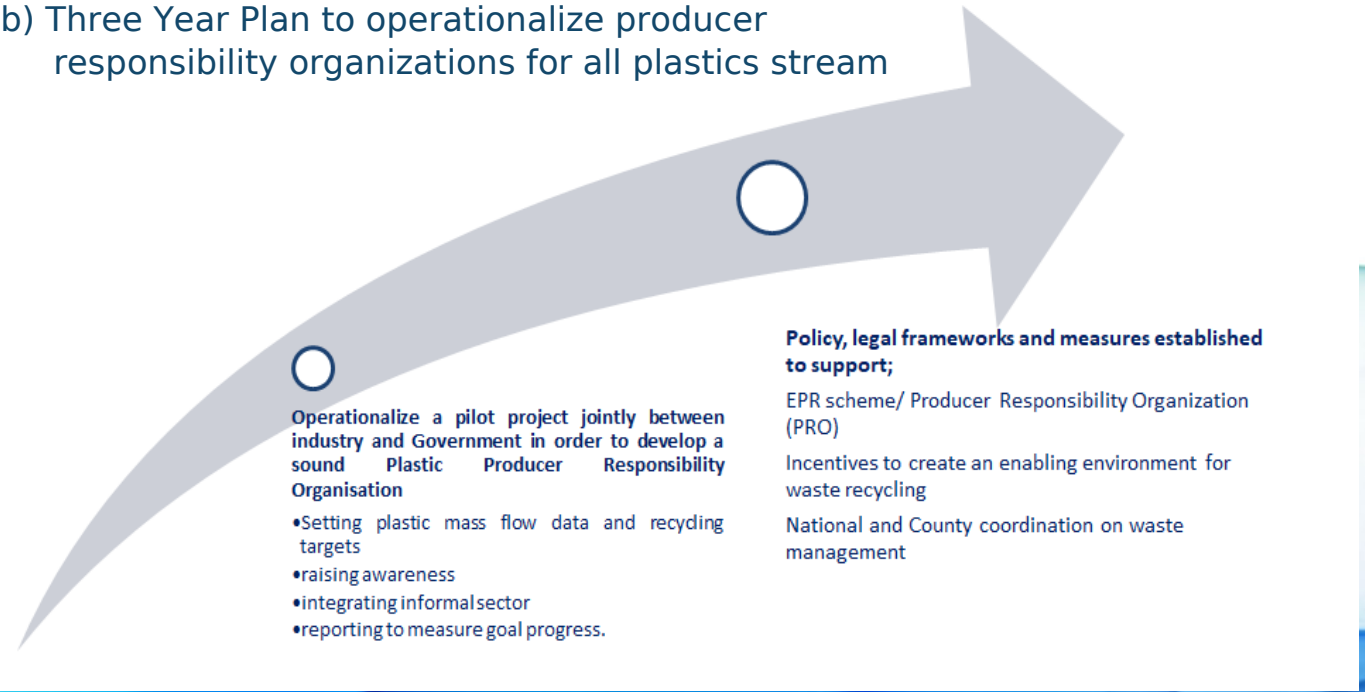


Table of contents

Table of contents

List of tables

List of figures

Definition of terms

Bio- based plastics	Plastics which are manufactured from renewable sources; sugar cane (as opposed to fossil-based plastics, wh fossil fuels). The term bio-based doesn't necessarily imp
Biodegradable plastics	Plastics which can be degraded or composted by specific, environmental conditions. Biodegradable pla both of bio-based as well as fossil-based plastics.
Circular economy	The circular economy is defined as an eco like plastics are used more efficiently through the of "reduce, reuse and recycle" to close the loo has economical as well as social and environmental reduced import dependency, employment creation, reduced resource extraction as well as improved humanhea
Deposit-refund system (DRS)	A surcharge which is placed on certain pr manufacturers. When consumers return quantities of the products, the surcharge is refunded.
Disposal	Refers to any operation which is not defined as the operation later results in a secondary consequer of substances or energy.
Energy recovery	A process in which energy (heat, electricity, fu the primary treatment of waste. The most common incineration. It is not material recycling.
Extended producer responsibility (EPR)	An environmental policy approach in which a pro a product is extended to the post-consumer i.e. when a product turns into waste. Already du sale (and export), producers are responsible for dis Producers/importers pay a fee for later disposal of when their packed goods are placed on the market. fee is used for collecting, recycling and disposing and other costs arising from maintaining the system. It contribution to the general public budget of a
Feedstock recycling	The process of breaking down collected plastics basic chemical elements. These monomers can be use alternatives in manufacturing new polymers. Particularl plastics which are difficult to recycle – du nature or low economic value.
Free riders	Producers/manufacturers and importers that enjoy the ber EPR system without paying the corresponding fee under-declare their volumes.
Material recycling	Describes a recycling process in which waste ma reprocessed into products, materials or substances wi properties – also referred to as closed-loop rec requires lower properties.
Manufacturer / converter	Companies which produce plastic packaging or plastic ite raw material.
Landfill	A location where most generated municipal solid wa the Kenyan context, there are no sanitary lan ecological precautionary measures like wastewater treatment sealing. In many cases, it cannot be distinguished wh site is a landfill or dumpsite.

Life cycle analysis	Life cycle analysis (also called Life-cycle assessment or to assess environmental impacts associated with all the lifespan (from raw material extraction through mater manufacture, distribution, use, repair and maintenance, to dispos recycling).
Obliged companies	Companies which are obliged to pay a fee within
Oxo-fragmentable plastics	Plastics which quickly fragment into micro-particles in warmth, light and oxygen but do not degrade becoming a source of environmental pollution in
Packaging	The materials in which a product is wrapped before being sold or transported.
(Packaging) user	Companies that use packaging for their products when market. In literature, often referred to as "prod
(Packaging) filler	Companies that fill empty packaging with their products the market.
Polluter pays principle	The waste producer or owner is the potential pollut (including financially). The "polluter pays" principle create incentives for environmentally-friendly conduct and the
Producer	See "(Packaging) user".
Waste prevention	Measures taken before a substance, material or produ which reduces quantities of waste and also includes and the extension of the lifespan of products. hazardous substances being used and the adverse impac waste on the environment and human health.
Producer responsibility organisation (PRO)	The central element for the organisation of all tasks EPR system. Allows producers/users to assume respon their efforts and jointly managing the arising waste through responsibility. The PRO is the most important stakeholder and is responsible for setting up, developing and maint as well as the take-back obligations of the oblige
Recovery	Describes any operation in which waste serves a useful other materials or using its material properties (inclu reuse, recycling as material or feedstock recycling
Recyclables	Materials that still have useful physical or chemical their original purpose and therefore can be re-ma of positive economic value as well (e.g. rigid PE,
Recyclates	A product which has passed through a life recycling process, which means it is made from used regranules).
Recycler	Companies that recycle pre-processed waste streams plastics) by washing, flaking, agglomerating and actions, an economically marketable output product is
Reducing	The practice of using less material and energy to generated waste and preserve natural resources. Includes materials from becoming waste before they reach the recycl includes re-using products.

Definition of terms

Re-use	The repeated use of a product in the sar purpose. In this case, the product does not bec
Rigid plastics items	Plastic items that are stable in form, e.g. PET-bottles, PP (in contrast to flexible plastic items such as film
Single-use plastics products	Are used only once and then thrown away, includes cutlery, straws or coffee stirrers.
Solid waste management (SWM)	The storage, collection, transportation and disposal describes a practice by which several waste ma used to manage and dispose of specific cor management techniques include avoidance, reduction, reu recovery and disposal.
Source separation	The segregation of specific materials at the sou
Waste hierarchy	Describes a ranking of waste management options best for the environment. It gives top priority to is generated, the priorities lie within preparing for then recovery and lastly for final disposal.
Waste management	The term waste management discribes characteristic activities (a) collection, transport, treatment and disposal of monitoring and regulation of the production, collection, and disposal of waste and (c) prevention of wa process modifications, reuse and recycling.

Abbreviations & Acronyms

BMO	Business Membership Organization
CGK	Clean Green Kenya
DRS	Deposit Refund System
EMF	Ellen MacArthur Foundation
EOL	End-of-Life
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
GWP	Global Warming Potential
HDPE	High Density Polyethylene
JICA	Japan International Cooperation Agency
KAM	Kenya Association of Manufacturers
KEBS	Kenya Bureau of Standards
KEPSA	Kenya PrivateSector Alliance
KPAP	Kenya Plastic Action Plan
LCA	Life Cycle Analysis
LDPE	Low density Polyethylene
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
NRED	Non-Renewable EnergyDemand
OECD	Organization for Economic Co-operation and Development
PE	Polyethylene
PET	Polyethylene Terephthalate
PP	Polypropylene
PRO	Producer Responsibility Organisation
PS	Polystyrene
PVC	Polyvinyl Chloride
SDGs	Sustainable Development Goals
SUP	Single Use Plastic
TOC	Total Organic Carbon
WEEE	Waste Electrical and Electronic Equipment

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Foreword

Waste is a fact of human life. How we handle of our most critical natural resources; or, restore enhances our humanity.

As the world's dynamism continues, time is in the world will stop long enough to allow greatest, most perfect solution, to any problem complex as that of waste. It is upon with innovative agile thinking, collaborative efforts and, create a better world.

The Kenya Plastics Action Plan is a giant step arrest the problem of plastic waste management, turning an environmental and economic solution. This initiative aims to be a catalyst for the term, progressive and revolutionary measures to tackle management holistically.

As we begin this journey, we need to enhance the collaborative frameworks bringing onboard actors that will ensure that the spirit of this initiative is discourse for the short-term and long-term. For instance, how do we mak our national consciousness, so that the ethos of every home, school, institution anchored on leaving the planet, better than we found it? How can we ensu restoration as a personal, institutional and organizational responsibility? How do

The Kenya Plastics Action Plan, with all its main actors that is, Industry and together the answers to the questions above at a primary level. It Economy for plastic use and waste management in the country. It looks at Extended Producer Responsibility schemes and establishment of re-cycling valu

As we do this we are conscious that we have just started to lay we must we must equip ourselves with innovation, technology, progressive regulations to advance the solutions in step with the needs of our country, and

I speak for the Association in saying that we are committed, and are at of a circular economy, towards sustainably managing waste, and conserving

Sachen Gudka
KAM Chairman

Executive Summary

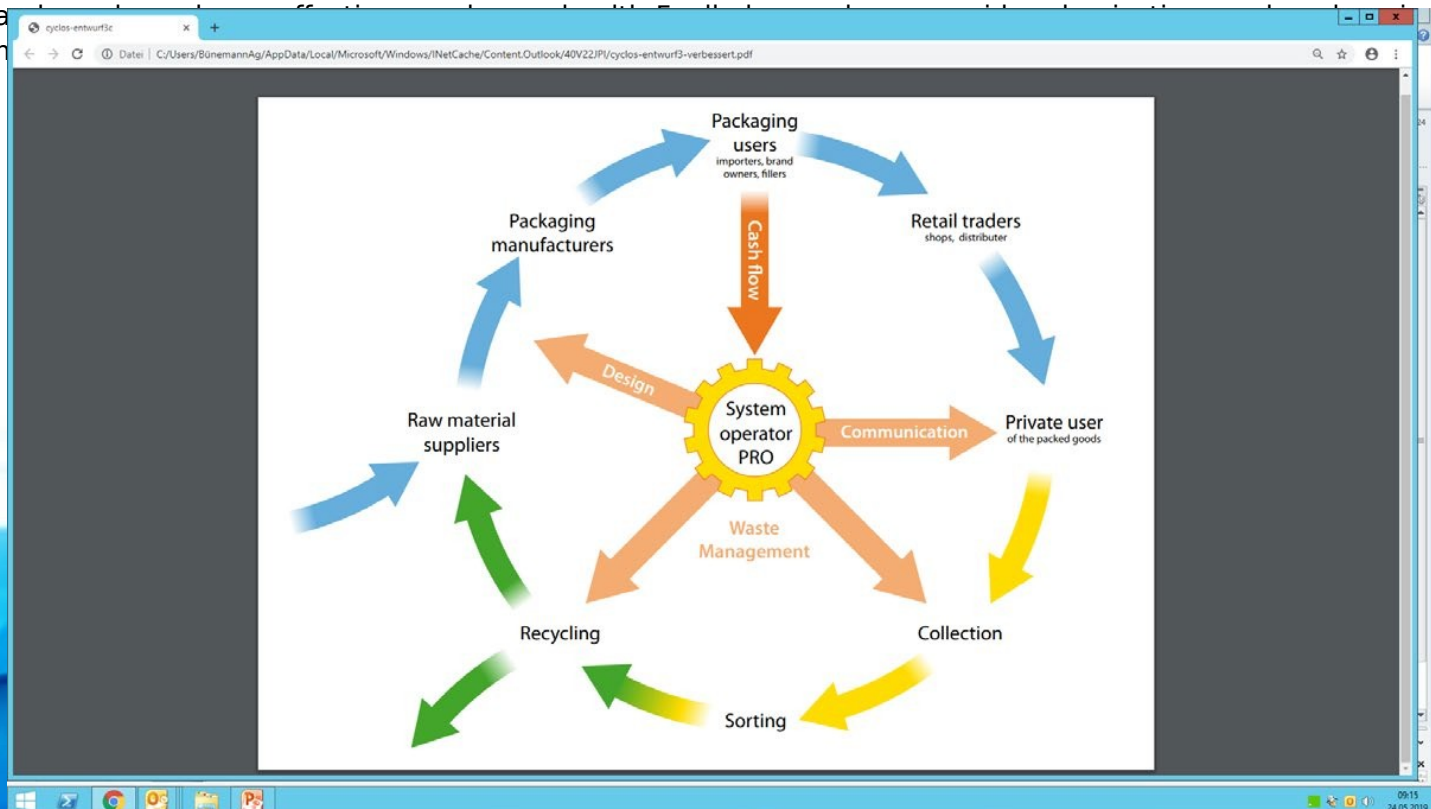
Context

The government, through the Ministry of Env
Forestry, has shown a strong commitment to stop
the environment which is particularly worsened by
waste management. This commitment is marked
the use, importation and manufacture of plastic carri
both commercial and household packaging. Following
National Environment Management Authority (NEMA)
its intentions to extend the ban to plas
Ministry of Environment and Forestry has indic
encourage manufacturers to develop plans to

The privatesector, through the Kenya Association of
(KAM), embraced the initiative to come up with
to come up with substantial solutions to curb
tackle management gaps and other challenges faced by
The Kenya Plastic Action Plan is a privatesector-drive
the aim to involve policy makers, the general public and the industry
and together to pave pathway to a green economy in Kenya.

The Kenya Plastic Action Plan written to foster concepts of circular economy, to
and the people. It proposes the creation of a model of Extende
successfully in many places all over the world. The EPR model establishes an in
Producer Responsibility Organization (PRO), that is financed by mandatory member
utilize plastics for packaging within the Kenyan market. It utilizesthe c
management strategies which ensure that plastic waste is managed appropriately – w
the recycling rate moving towards a circular economy.

Currently, the waste management structures fail to address the magnitude o
in rural and in urban areas. In the capital region of Nairobi, roughly a
metric tons per day is recovered for recycling. Around four fifths of th
– eventually entering water bodies – burnt onsite or disposed of at d
have by far exceeded their capacities to safely dispose of the waste v
a
n



The Kenya Plastic Action Plan outlines measures and proposes concrete actions existing waste management problems. Taking the best examples worldwide into cons existing value chains and pioneering actors within the country, the measures not towards a clean and healthy environment, but also showcase how the circu growth and welfare. All plastics that are consumed and processed in Keny Therefore, the responsibility to manage them properly must be taken jointly by the market, including both local and international companies.

Objective of the Study

By building an understanding of the Kenyan context regarding wast regulatory framework, the Kenya Plastic Action Plan provides in-depth research into It incorporates the entire plastics value chain, spanning from imports of raw to uses and subsequent recycling of different plastic fractions.

The study followed a qualitative approach and included a literature revie interviews throughout the whole country, focus group discussions and a stakeholder supported by the extensive local and international experience of the consultancy Plastic Action Plan aims to document local plastics waste management practices, high for extended producer responsibility as well as sketch a unified private sector posi to the Kenyan context. Most importantly, this report is meant to inform the sustainable policy framework on plastics in Kenya.

Summary of strengths, weaknesses, threats and opportunities for private sector engagement in tackling waste management challenges

Strengths	Weaknesses
• Private sector commitment to manage plastic waste • Strong support for need an EPR expressed by public and private sector • Functioning recycling value chains for certain plastics • Product design decisions made within the country • Most consumer products processed domestically	• Plastic waste spread throughout the country • Practically no tradition of waste se • Slow growth in formalized waste collection • Insufficient waste management infrastructure • Gaps in regulations and laws on pl management

Opportunities	Threats
• Government tax incentives to investors for recycling (15% Corporate Tax for investors operating a plastic recycling plant for the first 5 years and VAT Exemption on services offered to plastic recycling plants and supply of machinery and equipment used in the construction of the plants) • Rising awareness among the population on plastic waste management • Affordable labour cost and high need for employment particularly on recycling sector • Improvement on International standards on plastic manufacturer and waste management	• Unpredictable legislative framework to plastics management in the country • Disjointed efforts in management of pl by various stakeholders in the Industry • Voluntary measures on plastic waste manage which in most cases may fail to deliver r • Market highly price competitive

Key Findings

The research revealed that the regulatory framework concerning plastics in development. Tax incentives discussed by the National Government showcase, a commitment of the public sector to improve on privatesector engagement in K within the given framework, existing recycling companies have shown to be u requirements for proper plastic waste management. Three areas have been identified as su and regulative intervention.

1) Recycling infrastructure – consisting of grassroots businesses as well as the whole country. Visionary enterprises and committed individuals offer an role, also in the further development of a stringent framework. As the informal players – who played a significant role in the successes incorporated as well.
2) Awareness campaigns amongst citizens need to be further developed. This matter their social and economic status, are able to embrace better waste mana accordingly. Particular focus needs to be placed on better segregation practices generation and enhancing recyclability. Therefore, the need for environmental to be instilled from an early age onwards.
3) The evident challenges of existing waste management practices in Keny strong privatesector dedicated to taking this action, Kenya is in a position through coordinated action from both the public and privatesector. The key elem Extended Producer Responsibility (EPR) framework.

Proposed Measures

In order to tackle the challenges highlighted above, the researchers recommended

- An Extended Producer Responsibility (EPR) model led by the privatesector shoul independent Producer Responsibility Organization (PRO) as its focal actor.
- The Government should support the privatesector to take responsibility for mana should therefore be a privatesector entity enshrined in an appropriate regul
- Membership of the PRO should be compulsory by law – for all comp the Kenyan market, be it from imports or domestic production.
- Within the legislative and regulatory framework, provisions should be set to This may include tax incentives as well as set quota for recycling
- PRO members should pay a fee based on the volume and type of associated waste management costs.
- Non-membersof the PRO such as informal businesses, should participate in surcharged at the last interface with the formal sector, e.g. when liaisingwith
- The PRO collaborates with waste management operators in building incentives collection and recycling quotas.
- Existing waste management structures, including the informal sector, are involv need to scale up to increase their role in the growing circular
- The PRO builds a forum connecting all involved stakeholders – government distributors, consumers, collectors, aggregators, recyclers, converters, etc.
- Activities of the PRO should include awareness and capacity building waste management practices.

Phyllis Wakiaga
KAM Chief Executive


RAW MATERIALS
DESIGN
PRODUCTION, PROCESSING
DISTRIBUTION
USE, RE-USE, REPAIR
COLLECTION
RECYCLING
WASTE REMAINS
CIRCULAR ECONOMY

1. Introduction

Plastics are one of the most versatile materials of our modern so inert properties and high durability gives them an essential role in most e construction, automotives, food and beverages, agriculture, health and pharmaceuticals. Pl from a material used for niche applications in the first half of the 2 element of our global economy [Plastikatlas, 2019]. Represented in numbers increased from 2 million mt (metric tonnes) in 1950 to 381 million m 7.8 billion mt of plastics by 2015 [Geyer et al., 2017].

However, concerns about negative impacts caused leakages of plastic waste into our environment are rising globa forms of waste handling, which are happening world become a ubiquitous part of our environment to places far off from any human settlement. This waste in the environment is highly problematic; not but because of the multiple harmful, often such as entanglement, digestion of plastics hundreds of hazardous chemicals found in littere al., 2015; Rochman, 2015].

> The Kenya Plastic Actio Plan proposes meas favouring the implem and w of circular econon for the environmen s, sustainable use and for a of plastics in b catalyse action tailored Kenyan condition

As most of these negative externalities eventually result from a poor, improper damaging waste management, creating sustainable waste management for plastics is solve this issue. However, as the sustainable use of plastics requires m a more holistic approach is the most suitable solution.

Objective of the study

As a means to reduce plastic degradation and pollution in Kenya, the Ministry "the use, manufacture and importation of all plastic bags used for commercial a and proposed to expand this ban to PET bottles. Nevertheless, the M that they would encourage manufacturers to propose plans to recycle as

Thus the Kenya Association of Manufacturers (KAM), as the representative o commissioned the present report to document local plastic waste management p on managing plastic waste, as well as to articulate a unified position o Action Plan" and inform the preparation of a suitable and sustainable policy fr In particular, this Action Plan incorporates policy suggestions and sustainable funding circular economy concepts for the environmentally sustainable use and re the plan pursues three main goals:

i) To offer inclusive and broad stakeholder engagement,
ii) To propose policy recommendations to catalyse the transition towards levels, and
iii) To deliver achievable and relevant actions leading to tangible result increased investment and more effective circular economy financing mech

Methodology

To address this objective systemically, a qualitative case study methodology is situation and its possibilities from several possible angles. This approach case and its respective problems.. Thus, literature research, an online questionnai to face interviews are chosen as suitable methods. Together, they serv

As a first step, a literature review was undertaken to gain familiarity with regulatory frameworks, as well as conditions and practices of plastic waste man selected countries. Special emphasis is given to the distribution of responsibilit on the one hand and the devolved functions carried out by the Counties

Secondly, the theoretical part has been complemented by empirical insights the focus group discussions and the stakeholders' meeting. The interviews and disc of the legal and regulatory framework on the plastic sector value chain, the plast as well as opportunities of a circular economy applied to the environmental and social dimension) were conducted through personal meetings Services Eastern Africa Ltd. All on-site interviews were attended by two inter

Interviews were conducted in Kisumu, Nakuru, Naivasha, Eldoret, Mombasa which includes Thika/Kiambu and Athi River/ Machakos. In addition to the inter and a stakeholders' meeting covered key informants mainly from the Greater interviewees and participants in the focus group discussions and stakeholders' meeting all levels of the plastics value chain. Additionally, an online survey to gain a plastic mass flow in Kenya was conducted.

The interviews, the focus group discussions and the stakeholders' meeting, together the basis for the Kenya Plastic Action Plan and the proposed policy framework: the stakeholder interviews allow the Action Plan to be tailored to the present The Action Plan thereby entails an inclusive, holisticand broad privatesector-led road stakeholders across the whole plastics supply chain.

Figure 1 : Locations of on-site interviews

2. Plastic Waste Management Practices

The following chapter briefly introduces plastics as material and its recy
plastic consumption and waste generation on a global scale, with particular reference
can be found within the annexes. Concepts on how to handle plastic recycling
of different circular economy implementations are also outlined there.

2.1 Plastics consumption and waste generation on a global scale

The term ‘plastics’ describes a huge group of the
backbone that enable the creation of various s with
different characteristics for a vast range of

The most commonly used materials for plastic pack s,
a group of diverse materials that melt whe
cooled in a reversible manner. Polymers of instance,
polyethylene (PE; widely used in the form of eith LDPE
or “high density = HDPE”), polypropylene
chloride (PVC), and polyethylene terephthalate (PET). polyvinyl

For manufacturing any plastic material, so-called be
produced through separating the hydrocarbon che
fossil sources like natural gas, petroleum or sed
plastics or fossil-based plastics) or renewable or suga
cane (called bio-based plastics). These monomers form
for the polymers.

Due to its suitability for a vast range of s valu
has become a global network.
Looking at the African continent, the daily plas lly
ranges between 0 to 0.2 kg per person; the only
exemption. Kenya’s daily plastics consumption is 0.03 kg
per person (Figure 2), which is at the lower end and roug
represents a tenth of the total municipal solid waste volume [Jambeck et
al., 2015].

‘Plastics’ is an umbrella term for a wide range of different materials with very different properties. They can originat from both fossil-based as wel as bio-based sources.

Generally, all plastics consist of polymer chains, which vary in their composition and structure. There are two majo groups: the thermoplastics that can be reversibly heated melted and cooled down, and the thermosets which cannot be re-melted once they have cooled down.

This distinction has important implications for the recycling of plastics.

As plastics are used across all kind of sectors, the plastics economy has become a global business However, the plastics usage by sector and the plastic waste generation by sector vary significantl is rooted in the different in-use phases of the product. As packaging has the shortest in-use phase the biggest contributor to plastic waste.

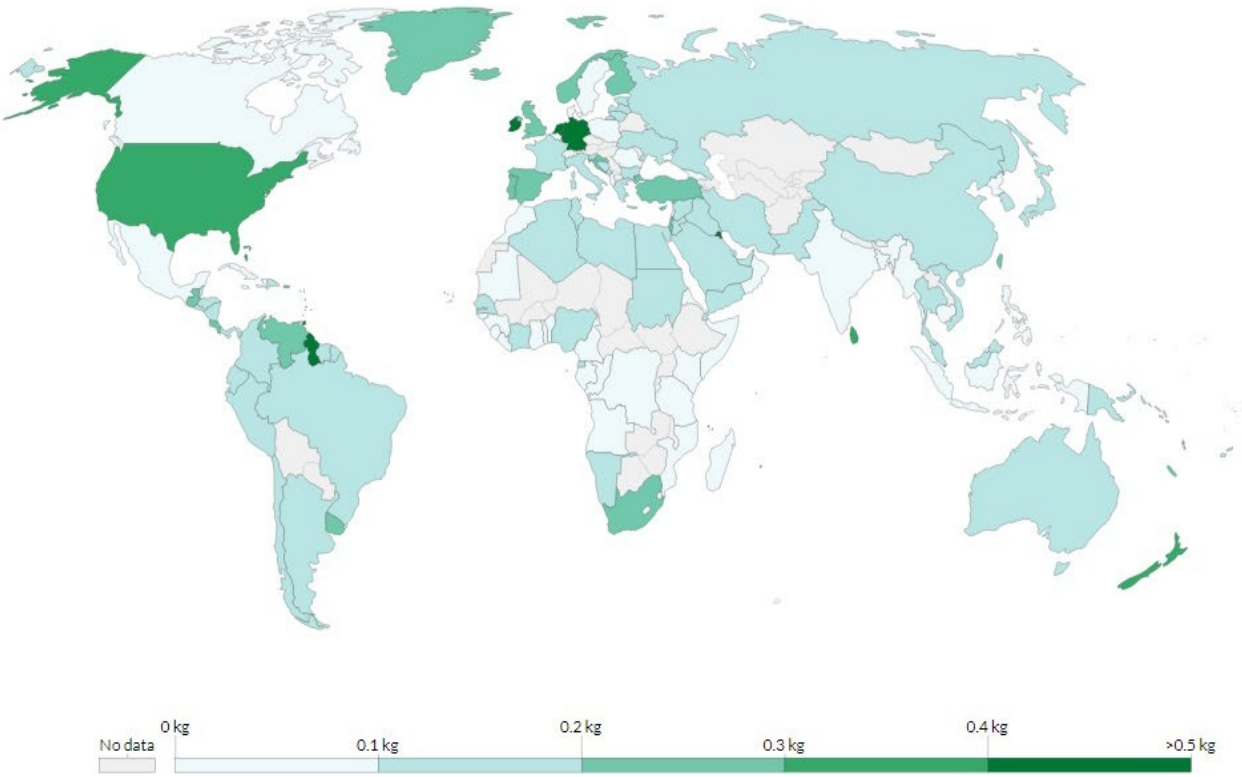


Figure 2: Global plastics consumption per capita per day [Jambeck et al., 2015]

Examining the plastics production on a deeperlevel by looking at p
emerges (Figure3): in 2015, the highest proportion (36 %) of all p
while building and construction were rankedsecond with 16 %.

When it comes to plastics, many terms are used in a vague manner. To clarify the following de are used in this report:

Plastics products is the umbrella term for any items which consist of one of several plastic typ regardless of purpose, properties and duration of in-use phase. Packaging refers to products from any materials for the reception, protection, handling, delivery and presentation of goods may range from raw material to processed product and which are passed on by the manufactu the user or consumer.

Single-use plastics (SUP) - often also referred to as disposable plastics - are items which are i to be used only once before they are thrown away or recycled. This includes plastic packaging bottles and containers but is not limited to packaging. Other items are grocery bags, straws, cutlery, among others.

However, plastic production does not directly reflect plastic waste generation, as th
by the polymer type and the lifetime of the end product (Figure4
use' phase of, on average, six months, also constitutes the biggest sh
building and construction are responsible for 4 % of the generated w
years. Total annual waste generation equals approx. 75 % of the annual plastics

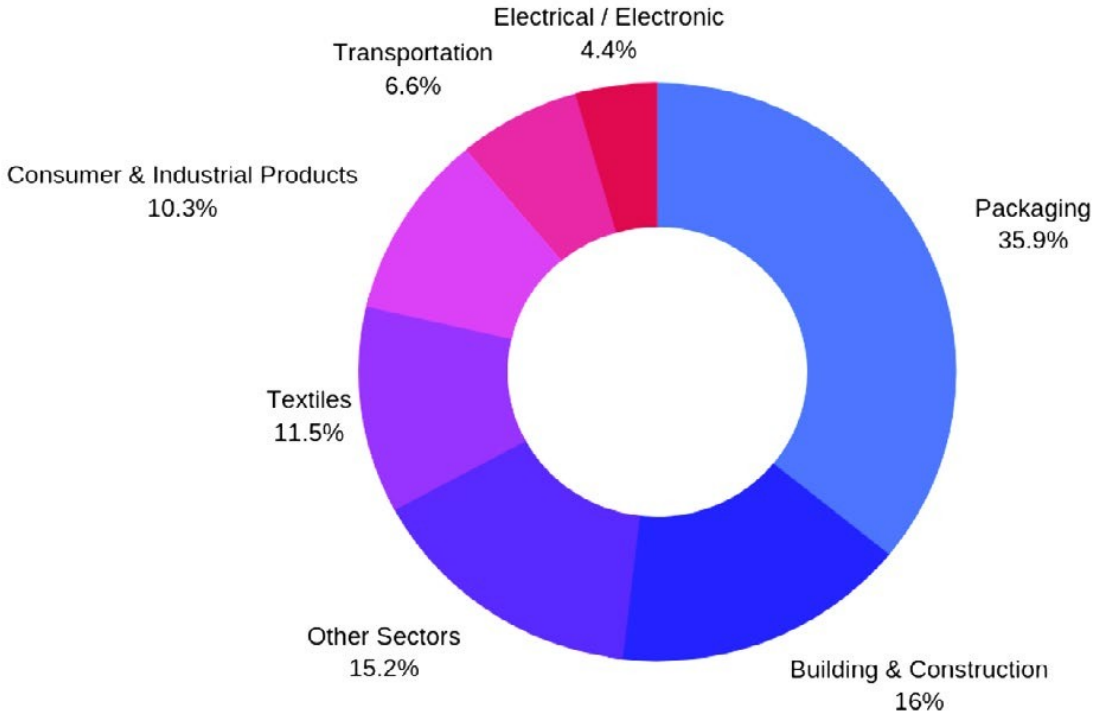


Figure 3: Primary plastics production by industrial sector, 2015, [Geyer et al., 2017]

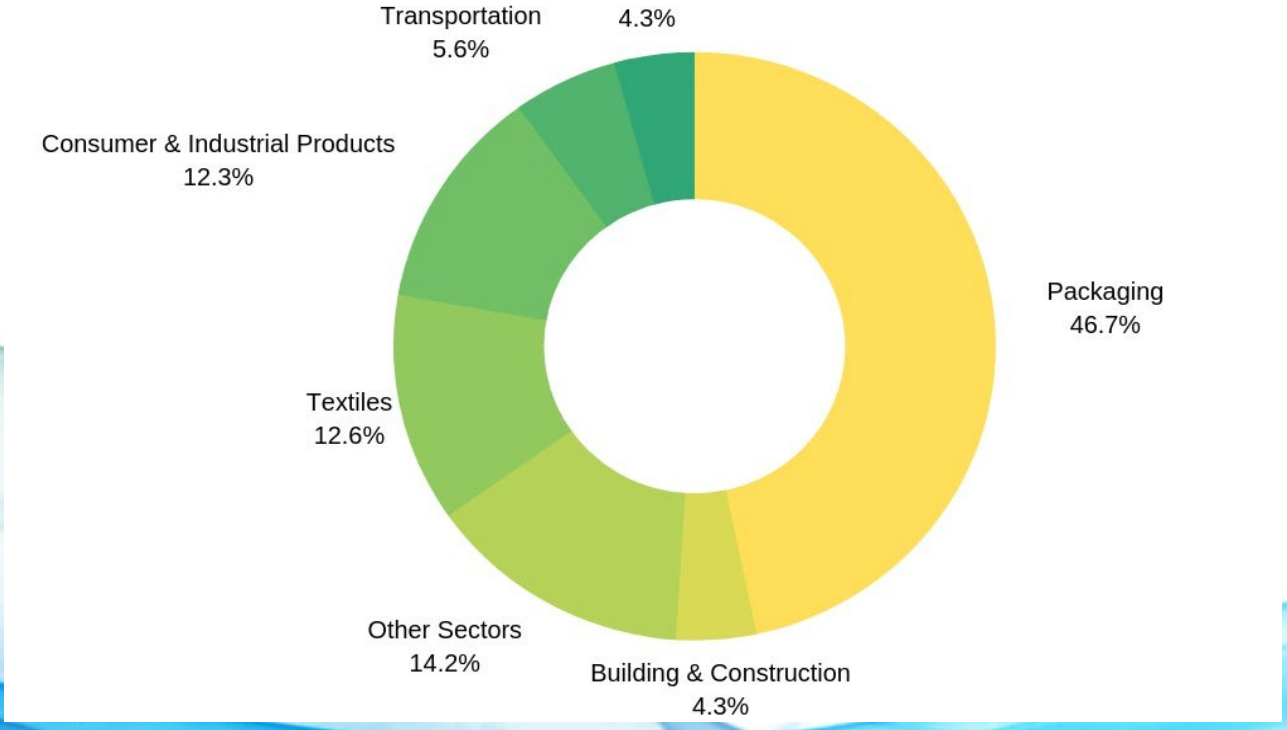


Figure 4: Plastics waste generation by industrial sector, 2015, [Geyer et al., 2017]

2.2 Recycling Plastics

To improve the waste management situation, basic concepts and definitions re as definitions of waste, recycling, recovery are a crucial prerequisite for ex waste and becomes a secondary raw material (so called end-of-waste criteria), waste and by-products.

The central concept for proper waste management and recycling is the waste hi European Waste Framework Directive (Figure5): It is a set of priorities waste treatment listing the most preferred to least preferred option starting w a product becomes waste), preparation for reuse, recycling, energyrecovery hierarchy is to ensure that waste management takes place at the highest le

Recycling means any recovery operation by which waste materials are reprocessed into products or substances, whether for their original or other purposes. There are two main types of recycling recycling describes recycling processes in which waste is mechanically reprocessed into a produc equivalent or lower properties. Feedstock recycling refers to recycling processes in which the ma transformed into its original building blocks.
Recycling includes the reprocessing of organic material but does not include energy recovery. As is not possible for all plastics waste, energy recovery is still a suitable and appropriate waste trea form for many plastics waste items.

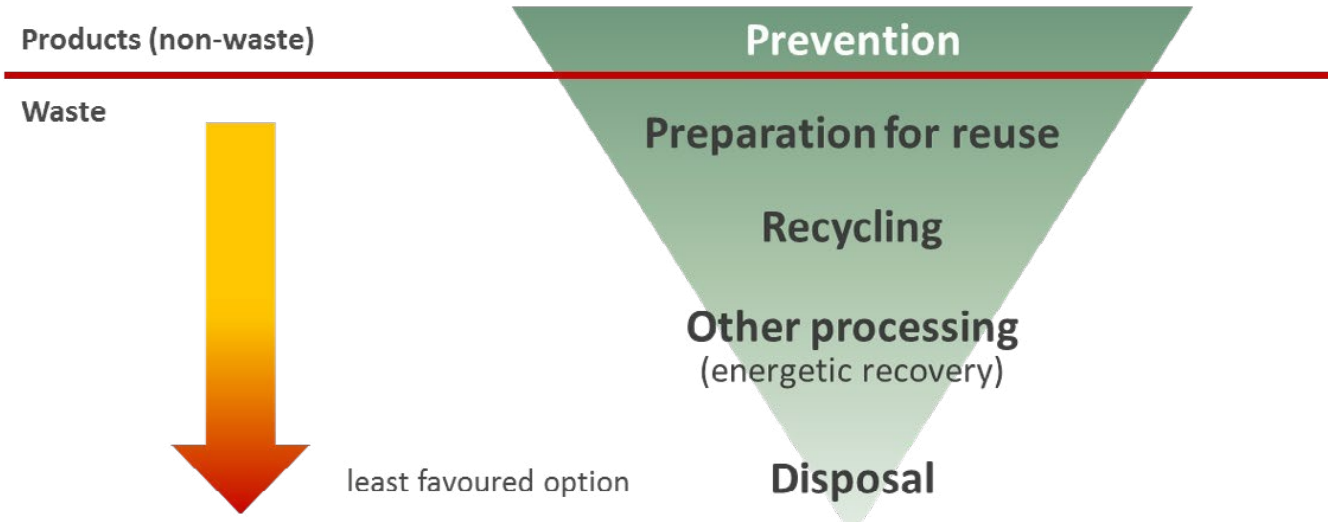


Figure 5: Waste hierarchy

Recycling requires a specific definition, as there are often different d about which processes are considered recycling and which are not. Generally, re of using recovered material to manufacture a new product. This definitio material and feedstock recycling.

Material recycling describes recycling processes in which waste is mechani equivalent properties – also referred to as closed-loop recycling – o

Feedstock recycling describes the de-polymerisation of plastics into their cl 2019]. Following the definition of the European Waste Framework Directive, e energyrecycling) is not a recycling process.

Recycling plastic polymers is highly dependent on the purity of the waste poly
presence of contaminants from other waste materials and other polymer types as
not suited to creating recyclates.

If a plastics product or good is truly recyclable is eventually determined by two criteria: the comp
quality of the object and the real recycling options after usage. In practice, recycling is only possi
there is corresponding, appropriate infrastructure. Otherwise, the product or packaging is only "re
for recycling". To turn it into a recyclable product or packaging, a comprehensive expansion and f
development of collection systems and recycling processes are prerequisites – defining general requ
for a product design. These processes aim at enabling the product to be recycled after use.

Recycling plastics is also emphasised in the EU as a crucial part of
the plastic sector and the usage of recyclates fulfil a central role in the trans
Increasing recyclate usage is rather a 'quality instead of quantity' prob
are the

i) difficulty to meet the required quality and
ii) difficulty to have a consistent, reliable supply of high-quality recyclates [

From a circular economy perspective, plastic recycling is recognised as a
problems, it is not yet used to its fullest potential. To overcome this
infrastructure, incentives as well as suitable legal and regulatory frames are

2.3 The Circular Economy Concept

2.3.1 Introduction

The 'circular economy' is a theoretical concept that stands in contrast
described as 'linear economy'. Contrary to the traditional model in which reso
distributed, consumed, and eventually disposed, the circular economy concept
within the economic system. Instead of disposing of waste, it is reint
stage, thereby closing the loop. Thus, in a circular economy the
[Ghisellini et al., 2015; Wilts, 2016]. According to the Ellen Macarthur Foundation
on the principles of designing out waste and pollution, keeping products
natural systems" [EMF, 2017a]. Applying elements of the circular economy
plastic waste management and the associated negative externalities.

Due to this circulating character, the circular economy offers a more effic
environmental, and social benefits. The circular economy concept is base
reuse, and recycle [Ghisellini et al., 2015; Wilts, 2016]. As the name implies,
maximum reduction of raw material and energy demand. It aims to mini
as well as waste incurring at the point of consumption. The reuse principle
of products that are not waste should be reused again, or – if they have
for reuse [Ghisellini et al., 2015].

The circular economy is defined as an economic model within which resources like plastics are used in a more efficient manner through the three guiding principles of reduce, reuse and recycle to close the loop. Shifting to such a system has economic as well as social and environmental benefits through reduced import dependence, employment creation, reduced litter, less resource extraction and improved human health. Putting the circular economy principle into practice requires measures, which need to be taken at all level of the supply chain. Thus, a good collaboration among the different stakeholder to align measures is crucial.

This offers especially environmental benefits as it decreases the resource
energy demand since the product is not newly manufactured [Castellani et al
principle, refers to any process in which waste is recovered through re
constituents, thereby making it available for new manufacturing processe
al., 2009].

Taking circular economy concepts into cons
implications for all steps of the product
measures cover a broader field than just
operationalised at different scales – ideal
fashion (Figure 6). However, this is
initiatives, despite often being promising, rema
measures across scales are often poorly aligned
[WEF, 2016].

Shifting towards circular economy concepts creates more revenue and thereby also more jobs in fields of designing circular products, collecting and sorting, all crucial for reusing and most recycling. This requires both high-skilled as well as low-skilled labour.

Figure 6: Circular economy conceptualisation

2.3.2 Plastics in a Circular Economy

As mentioned, plastics as material have part or our daily life due to their versatility. plastics waste has also become pervasive concerns and discussions about the multiple the improperly managed and littered plast globally. Shifting towards a circular current situation would focus on closingthe amount of plastics that are recycled.

> Reducing the overall amount of plastics used while increasing the reuse and recycling of the generate plastic quantities are the key elemer for transitioning the plastics econom into a circular one.

se to

Putting this into practice requires multiple measures which need to be chain and adopted by multiple actors, for instance Extended Producer Resp designs for enhanced recycling, a well-developed recycling infrastructure, well as waste segregation.

Moreover, implementing the circular economy for plastic waste opens the door to employment creation:

- The global plastics recycling market value equalled US$ 31 billion in 2 billion worldwide by 2024 [TMR, 2017]. This is estimated to be approx. 8 which is expected to be worth US$ 654 billion by 2020, and US$ 721 b Research, 2019a].
- The plastic-to-fuel market is expected to grow significantly in the next y demands. Processing waste plastic would offer a suitable solution to respond processing the increasing quantities of plastic waste; releasing pressure from t resources [Grand View Research, n.y.].
- In 2018, the global PET recycling market stood at US$ 7 billion and its c to be 7.4 % until 2025, resulting in a value of US$ 11 billion. T environmental sustainability is a key driver together with the increase c for recycled PET is created by several industries such as the textiles industry, consumer goods, automobiles and food and beverage packaging [Grand View Research, 2019b].

Hence, incorporating circular economy concepts will generate more revenue and thereby more jobs i fields of designing circular products, collecting sorting; all of which are crucial factors for r and recycling. This requires high-skilled as low-skilled labour.

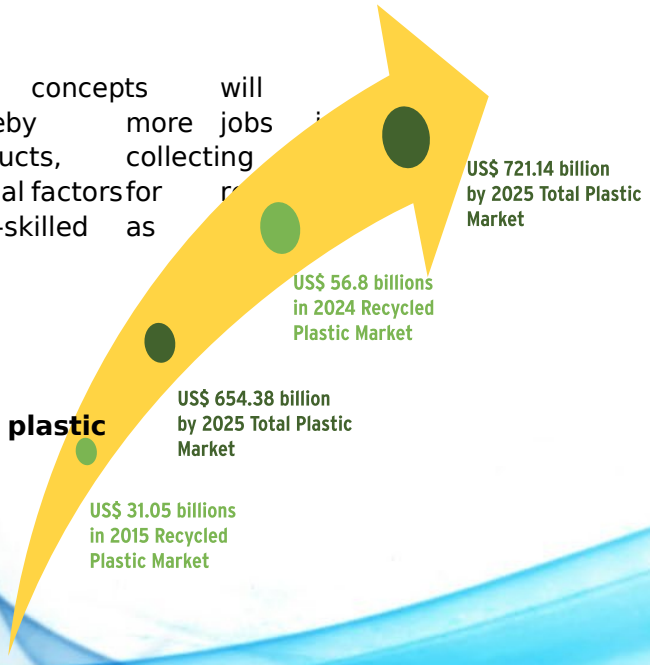


Figure 7:
Expected development of the plastic and plastic recycling market

2.3.3 Global Circular Economy Examples

Worldwide, several countries have initiated shifts towards a circular e
While their approaches have several similarities, they also exhibit noticeable differenc
conditions present in the respective country.

To push circular economy also on a global scale, there are several gl
as well as private sector initiatives to transit to a waste-free circular pl
global practices is presented in annex 8.5.

Belgium

In Belgium, waste management is a devolved responsibility which is organise
three regions Flanders, Wallonia, and Brussels-Capital in charge. In 1
waste collection system and a respective EPR system, the three regions
law to establish a strong, legal basis. Since then, Belgium has developed a
the country, which is reflected in the high recycling and recovery ra
whole European Union (EU) [Eurostat, 2019].

Additionally, to increase recycling rates, Belgium is addressing the issue of
comprehensive plastics waste strategies that contain dedicated policy instrume
2019].

The Producer Responsibility Organization (PRO) of the Belgian EPR
system is called Fost Plus; it operates in Belgium as ation.
Fost Plus was founded private sector. Although there are no of th
only one PRO has been created so far.
operational monopoly. It comprises approximat
each paying participation fees. Today, there is a
compels every company putting more than
packaging annually on to the Belgian
in Belgium) effectively to become mem of
these companies is obliged to pay for and
recycling of packaging that is brought Plus is
responsible for all packaging sales according
and publishes a respective criteria catalogue.
and packaging from online sales also fall unde
funding of waste management, Fost Plus uses
budget for education and awareness campaigns focusing on litter.

From a circular economy perspectiv
the Belgian system is overall runnin
well. The Belgian system started wi
only separately collected valuables
like plastic containers and bottles
beside metals. Other packaging like
flexibles, films and mixed plastics
were collected together with mixed
municipal solid waste for later
incineration.
Due to the increase of recycling
quotas set by the EU, Belgium is no
expanding its separate collection to
all packaging for subsequent sortin
and recycling.

The results of this system are good in terms of collection, sorting and re
are not collected within this system throughout most of Belgium. From 2
the system to cover all other packaging materials. By 2022, 90 % o
in the region of Flanders is meant to be collected and recycled. A
packaging waste is set to be recycled. By 2030, the government aims to
plastics packaging waste. These quantitative targets are laid down in the a

Denmark

In January 2018, the EU introduced its European strategy for plastics including goals to make all plastics packaging recyclable and to reduce single-use plastics where applicable and use of micro-plastics. Moreover, binding which oblige manufacturers to use a certain in their products and obliges Member their plastic packaging by 2025 and 55 % of

> Despite extensive waste management frameworks in place, the majority of Danish municipal waste is still incinerated. In Denmark, it is assumed that per 1,000 metres of recycled – not incinerated – plastic waste, three to four permanent jobs and an economic value of roughly US$ 900,000 can be created.

The current waste management system comprehensive waste collection infrastructure. However, to a study by the Danish Ministry of the majority of this waste, 63 %, is all plastics and only 18 % of all plastics packaging are recycled. new strategy to transition to a more circular economy and meet the Action Plan (Figure 8), the Danish government portrays a holistic approach with measures chain. In particular, they highlight six focus areas and 27 reinforcing action measures a more sustainable, more circular economy. The six focus areas are:

- To strengthen enterprises as a driving force for circular transition
- To support the circular economy through data and digitalisation
- To promote circular economy through design
- To change consumption patterns through circular economy
- To create a proper functioning market for waste and recycled materials
- To increase recycling of material used in buildings and biomass

All stakeholders in the value chain of plastic packaging in these actions. To increase recycling of plastics a standardised waste collection is planned, as well as EPR system. Also, better plastics waste handling is to transition into a more circular economy. encouraged to develop sustainable plastics solutions reuse, recycling, circular business models and

VEmbracing a more circular approach also offers benefits as it is estimated that for every 1 waste (which are not incinerated), three to four jobs along with additional revenue of 6 million Danish approx. US$ 900,000). The Danish government has 16 million to implement these initiatives [MFVM,

Figure 8: The Danish Plastic Action Plan

Chile

Pushed by an OECD report of 2016 that listed Chile alongside Turkey at th
with regard to recycling quotas, the country has initiated a change
measures. One of the key factors driving this change is the establishment
awaited waste management law entered the congress and has been officially
Extended Producer Responsibility and Recycling Incentives Bill' [Ley N°20.920, 2

This bill defined clear goals and requirements for several circular economy
the law, Extended Producer Responsibility (EPR) systems for six product ca
lubricant oils, waste electrical and electronic equipment (WEEE), automotive b

Through this law, an instrument for producer responsibility was created, o
categories to create Producer Responsibility Organisations (PROs) or deliver proof of ta
producer register has already been established. This law will gradually st
regulations and targets (collection and recovery rates) are defined and p
[dated June 2019] to tailor them to local conditions. Moreover, most of the C
areas, while vast parts of the rural areas are only scarcely populated. As a
and collection of the recyclables will first be introduced in urban centres
areas. The advantage of this approach is that the first quantities will al
infrastructure, like accessible roads, will be built later.

As another key factor, the law considers the inclusion of the informal
through a formalisation as accredited waste operators to be tendered separately a
N°20.920, 2016]. Collection and recycling have once they obtain the co
are treated with preference by the PRO. Through including and formalisi
inclusive approach rather than taking away the livelihood of the workers, w
the circular economy approach [Ministerio del Medio Ambiente, 2019].

Comparing these three countries, it appears that the following are requirements for success:

- Sound legal basis
- Holistic approach with measures all across the value chain
- Inclusive approach which integrates all actors (including the informal sector)
- Focus on comprehensive and extensive waste collection and sorting to increase recycling
- Establishment of an EPR system as a sustainable financing basis

2.3.4 African Circular Economy Examples

Complementing the global examples, there are also examples of circular economy implemented in African countries.

Kenya

TakaTaka Solutions is one of the prominent examples of companies active in waste collection and recycling space in Kenya. As a leader in waste collection in Nairobi and on a smaller scale in neighbouring cities, it is successfully collecting and sorting waste from major waste sources like notable hotels and malls as well as national and international institutions (Figure9).

Figure 9: Waste sorting at Taka Taka

To reduce the amount of waste ending up in dumpsites, TakaTaka recycles 95 % of the waste it collects; this is partly undertaken by themselves or, predominantly, by one of the numerous recyclers and converters that feed sorted and pre-treated fractions from TakaTaka into their production processes. Waste is sorted into more than 45 fractions within their two sorting sites in Nairobi.

As part of its recycling strategy (Figure10), the company makes composts out of their separated organic waste, which is sold to farmers.

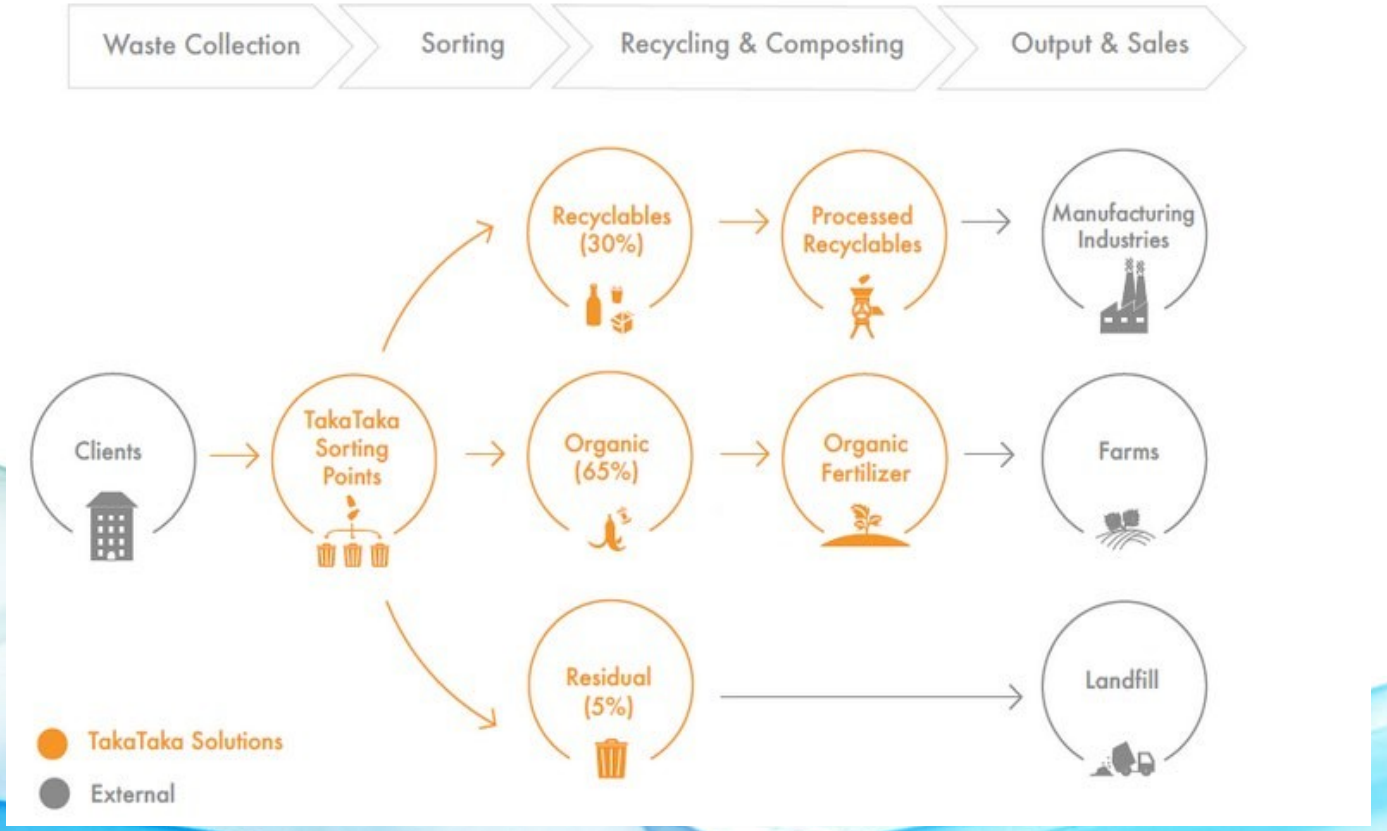


Figure 10: The Business of Taka Taka

Mr. Green Africa is another example of an innovative business model ai
concepts in Kenya. The company works with informal waste collectors (pickers)
value chain. The company collaborates with these informal waste pickers and a
of 25 trading points, predominantly set up in Nairobi's low income
Green measures and keeps a record of each of its suppliers. Through th
the rates plastic wastes are sold at, thereby assuring transparent prices paid to
managed to build a relationship with their suppliers by giving fair and st
loyalty programmes and services (see Figure 11).

Mr. Green focuses on the collection
of plastics, specifically
HDPE, PP as well as
papers like cartons. The
plastics are sold as
locally and internationally.
awareness plays an im
role in Mr. Green's
model. Continuing their so
and environmental approach,
Mr. Green Africa partnered
the international consumer
goods company Unilever
plastics recycling pro
primary schools. Th
entice children at an
become environmentally
and to help lead soc
behavioural change (see Figure 12).

Figure 11: The Business of Mr Green Africa

Figure 12: Awareness rising in schools

Rwanda

Rwanda is a pioneer in Africa in terms of maintaining a clean envi
policy for litter, which is still a problem in other parts of Eastern Afric

For over ten years now, the country's economy has been running with an
understand and learn from this example, Rwanda has:

i) Banned the use of single use plastic bags in 2008
ii) Put in place a heavy fine on the banned items
iii) Made it easy to package stuff with paper, which are available in shops a
iv) Invested in education and awareness
v) Drafted a bill on the ban of all single-use plastics in the c

Rwanda has successfully managed to prom
its population in environment related topic
Environment Management Authority initiated a
Programme [REMA, 2019]. In addition to
school grounds, using improved handwashing facili
children aware of the importance of the
waste management the country has managed
on the importance of a clean living envi

> Rwanda has successfully managed to promote awareness amongst its population in environment related topics. As one measure, the Rwanda Environment Management Authority initiated a Greening Schoo Programme in 2011.

Within the framework of the UN Education for Sustainable Development (ESD) prog
two local organisations with the support of the British development agency, DFID
aroundthe topic of the environment through the development of Eco-School Rwa
projectis to promote environmental education in the country starting
using education to help reduce poverty levels, as well as develop environmer
mitigation knowledge amongst the children [Foundation Saint Dominique Savio, 2014

Rwanda has been successfully able to keep its streets clean with help of the
put in place once the plastic bag ban was implemented. Rwanda has one of
on this in place, which all people living in Rwanda adhereto. It ensures
capital Kigali and beyond.

Compliance with authority is a culturein Rwanda. Therefore, regulations put
adopted by the population. The way the citizens have adopted the polic
assimilated by a country.

Early 2019, the country also drafted a law to ban all single-use plast
If this passedas legislation, companies affected will have to adapt to this.

The country's infrastructure still remains inadequate as the population is fast
develop furtherthe city's infrastructure and residential buildings. The country has
construct high density buildings by 2040, by multiplying the medium rise
apartments by more than three times the number (State of the Environment and
2015).

2. Plastic Waste Management Practices

Even though streets and roads in Rwanda are clean, recycling remains a pr
Some categories of waste cannot be recycled in the country due to la
number of companies in the sector is insufficient and therefore the in
Thus the recycling industry is not entirely developed.

With increase of the population in City of Kigali, there has been a ri
on daily basis. Solid and liquid waste (SLW) are collected from households and tr
the tune of 300 tonnes par day and only 2 % of solid waste is re
a waste segregation system.

Just as it is the case in many developing countries, a dumpsite co
therefore closed down its Nyanza dumpsite and is now operating the la
State Finances, 2016].

As much as the country has an efficient way of ensuring the st
from free of waste, the final handling of the waste is still a challeng
which in addition to the regulatory framework helps to keep the streets cl
still needs to be improved in order to apply more circular practices in

Tunisia

In 2004, Tunisia set up several systems for the collection, treatment waste, such as ECO-Lef. To foster the development of the sector, the Tunisian creation of microenterprises by awarding contracts together with the mun

The system was financed by an eco-tax, although it was labelled 5.1.1). A fee of 5 % on the net added value has to be paid for raw materials. For the import of already packaged goods, no tax needed

The funds collected via the eco-taxes were (partially) used to;

- Finance the ECO-Lef system,
- Cover part of the operational fees of the municipal and hazardous waste i
- Cover part of the functional costs of the National Agency for Waste M

ECO-Lef is a public system for the recovery and recycling of pack local authorities. It includes the collection of packaging waste and recycling conditions set by the National Agency for Waste Management. The Eco-Lef types, namely PET bottles, milk bottles made of HDPE, plastic films and bags mad – cardboard packaging is excluded.

The collection of recyclable materials is done by approved and authorised companies can also buy material from informal collectors, which play a majo in Tunisia. In turn, the collections companies (can) sell their collected quar mandatory. Eventually, the material is sold to recyclers. Despite their grea the informal sector is not visible in the ECO-Lef system.

After an initial success, which peaked in 2008 with collection of 15,700mt gradually but significantly decreased to 5,400 mt of collected packaging wast significant decline was rooted in the mismatch between funds generated from packaging waste quantities and the lack of adequate steering function of recycling infrastructure. This was exacerbated by further structural weaknesses, as the of certain parts of the system was diminished due to the decrease in poor outcomes include a lack proper control, complaints over the quality of non-approved recycling companies, long transport distances connected to relatively not least, limited domestic recycling value chains.

To improve their system, the National Agency for Waste Management is it into an actual EPR system.

2.3.5 Alternatives to Plastics

In light of the growing wealth and consumption and therefore also increase this growth, efficient and effective waste management has become more in a central role for nature and resource conservation.

As part of the reduction pillar of the circular economy, it is in the substitution of plastic material with other materials in packaging and o in the following chapters, there is currently no comprehensive waste c for waste in general and plastics in particular in Kenya. In light o (predominantly landfill, low recycling structure for glass and plastic, n resources, for instance in the form of packaging, should be reduced as resource losses and unorderly deposits with the associated ecological consequ

Against this background, it is important to compare plastics vis a and impacts in regards to a multitude of impact categories. Such a part of the research and is presented in annex 8.9. In particular:

- carbon emissions (expressed through the global warming potential (GWP)) and indicators
- health, safety, collection and recycling situation as economic indicators

These comparisons are based on Life Cycle Analyses, which compared different m purpose at item level. Life Cycle Analysis (LCA) is a technique to as all the stages of a product's lifespan (from raw material extraction th distribution, use, repair and maintenance, to disposal or recycling). In c conditions in each case are considered. LCAs indicate the product's impact re warming potential, acidification, photo-oxidant formation, ozone depletion potential, te aquatic eutrophication[1], particulate matter, total primary energy, non-renewable water use (related to water input).

Generally, it is not possible to derive a general rule stating that a a statement is always item-specific and dependent on a multitude of c of a proper waste management system. Thus, from a resource conservation p of an orderly and comprehensive recycling structure is the preferred al foreseeable future, substitution will largely not be able to replace the specific attributes of plastics.

[1] Aquatic eutrophication describes the process when an aquatic body becomes over-enriched in excessive algal blooms, potentially leading to oxygen depletion and a shift in detrimental effects on the aquatic ecosystem [Chislock et al., 2013]. Terrestrial eu process and outcomes, although the enrichment of nutrients caused by air p

2.4 Kenyan Plastic Mass Flow

2.4.1 Quantification of plastic volumes

To quantify the flow of the various finished goods import, use and export, consumption in Kenya, the plastics material value chain have to be verified. The appr that plastic material is introduced in Keny

The researchers conducted a mass flow analysis by combining: modelling of national data sets on plastics and plastic packaging consumption from 2016 inflated to 2017 with a survey of Kenyan recycl regarding the quantities of recycled plastics and plastic packaging wast

the capita the

i) imported raw material for plastic packaging (raw material for resins and p
ii) imported packaging material as well as plastic goods, or already as
iii) waste material

Within Kenya, the raw material for plastics is converted into plastic pac together with the imported packaging and products – are sold to com become waste. This waste is subsequently prepared for reuse, recycled, disposed and informal channels, or potentially even exported to other countries. Othe of the country are through the export of plastic packaging and plastic prod export of raw materials.

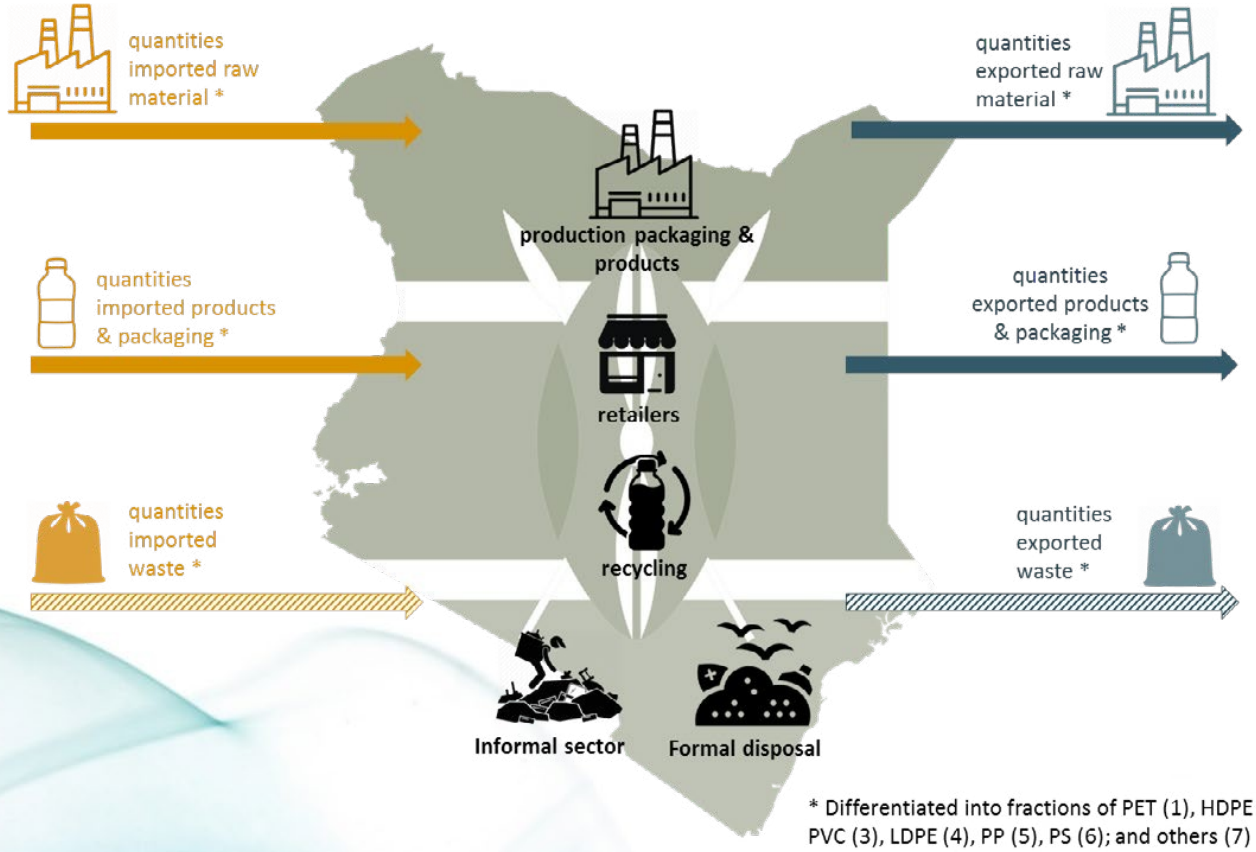


Figure 13: Mass flow of plastics material within Kenya

To identify the flow of plastic material at every step of the plastics value chain (see annex 8.3), KAM was conducted with relevant actors from all steps along the value chain and were asked to indicate their activities in relation to plastic use and fractions (see annex 8.2), the respective volumes purchased and potential

This is complemented by insights derived from the key informant interviews conducted in the Action Plan's research.

The results of the online questionnaires have been compared and complemented with a study undertaken by Eunomia [2018] which is based on the accuracy of conclusions. In particular, the study generated in Kenya. Eunomia's research identified quantity of waste on the market equals the quantity of waste generated, assumption that the volume it has to be considered that this is not due to the fully accurate packaging is reused either for the same purpose or for a different in the main research method is interviews of different stakeholders important study can therefore rather be considered estimates. The second market Ipsos [2019] with focus on PET bottles: within the course of the material in Kenya was also conducted, based on data from 2017.

Import of plastics

Although Kenya possesses crude oil, there are no plans to set up a refinery Domestic crude oil is therefore not (yet) used for the generation of plastics and/ or product must have been imported to Kenya at some point (including for resins). This assumption matches the most relevant approach of the other st quantifying this interface is the most relevant one.

According to Eunomia [2018], an estimated 567,000 mt of primary and non-primary plastics was imported into Kenya in 2016. The study reports 453,781 mt of imported plastic year (and 469,400 mt in 2016). Due to this numbers production, it is assumed that this numbers primary plastics in the form of film, granulates, resins and in 2017, the plastic industry empty containers and around 240,000 mt of primary plastics with the balance, processed roughly half the total imported volumes, The import of plastics in the form of already packed goods is, the numbers of the two studies are not fully congruent, they are 450,000 to 570,000 mt of primary and non-primary plastic imports different nature of the data, as one is an estimated value, based developments. Moreover, it also shows the uncertainty of the market into perspective that Eunomia also includes packed/made products in its of all goods consumed in Kenya, the gap shrinks – making both

The numbers on imported plastics of the two reviewed studies are not fully congruent, but they are general close to each other indicating a sca of 450,000 to 570,000 mt of primary and non-primary plastics for 2017.

The main countries from which the material is imported are China, India instance, 86 % of imported PET originates from China and India alone [I

The interviews revealed that sorted plastics fractions are also occasionally impo
Tanzania, to be recycled in Kenya as the prices for waste material are
countries [Kenya Plastic Action Plan Interviews, 2019]. These amounts seem to be relat
to the domestic volume flows, altough no exact quantities could be asse
assessed, was the illegal import of plastics in any form. Thus, the magnitude

Domestic processing of plastics and production of packaging

As the domestic production of plastics material and products is depe
materials, the material flows from the previous step to this one are inev
important verification of the mass flow.

As briefly mentioned in the previous sectio tion
of plastics material is non-existent; the
whole demand. Around half (equalling 240,
imports are processed domestically. These local
have to compete with oftentimes cheaper
and the UAE, for example [Ipsos, 2019]. The
survey display, particularly raw material for
is imported, while the quantities for PVC minor
importance – which is also reflected in rs
(see below ‘Waste management and recycling’).

> The numbers on imported plastics of the two reviewed studies are not fully congruent, but they are genera close to each other indicating a sca of 450,000 to 570,000 mt of primary and non-primary plastics for 2017.

In Kenya, the domestic packaging, supposedly linked to domestic production, is
import of packed/ made goods. According to Eunomia [2018], aroundfour fifth
is used locally from imported packaging, imported virgin material (processed into
to a lesser extent, domestically recycled materials. Only arounda fifth of
of packed/made products. The Kenyan privatesector comprises a diversified stru
and multinational consumer goods companies that serve Kenya and surrounding markets
of products. With production and packaging operations on site, they together
packaging material consumed in Kenya [Kenya Plastic Action Plan Interviews, 2019].

Export

Just as the with the import group, this group is an umbrella for three diffe
materials (both made virgin materials as well as recyclates as secondary mat
including packaging, and the export of waste. Regarding the export
of raw materials, Eunomia [2018] reported d
plastics have been exported. Exported plast
at 51,000 mt for 2017 [Eunomia, 2018; Ipsos
primary source of export data does not clear
of all packaged products and plastic good
Information about exports of plastic waste could not be identified. number.

> Around 80 % of packaging materials volume is used locally from importe packaging, imported virgin materia processed into packaging domestica and domestically recycled materials

Waste management: recycling quota

To analyse the quantities of the plastic fractions which have been consume
exported raw materials (only primary, not secondary) and exported products
of plastics introduced on the market (either imported or produced lo

As presented by the Eunomia study, a total of 36,193mt of plastic w
1), meaning processing plastic waste through washing, flaking, shredding, g
recycled plastics in the production of new products. The volume fo
mt, indicating that only parts of the recovered materials met the criteriafo
amount of plastic packaging recycled was 23,006mt. The remainder, 13,907m
plastics applied for different purposes. Whereas practically all PET re
significant percentages of other recycled fractions HDPE, PP and LDPE were o
packaging. Differentiated according to the seven plastic fractions, the numbers a

Table 1 : Quantities of recycled plastics and plastic packaging acc. to fraction in 2017 [Eunomia

	Plastic waste forwarded to recyclers (mt / year)	Amount of plastics recycled (mt / year)	Amount of plastic packagi recycled (mt / year)
PET	Specific data not available	5,778	5,778
HDPE		10,943	4,407
PVC		177	0
LDPE		8,091	4,998
PP		6,806	4,873
PS		0	0
Others		4,398	2,950
Total	**42,950**	**36,193**	**23,006**

Reflecting on all steps of the mass flow and the plastics consumption in
recycling capacities regarding the different plastic fractions vary significantly: O
to the difference of the in-use phasesbased on the sectoral uses, as e
fractions, for instance, are utilized for longer periods, e.g. in construc
waste yet. On the other hand, it is also based on the differently develope
in Kenya; for instance, no PS recycling infrastructure has been identified, in
recycling loop.

Overall, **the quota for recycled plastics equals 7 % according to the data of the Eunomia stu**
coupled with export data from the Ipsos Study [2019]. Putting these two sc
the recycling quota is based on the following calculation:

$$\frac{\text{36,193mt plastics recycled}}{\text{(567,000 mt plastics imported - 51,000mt plastic products exported}}$$

The underlying data shows certainamounts of uncertainty. Therefore, utilizing al
resulting recycling quota varies. Nevertheless, even taking into account different d
that the recycling quota for plastics in Kenya stands at less than 10 %

However, different to the above, the quota by analysing the generated waste. According to every Kenyan generates 0.39 kg of wast plastic has not been evaluated for the whol the percentage ranges from 9 % for low income to 15% for high income hous Nairobi [UN Habitat 2019]. Data obtained by JICA [2010] assumes for midc the portion of plastic at the lower end of this, with 9.5 % of whole of the

Taking a total population of approx. 50.2 million inhabitants in 2017 [World Bank Each person generates 0.39 kg of solid waste per day [World Bank, 2018], the of almost 20,000 mt of waste and around 7 million mt annually. that 11.8 % of the municipal waste streams are composed of plastics plastic waste are generated annually in Kenya. This is significantly high [2018]; amounts of imported plastics estimate supposed to be higher usin rate would thus be significantly lower.

Closing the gap related to recycling and a circular economy depe current waste management practices, recycling possibilities and demand for recy and legal framework.

> Estimates for plastics used in Kenya range from around 500,000 to 800,000 mt per year. Less than 10 % of these plastics are currently recycled.

Waste Management in Kenya

Kenya counts a population of around 50 million people. The metropolitan area arou includes neighbouring counties Kiambu and Machakos and comprises a popu city Nairobi itself houses around 4.6 million inhabitants [UN Habitat, 2019]. The secc counts more than one million inhabitants and forms another major economic and logis apparent in its role as the main harbour for several countries in Eldoret and Nakuru exist in the more densely inhabited highlands towa country. Especially in the agriculturally productive highlands and a narrow stret density is quite high even in rural areas, while particularly northern and east the borders of South Sudan, Ethiopia and Somalia, are scarcely populated. Kenya's characteristics as a rapidly developing country are also present **0.39 kg of waste per capita occur daily,** compared to 2.7 kg per capita in Gerr

In the Greater Nairobi areas, Kenya's political and economic hub, 3,000 mt or 0.64 kg per capita of waste occur daily from residential areas, industry and other private companies as well Habitat 2019], a slight increase since the estimates by JICA [2010]. All plus minor amounts of glass, paper, metal and others. According to JICA [2010], 9.5 %. Recent data collection carried out by UN Habitat [2019] assumes plast %, specified as per different income levels in Nairobi; countrywide data count relatively lower volumes of plastics on other, high income areas account for the highest Middle income areas are, by far, the most relevar of absolute volume of plastics in munici function as the economic and political hub, Kenya's high-income areas are concentrated in Nairobi

> Roughly a tenth of municipal waste volume in Kenya comes from plastic mainly packaging material.

Putting all these findings together, plastics account for the largest shar waste and paper. These volumes predominantly originate from plastic packaging inclu manufactured goods [Eunomia, 2018].

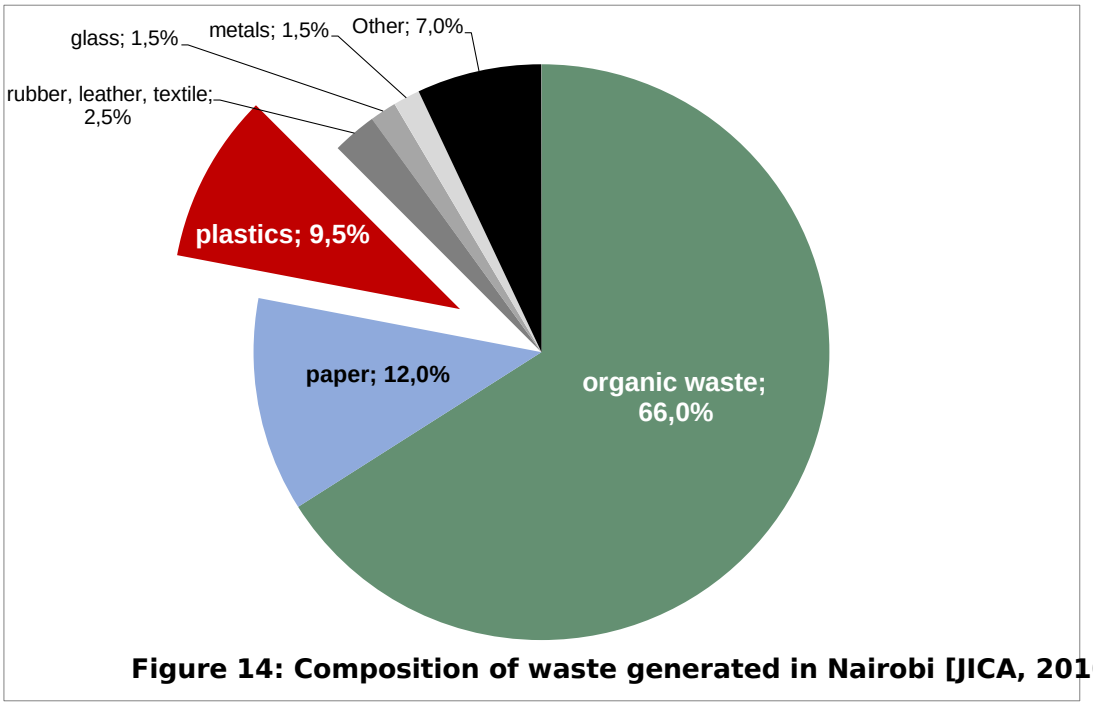


Figure 14: Composition of waste generated in Nairobi [JICA, 2010]

2.4.2 Collection Systems

The public sector as a stakeholder steers the general direction of Kenya's actions plans. Institutions like the National Environmental Management Authority operation in the field. Additionally, some rules and regulations are set by th responsible for executing national law by implementing waste management infrastru County Government Act, 2012]. A detailed overview of relevant legislatic provided in chapter 3.

Within its legal boundaries, Nairobi City Coun charge of collecting waste effectively. However, services ranging led to the rise of a dom from waste pickers (also called scav sorters to recycling happen without collection, group recyclers [UNEP, 2015]. Private restrictions, based on an open competition of buyers and sellers, and is a largely cash-based economy [UNEP, 2015]. Waste c informal sector also plays a major to dominant role in all other Counties may vary [Kenya Plastic Action Plan Interviews, 2019]. Collection run officially public or private sector, are nevertheless shown to have many systems, or are si country-wide data is only limited or not available at all irregularities [Kenya Plastic Action P

In Nairobi, economic activities and services relating to waste management are mainly undertake by the informal sector.

Thus, systematic waste management infrastructure is lacking. A recently undertaken estimates that around 75 % of Nairobi's waste volume is collected in at best. The remaining roughly 25 % of waste volume ends up bein neighbourhoods or self-treated, i.e. incinerated on site [JICA, 2010].

To the contrary, some professionals in the waste management value chain assume around 25 % to be more realistic [Kenya Plastic Action Plan Interviews, 2019]. Abou is collected in high-income areas, whereas it is respectively lower with decl confirmed in both studies, that collection rates are significantly higher in being true in low income areas. UN Habitat [2019] assumes a collection is estin referring to 13 % of Nairobi's population. The collection rate population, income areas, representing around 35 and 52 % of the total

At generation of 'domestic' source, mainly households but also public and private offices, waste is usually not segre Waste segregation at generation of source is generally absent in Kenya is true for waste from streets and public areas only. In gene picked; hence the informal part of streets of valuable waste segregate mate the environment but results in the collection casual waste workers dumpsite, in a mixed collection lorry. During transport, chain. When reaching UN Habi seem of value for the subsequent recycling put aside. According a % rigid plastics, PET bottles and glass have been more than 20 of rate before reaching a dumpsite stands at slightly first segregation on than 30 % of collected volume. After this dumpsite, the health out materials at the dumpsite. Particularly on the of the water as well as the environment in and downstream limited. This collection lorry and on the proximity sorting capacities are [JICA, 2010; Kenya at source and declining value dumpsite, and moist materials barely cover 1 2019]. These secondary recovery of dirty at the dumpsite a dumpsite, i.e. 2.5 % of the waste activities has reached 2019]. dumpsite will never be recovered that [UN Habitat

Putting these numbers into proportion: In Nairobi, around 3,000 mt of mun of these are collected, 750 mt are directly disposed into rivers or burn recovered either before or on the collection truck and another 40 mt from of almost 3,000 mt. The recycling rate of municipal solid waste in Nairobi 22 % of the total waste or 30 % of the collected waste volumes.

Aside from the above mentioned "domestic" waste (including private and public offices), on a more industrial scale, usually by private enterprises. Some manufacturing indu waste management by either contracting companies to collect – whereby usually unknown – back or by private internally. Small scale to shredding production waste into the managing it or to sell it it for secondary use. To loop raw materials is practised to waste. Some industrial steam boilers a limited extent, incineration as plastics as a exists, however both business models have the capacity to burn at scale and are are not realized

Some companies prove to be especially innovative as they expand to d on their by-product; hence closing materials loop within own operations. The general manufacturing sector has applied proper solid waste management practices in it feeding back most fractions into the production processes and selling remainin recyclers. [Kenya Plastic Action Plan interviews, 2019].

2.4.3 Recycling Infrastructure

Recycling infrastructure in Kenya is composed of privatecompanies that access waste through market mechanism convert it into secondary materials that production processes/be used for a new purp recovered by waste collectors, including wast sold to a waste recycler. After undertaking steps, depending on the material and inclu sorting, washing, shredding, etc., the segr yard is usuallyundertaken by hand, enabled cost of labour.

Rigid plastic recycling (like recyclin of PE bottles, PP cups or PET bottles new is common with a large number of small-scale recyclers throughout Kenya. In bigger economic hubs, recycling infrastructure for HDPE an PP is in place; other areas are yet to attract recycling businesses.

The secondary resources are then resold to material converters that produce of the recycling value chain but are usuallynot regarded as recyclers th also consists of many companies whose business areas overlap into several

Organic Material

With aroundtwo thirds of the volume, organic matter accounts for the va in Kenya. Composting for organic waste is undertaken usuallyon a small sc horticultural waste, whereas only one industrial composting facility exists in the co in urban areas, most of the collected organic waste is disposed on d animal consumption and especially pigs are fed and bred both in rural areas a Especially pork that is produced in the surrounding of dumpsites is d only limitedly suitable for humanconsumption.

Paper, Glass and Metal Recycling

For paper recycling, several processing facilities that convert waste paper into carton boxes form value chains that recycle high percentages of waste paper, both from neighbouring countries. A fair number of paper segregators are located converting facilities mainly concentrated in the Greater Nairobi area; one exce plant in Kisumu/ Western part of Kenya.

Only two companies have the capacity to properly recycle glass bottles. existing recycling capacity is barely sufficient to supply the two main exist glass; one is located in the capital Nairobi, being run by the market glass is dominated by the second one. Based on the coast, this company country. The glass recycling plant is therefore both a focal point and a and aggregating glass waste. Seen from a closed-loop perspective, the limited connected with the supposedly high inflow of import glass result in poor recycling for subsequent use as e.g. filling material in construction is a commonly

Due to the relatively high value and good recyclability, the scrap metal recycling fulfil its requirements. Metal is used in relatively low quantity for packaging % of household waste in Nairobi [UN Habitat 2019]. The two main appl lower extent, soft drink cans as well as tinned foods with both commanding relat seems no recycling facility for canned beverages operational in Kenya; recycling directed abroad which due to its value-weight ratio seems to be a feasible is recycled domestically.

Plastic Recycling

Rigid plastic recycling is common with a large number of small-scale recy Rigid plastic items are stable in form, e.g. PET-bottles, PP cups, plastic pipes (in cont such as film) and more easy to collect. For the main fractions, HDPE and waste materials into flakes is in place within the bigger economic hubs and part bigger dumpsites. Newly urbanised areas outside the traditional towns are lagging value chains for the mentioned plastics do exist in e.g. Eldoret, Kisumu Meru and Kisii, among others, have yet to attract recycling businesses and build loca of several recycling companies.

Figure 15: The hierarchy of the plastic waste recycling chain

Especially outside of areas with functioning recycling value chains, so-called a
small businesses by nature, serve as focal points for informal waste pickers.
and subsequently send the fractions for recycling into other parts of the c
recycling happens more selectively and recovery rates are lower.

Similar to the above described practices for rigid plastics, recycling is u
namely LDPE. Recycling rates seem to be lower and the recycling value c
mainly due to more logistical challenges in collecting the relatively light a

Mechanical processes mainly include baling, shredding, washing, flaking and palletizin
into new products usually happens after the primary recycling at plastic c
can be mixed with virgin materials to produce rigid plastics, mainly for h
and related products.

PET plastic recycling is done by a small number of companies on fe
recycling sites have been identified in Kisumu, Nairobi and at the C
because of economics of logistics, e.g. lack of decentralized baling facilities
with the low volume-value ratio; similar metrics are found for any LDPE (flexible)
often exported for fibre production in Asia. Currently, a single project to d
recycling is being undertaken. With newly set up infrastructure, PET is e
Despite scattered existing and upcoming recycling infrastructure, most P
[Kenya Plastic Action Plan interviews, 2019].

Recycling value chains for PVC and PS have not been identified within this as
seem not to be recyclable domestically. They are, however, of less importan
the aforementioned materials. Mixed packaging materials, e.g. ‘Tetra Pak” but al
specific attributes, e.g. coffee or tea multilayers, lack recycling facilities. C
converting ‘Tetra Pak’ packaging into building material is underway [Kenya Pl

2.4.4 Disposal Practices

The current disposal practices in Kenya are described best by initially
Kenya’s biggest waste disposal site by volume, the Dandora municipa
dumpsite is located eight kilometres away from Nairobi city centre and spreads
It was originally designed as a temporary disposal site, but was d
Dandora’s capacity stands at around 500,000 cubic metres. Since the year 2
with 1.8 million cubic metres estimated in 2016 [JICA, 2016]. Dandora has a li
is unrestricted and stated that still kind of industrial, agricultural, domestic and medical
2010 estimate organized in of between 1,200 and 1,500 waste pickers work at D
others 2,000 mt waste are often unethical structures [JICA, 2010]. Accordin
operators, collected and transported disposed of at Dandora on a da
picked, from UN Habitat [2019]. out of Dandora to recyclers and c
figures

Around 70 other smaller dumpsites are spread across Nairobi. None of th
to dispose waste. In addition to dumpsites, dumping of waste on th
more so in low-income residential areas. Already polluted upstream by in
River later flows through Dandora, causing downstream water used for domestic
be highly contaminated [UNEP, 2015].

The waste disposal practices in the second biggest city of Mombasa, similarly dysfunctional. Here, the collected volume of around 800 mt of solid rate of around 68 % [UNEP, 2015]. Semi-formal and informal dumpsites exist thro particularly in the proximity of urban areas. The problems described for Nair in all other urbanized areas, with their respective sizes always being smaller. With ongoing setup of a new dumpsite in Murang'a County (due to its waste), no dumpsite in Kenya is operated according to international stan

All in all, the absence of formal waste management services, insufficient treat operated in an unregulated environment bring severe societal and environmental issues exist which are yet to be overcome in order to enable an effective organisational, logistical as well as legal terms. The current organisational management, insufficient monitoring, lacking legal enforcement as well as very limit of land zoning fuels conflicts when new residential areas appear close to industry terms of the collection and transportation system, the formal and informal unorganised and inefficient way. Collection and transportation are usually beyond governments, hence so far not organisable, resulting in illegal dumping scattered parts of the country [JICA, 2010].

Figure 16: Dandora dumpsite

2.4.5 Challenges for Plastic Recycling in the Waste Management Ecosystem

Segregation

Systematic segregation at source, i.e. mainly at the household (and office) le
rates for recyclable materials. Several factors contribute
to this finding, among them are limite
infrastructure, informal waste collection
regulatory framework and, compared to
low plastic waste generation due to low
packaged goods due to low income.
organic waste makes the recovery of
difficult. Additionally, due to moisture
the fractions is lowered further,
segregation.

Challenges in the Recycling Value Chain:

- Segregation
- Logistics
- Licencing/ Regulatory Framework
- Product Design
- Secondary Market
- Awareness/ Education

Logistics

The value of the potentially recycled material in its unprocessed form is
costs of collection, segregation and transport, due to the low volume-value ra
to be transported over far distances to certain hubs to be fed into th
baling or shredding are missing. Only the areas around Nairobi and, to a
possibilities to recycle all main fractions (not to speak of completely m
whereas logistics have to be organised in order to ship certain fractions

Licensing/ Regulatory Framework

The regulations and policies related to solid waste management are outlined in
loose, the currently biggest hurdle for the recycling value chain are licences
i.e. secondary materials. The attributed costs and frequent time-delays in ol
economics of transporting waste. Furthermore, there is limited clarity on whether th
secondary resources. It is thus unclear if single fraction shipments a

Product Design

With certain criteria taken into consideration when designing product packaging, recycling
significantly eased. Currently, some products contain an unfavourable mixture of
recycling value. Additives like filling chemicals, partially applied in rigid pl
collector and likewise the recycler and may only be noticed by th
converter). By then, all costs within the recycling value chain have already oc
created. The change of material for a certain packaging, e.g. from H
value chain as casual collectors and workers are not aware of the respectiv
different colours imply different value; e.g. the recycling value for coloured
than the already marginal one for clear PET.

A bottler of carbonated drinks in Kenya is currently harmonizing its product
utilizing PET labels. This is exemplary for a producer's action to create m

Secondary Market

The current plastic recyclers are by and large small companies processing relat
waste, thereby usually building the transition point between the informal and
subsequently in the value chain, the converters face a number of hindrances
recycling. Two main factors are unpredictable and unreliable: mass flows and the qual
The efficient utilization of fixed assets can only be assured if the inpu
informal collection and aggregation structures that are sensitive to price char
a certain risk of not recovering their costs. The oftentimes low quality of inpu
sorting practices, unfavourable composition of fractions (e.g. through filling material
as the lack of waste segregation at source (dirt, moisture). The use of recy
narrow range of applications that only require low qualities, which is why the
practises “downcycling” towards end-of-life solutions. Recycled material ther
virgin material – in regards to price, quality and availability. Thus, the vast
Kenyan recycling sector are disabled at this moment. This is also prov

Awareness/ Education

Awareness and Education are identified as one of the key hurdles for
Littering in public at a small scale or the irregular disposal of wast
spans multiple generations. Some programmes and activities in schools and the
drivers of those are non-profit organizations, private companies including those in the
well as the public sector. Despite these numerous efforts, education on waste man
in the school curricula.

Nevertheless, the current lack of a proper recycling infrastructure also creates
managing waste; despite some behavioural changes when it comes to littering,
related activities, by and large there are just no best practices in plac


re-use

3. Legal and Regulatory Frameworks affecting the Plastic Sector

Following the previous description of the situation, the following chapter on the underlying legal and institutional analysis includes the identification of legal gaps which have to be addressed to waste management system. Currently, directions and goals are stated by a number of plans. Looking at the overall picture, are under-, others rather overregulated.

In Kenya, waste is defined as 'any matter prescribed to be waste and any matter whether liquid, solid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume, composition or manner likely to cause an alteration of the environment' – according to the National Environment Management Authority (NEMA).

3.1 Review of Kenyan (regional, national and county) legislation formulation on plastic and waste management

Plans and Strategies

In 2007, Kenya's government published a strategy that described the pathway into a middle-income nation by the year 2030 [GoK, 2007]. The industrial waste management system in order to handle need for a sustainable waste management in a just and cohesive pillar. The latter claims in paragraph 5.4 to realize 'a clean strategy calls for development in a clean environment.' In particular, the establishing waste management through economic incentives. Regulations regarding and hazardous products are one of its figurehead projects [AWEMAC et al., medium-term strategy of the Vision 2030, set by the current government after Big Four Agenda does not state waste management and circular economy in 2017]. to enable its goals in regards to food, health, manufacturing and housing [GoK, Big Four Agenda, 2017].

The Third Medium Term Plan 2018-2022 (MTP III) and Green Economy Strategy (GESIP) comprise specific reforms, programmes and projects for the realization of strategy. With regards to solid waste management, they call for separation at new collection infrastructure, treatment facilities and disposal sites. It to build these in respective areas. The goal for 2030 is a nationwide quota form of recycling and composting. The implementation of extended producer legislation is stated within GESIP. Financial incentives to support functional markets shall be established. This relates to the promotion of recovering and utilizing recycled products. Furthermore, the national and County Governments are obliged total ban of plastic bags [GoK, GESIP, 2016; GoK, MTP III, 2018]. Despite pointing waste management practices in Kenya, the mentioned documents remain vague in setting out implementation measures.

Kenya's plans and strategies on waste management are guided by Vision 2030. Vision 2030 calls for reducing pollution and establishing waste management systems through economic incentives. In light of the pillars of the Big Four Agenda, it will be important that waste is managed in a manner that creates jobs and allows the manufacturing sector to flourish.

The National Environment Policy requires the development of an integrated National Waste Management Strategy with economic incentives cleaner production, waste recovery, recycling [GoK, 2013]. The Solid Waste Management Strategy of the National Environment Management Au

(NEMA) translates this into the 7R Zero Waste Principle, applicable at th
recovery and 20 % landfilling by 2030. The latter strategy links EPR to
accountable for their products and end of life. However, it mainly triggers
recycling is not specifically mentioned.
For medical waste, the National Health Care Waste Management Plan guides the p
monitoring of waste management across the health sector. Emphasis is placed on se
safe disposal [Ministry of Health, 2016].

To ensure a holistic, clean and healthy environment, the Kenya Environmental
2016-2030 (KESHP) claims to reduce solid waste and, in particular, to minimize
management systems and mechanisms shall be established and enforced by n
in every city, municipality and town. Especially the use of plastic bags shall b
incentives. The privatesector is invited to provide services for realization [G

Another relevant legislative document is the National Climate Change
Priority No. 5: Health, Sanitation and Human Settlement, the Plan ca
substantially reduce waste generation through prevention, reduction, recycling and re
2019]. By 2023, five waste management plans and regulations shall be developed o
NEMA's National Waste Management Strategy 2015 [GoK, NCCAP, 2015]. The la
integrated solid waste management system that follows the principle of the w
reduction, reuse, recycling, resource recovery, incineration, and landfilling [NEMA,

Laws and Regulations

Kenya's Constitution states that every individual has the right to a clean e
generators, transporters, recyclers and institutions that own disposal facilities a
not threaten citizens' rights. Refuse removal, refuse dumping and solid waste d
governments in order to ensure environmental conservation [GoK,
Constitution: Article 42, 2010].

According the Constitution of Kenya every Kenyan has the right to a clea environment.

Urban areas and any physical planning need
of waste effectively, offer designated sites and
for adherence according to the constitution
Act, 1996; GoK, Urban Areas and Cities Act, 2011].

The Environmental Management and Coordination Act 1999 (EMCA), with its sp
Management Regulation from 2006, sets the applicable rule of law. The act d
generate waste to implement mechanisms for reducing and appropriately treating
dangerous handling of waste, denies the disposal of any waste in a w
responsibility for pollution to its producer. The principle that the polluter
exercising jurisdiction [AWEMAC et al., 2019].

Moreover, the transportation of waste and
need licences from NEMA, which come with standar
Effective from 2017 onwards, a ban was the
use, manufacture and import of all plastics
and household packaging. This ban covers the
bags and flat bags made from polyethylene (PE).
packaging and garbage bin flat bags are
clearance is issued by NEMA.

A majority of those interviewed welcome laws and regulations, however they would prefer that implementation is phased and predictable. This would allow the industry to be better prepared fo changes and plan their strategic if investments accordingly.

Clearance approval is subject to exerting producer responsibility, e.g. in measures; labelling needs to enable traceability of the plastics and sufficient and dissemination needs to be provided [Gazette Notice No. 2334 &2356, 201 The plastics bag ban was expanded by Gazette Notice No. 4858 in June straws and other single use plastics in protected areas, i.e. National Parks, Fore effect in June 2020.

County governments are responsible for the implementation of waste manageme level. However, counties are free in their decision on how effectively to publish a pricing policy that sets tariffs for public waste management services that and recycling of waste [GoK, County Government Act, 2012].

Draft Policies and bills

Several legislative documents that affect plastics are in the pipeline or Waste Act, 2019, opts for a more sustainable, circular economy in which wast resource. Therefore, Zero Waste Principles are applied. Within the Bill, EPR a […] firm's financial or physical responsibility for a product to the stated as being a key pillar for policy development and implementation by the in order to prevent causing waste and to enable re-use initiatives.

The Ministry of Environment is tasked with developing regulations to expand the recyclin tax incentives and government procurer [AWEMAC et al., 2019]; the Nationa to come up with a milestone t management and design necessary regulati entities are obliged to apply and are fined if not compliant; citizens are obliged to minimize wast recover measures for the remaining consumed materials. Waste has to be prosecutors will be held liable including the possibility of imposing fines [GoK Bill, 2019].

> The draft policies emphasize recycling and recognition of waste as a resource that should be harnessed and exploited for the purposes o jobs creation and cleaning of the environment.

Within the budget statement for fiscal year 2019/2020 it was proposed to plastics recycling companies from the usual 30 % to 15 % for the to plastics recycling plants as well as the supply of machinery and equi plants are supposed to be exempt from Value Added Tax. These proposals are 2019 that is yet to be passed.

Another draft Environmental Management and Co-ordination (Plastics Bags Control 2018 refers to plastics bag control and management. Every manufacturer and importer packaging has to propose and uphold a recycling plan to support th into the market. The plan can be developed individually or in collabora submitted to the authority in charge (NEMA) for publishing and documer Each manufacturer and importer has to submit a Recycling Program Report to mass flow and treatment activities. Due diligence is required throughout th requires a recycling rate of 30 % for the manufacture of any pl plastic collection sites shall be published by NEMA. NEMA is also accountable fo mentioned and all other facilities that handle any plastic packaging material th Draft Environmental Management and Co-ordination Regulations, Plastic Bags Control a

3.2 Discussion of the existing regulatory gaps

Whereas some forms of EPR such as take-back schemes are already in infrastructure for waste recovery are non-existent. Moreover, several regulatory g three framework dimensions, i.e. policy, legal and institutional, that hamper an a waste management system in Kenya. The following descriptions are based on in stakeholders along the plastics value chain. Research undertaken by AWEMAC et is additionally taken into account. The following collection assesses existing consumer plastic packaging EPR schemes in Kenya.

Policy Framework

Currently, certain provisions in the policy framew another. For example, on one hand, bans and use of certain materials have been declare Notice No. 2334 & 2356, 2017] whilst on the operation of recycling is promoted [e.g. Policy, 2013]. Investments into recycling infrastructure sinking if respective input materials are are not aligned. For instance, different rate targets. Some policies, like the Sustain EPR schemes. However, roles are not clearly allocated among the plastics va and/or physical responsibility in the system lacks definition. Uncertainties, unspecif of the timeline for enacting draft policies, particularly the awaited N Policy, 2019, discourage the privatesector from engaging and building value chains th a functional waste management ecosystem.

> Currently, a number of political documents are tackling waste management practices. Nevertheless, different policies have little interconnection to each other, resulting in an overal blurry, partly self-contradicting framework.

Legal Framework

The definition of the term 'waste' in Kenya is currently done by N of waste. The concept of transforming waste into secondary resources once va or further steps in the recycling process, does not exist. This situation cr comes to transport during the process, as the trucks are subject to th as waste collection transporters (dump trucks).

Waste segregation is mandatory by law, but in reality applies only to the hazardous waste. There are no consumer obligations and regulations to segregate the local authorities fail to provide infrastructure for adequate littering prev segregate waste in any terms is difficult to enforce. A comprehensive e.g. campaigns or insertion into curricula is lacking. Last but not least waste management at County levels – laws and infrastructure are not harmonized at every county border impose costs that discourage value adding processes and hind value chains. Putting the mentioned circumstances together makes waste recovery the economics of collection, transporting and processing of waste hardly build viab

In respect to plastics, first responsibility for the plastic life cycle is alloc of end market goods only; the role of other stakeholders in the plastics importers, retailers, collectors and consumers, among others, remains undefined. Secc law to set up appropriate recycling plants either individually or jointly. However, directions on how to set up and implement any of those do not exist collection and recycling targets for obliged companies hinder monitoring proc

Regarding the establishment of an EPR system, existing laws and regulations and the potential setup of an overarching EPR system. So far, NEMA guid Management and Co-Ordination Act on Plastics Bags lay out control and manageme focused on polythene bags, with other plastics fractions/ product categories Sustainable Waste Management Bill also claims to set up measures and necessary take-back schemes and deposit systems. In reality, it neither gives suffi be taken, nor does it provide a timeline by when those rules and sche

Moreover, no measurement in respect of to 'how to identify the plast The enforcement of a potential EPR is therefore made difficult. Despite monetary incentives are not sufficiently aligned to spur changes. This appl production and packaging, as well as putting minimum collection rates in laws allow 'cherrypicking', and do not properly outline how to increase recy avoiding contributions to a potential EPR throughout the value chain is still therefore imply rising costs and worsening competitiveness for participants/ contributors

Institutional Framework

Any enforcement and monitoring by the government and the authority in charge (NEMA) is lacking due to nisms. Standards of KEBS for recycling products The same applies for NEMA guidelines that production patterns, i.e. through labels etc. oblige the manufacturing sector to participate waste recovery and recycling processes. Countie capacity to implement waste management practic instance, the segregation and responsible waste demanded by law on the one hand. On to comply with these regulations is not consumers nor for the disposal industry. of supervision measures and compliance enforce considering the double burden from both national requirements and regulations. This is especially to licensing requirements and non-harmonized rules, fees and charges.

Within the plastics sector, more so recycling, there are different government agencies in charge for regulations. Harmonization of the enforcement efforts between the different government agencie would greatly benefit the plastics industry. For instance, with no cle standard from KEBS on plastics waste, the transition from waste to resource cannot be specifically defined.

in

ucture littering

4. SWOT analysis of the Kenyan Plastics Value Chain

The following Strengths-Weaknesses-Opportunities-Threats analysis evaluates the statu
plastics value chain.

Strengths

- Strong and well organised privatesector which is ambitious to take action on b
  management practices
- Strong need for an EPR expressed by both public and privatesector
- Relatively well working individual recycling value chains for certainfractions, e
- Plastic packaging value chain does exist in Kenya and can take joint action/product
  can be effected within the country

Weaknesses

- Spread of plastic packaging throughout the country/ limited local
  consumption paired with high cost of transport/ logistics
- Lack of awareness and cultureon proper waste management practices amongcitizens
  part of the lower income class living above the poverty line
- Practically no tradition of waste segregation especially in households
- Little experience in formalized waste collection systems
- Insufficient general waste management infrastructure: lack of waste bins, formal c
  collection; poor roads etc.
- Little legislation concerning waste management/many relevant areas not sufficiently c
  legislation
- Enforcement of existing waste management regulations partly deficient
- Lack of clear definitions, responsibilities, roles, etc., leading to different i
  practices across the country

Weaknesses

- Growing industry of local consumer goods manufacturers with continuing n
- Strong multinationals with strict internal targets on better managing waste w
- Lack of alternatives to plastic packaging for a range of applications/ banning
  more problems than solutions
- Rising awareness of some parts of the population with regards to better w
- Low cost of labour/high demand for employment enables business modelsf
- Raising the value of disposed plastics even marginally is a viable n
  rates due to high need for even marginally paid employment/ income generat
- Adaptation of circular economy concepts can create “green jobs” while increasi
  from currently low rates.
- Waste management is a devolved responsibility, hence allowing pilot projects i
  through local decision making

Threats

- Unpredictable regulatory frameworks
- Risky environment for investment due to uncertainty of coming legislation
- Fragmented opinions within industry on the way forward
- Industry may not find a common voice/ voluntary EPR schemes not interest with competitive disadvantages and free riders
- Voluntary take-back schemes would cause competitive disadvantages due to market
- EPR organization may not be recognized by all relevant stakeholders/might

The insights from the analysis of the Kenyan waste management situation gaps as well as the SWOT analysis are considered for creating tailored in the subsequent Action Plan.

5. Proposed Measures and Initiatives for the Action Plan

Based on the analyses and evaluations in the previous chapters, this ch initiatives and measures to accelerate Kenya's transition towards a ci sustainable use and recycling of plastics. In particular, it focuses on mechanisms to create a sound basis for further actions. Thus, the first part w organisational and financial basis while the second part will introduce sp

5.1 Establishing a Financial and Organisational Basis

Economic instruments are crucial to establish a sound financial and organisa management and recycling. Generally, there are three different types of economi

- Revenue-raising instruments which create a direct income from the industry taxation or charges as, for instance, a landfill tax
- Revenue providing instruments which create an indirect income for indus reduction of charges or subsidies, like tax rebates or variable
- Non-revenue instruments which do not create revenues but motivate the indus improve their individual waste performance, as it is done for example chapter 5.1.2 below
- Ideally, instruments from all three categories are implemented in a comp results.

5.1.1 Tax incentives

Generally, taxes can be raised on several products at several steps al to avoid unfair double taxation and use taxes which are complementary to th in the next chapter. Thus, the most important taxes to consider are th payments.

Landfill Charges

Generally, landfill charges are composed of the gate fees imposed by th tax imposed by the authority: The gate fee is charged in order to working order and finance the provided services. The landfill tax is a on a national, but also on a regional or municipal level) for w tax, the lower the incentive to recycle waste. Thus, there is clear and li charge and the percentage of recycled waste, i.e. landfill charges are a k

To allow the system and the relevant authority to adapt to raising la increased gradually. However, it is crucial to have clear commitments to in municipalities and the (informal) industry time to adapt. From a long-term p such as landfill restrictions or bans may be effective in redirecting waste in waste segregation at source and a corresponding collection system.

Refunded virgin payments

Refunded Virgin Payments is a two-part measure: producers of products pay a fee that is used to refund producers whose products consist of a producers using more recyclates than their peers become net receivers of the predominately use virgin materials become net payers in this system. This on recyclate usage.

To avoid double payment, this tax should only be applied to plastic products system. So far, Refunded Virgin Payments are piloted in Sweden to ince

5.1.2 Extended Producer Responsibility

Extended Producer Responsibility (EPR) is an environmental policy approach in for a product is extended to the post-consumer stage of a prod waste. In the approach, already during the production and sale (and export), disposal of their packaging. Producers/ importers pay a fee for later disp packed goods are placed on the market. The contribution/ fee is used for the packaging waste and other costs arising from maintaining the system. It is general public budget of a state.

The concept of Extended Producer Responsibility and its basic principles

The concept of an extended producer responsibility (EPR) was developed in based on the idea that the producer responsibility, which e.g. determines that the their products regarding aspects of safety, health and environmental impacts, stage. 'Producer' in this context describes companies that put plastic goods (pro market for consumption, which are usually referred to as 'users' in the Keny

This means that in the EPR scheme, the producer (or user) is responsible tasks like collecting, sorting and recycling. Thus, the EPR involves producers in packaging waste and gives them the obligation to assume responsibility for their vary across countries with regard to certain aspects of their set-up, EPR schemes the obligation of producers while balancing the mandates of environmental pays' principle. Accordingly, the basics of EPR are almost the same in every cour

- Every obliged company pays a fee when introducing a packaged good c
- The fee serves for the collection and further processing of the packaging w
- Collection, sorting, recycling, or energy recovery of packaging waste remains companies.

This basic concept is illustrated in the Figure 17 on the next page.

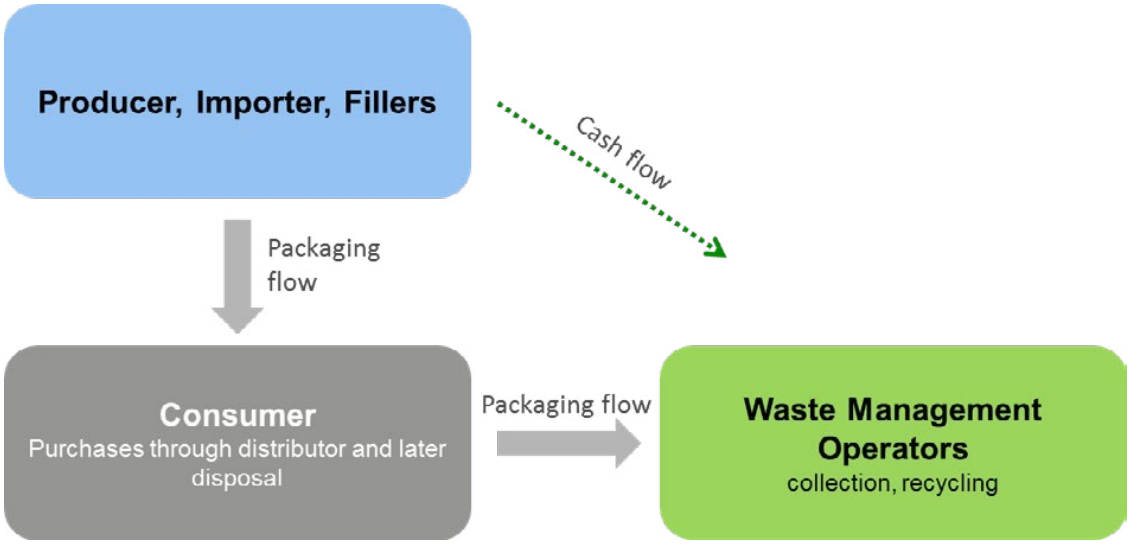


Figure 17: Basic idea of an EPR system

In its simplest form, EPR is rooted in an individual responsibility through importers, fillers and the source of waste generation; meaning that they will d to collect their waste and take it back. This very simple form of EPR is al legislation obliges producers to organise a take-back scheme for th is only practicably applicable to a limited extent as it requires the p the exact spreading of their packaging and how to access it. Furthermore, lo products are distributed in small quantities, still requiring similar logistical in as applicable with bigger volumes.

Collective responsibility through Producer Responsibility Organisation

As it is, from a practical perspective, not possible for each producer transition to a collective responsibility is needed. As a key element is needed as a central element. It takes over the take-back re organisation is referred to as the Producer Responsibility Organisation (PRO; sc system operator) as it allows the producers/ users to assume responsi jointly managing the arising waste. Thus, the PRO becomes the central element fo associated to the EPR system. In particular, this means that

- The PRO is the most important stakeholder (organisation).
- This organisation is responsible for setting up, developing and maintaining the
- This organisation is responsible for the take-back obligations of the oblig

As the compliance of the PRO with all its tasks and responsibilities is is responsible for supervising the PRO in this regard. The following g of an EPR system with the PRO as central organisation for a collective

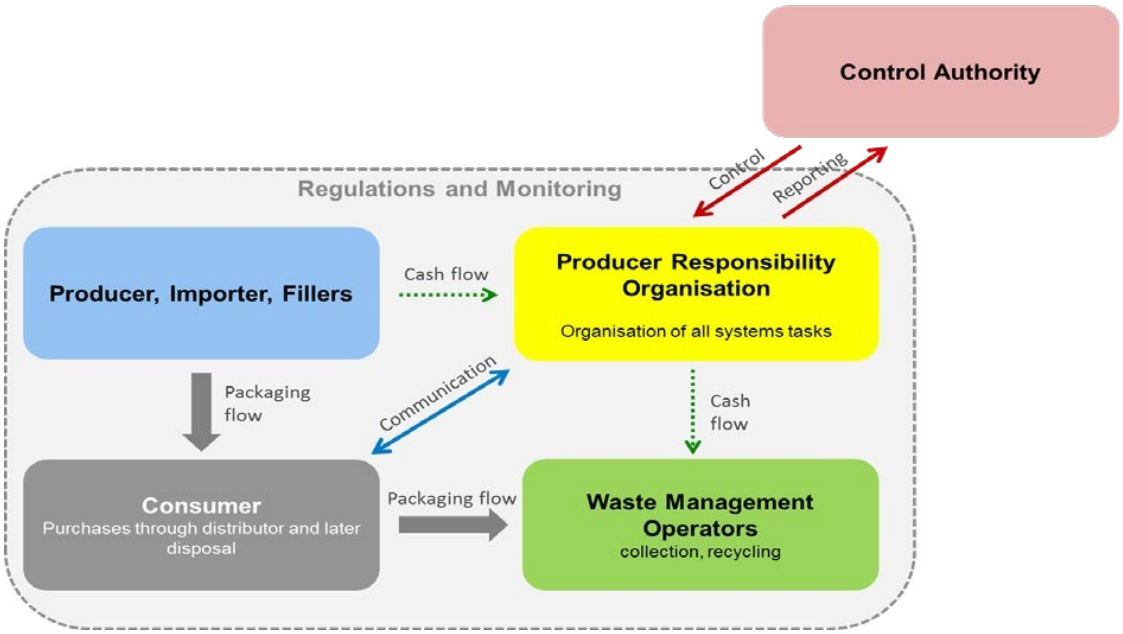


Figure 18: Basic scheme of an EPR system based on a collective responsibility

Figure 19 emphasises the organisational differences between the collective and

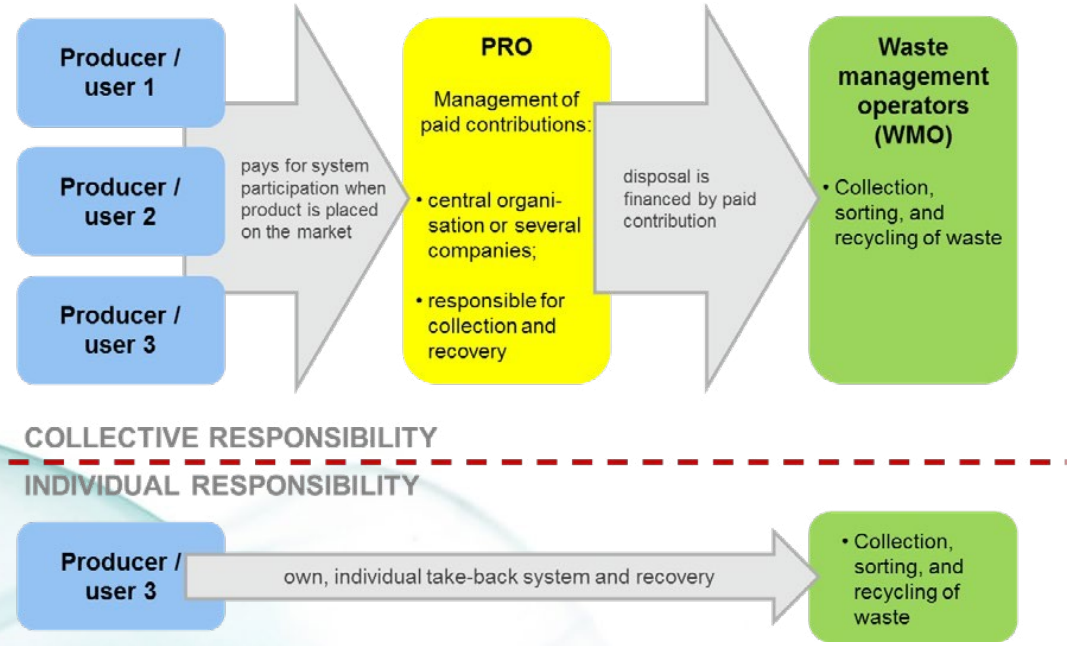


Figure 19: Comparison of collective and individual EPR system

Another specific form of EPR system is a deposit-refund system collection is based on consumer participation. In a DRS, packaging or o by obliging consumers to pay money as deposit when purchasing the it they get back the same amount they paid as deposit. Thus, consumers a take-back stations instead of just disposing them as waste. DRS are sy which reduces littering of these items. Moreover, as the DRS focuses o allow well sorted material fractions to be collected in large quantities. S for high quality recycling of these items. Furthermore, DRS also increase the c such as bottles in supermarkets or cutlery in food stores, thereby contributing to circular economy.

A return of the items takes place at designated take-back stations, such as the consumer receives the reward. In most cases, this reward is monetar The specific product is sold to the consumers with a deposit a instance $ 1.25) is the sum of the price of the single item ($ 1 has been returned, the consumer is repaid the deposit amount or a other rewards are also possible, such as vouchers for services.

Creating DRS as form of EPR is limited to specific, easily identifiable items like beverage bottles is not suitable to cover a broad range of plastic items.

Successfully implementing an EPR system requires a system which can b environmentally and socially sustainable as well as guaranteeing a level p unambiguous legislation coupled with a multi-stakeholder cooperation between a value chain. Crucial actors include governments, local authorities, producers organised in organisations (BMOs) and waste management organisations. The legal framework has to responsibilities, enforcement mechanisms and a timeline for implementation co for the PRO.

The Producer Responsibility Organisation

Since the PRO is responsible for operating the entire system, it is th the following:

- Registration of all obliged companies (in cooperation with the supervisory introducing packaged goods onto the market, which are consumed in the needs to be disposed in that respective country (financed by the
- Collection and administration of all funds from all obliged companies not harming the competitiveness of a participating company
- Tendering and contracting for collection and recycling of packaging waste
- Documentation of collection, sorting and recycling of packaging waste
- Informing all waste producers/ consumers about the importance of separate
- Controlling all services that have been awarded to service providers, fulfilment of collection and recycling by waste management companies
- Financing all tasks with funds provided by the obligated companies
- Documentation and verification to the supervisory authorities: the PRO has fulfilled all its tasks and aims and used the money of the obliged for instance in form of a report, which is verified by a third

Fulfilling these tasks can be achieved through different PRO setups. The setup are based on

i) whether the PRO is a privateorganisation or a public authority,
ii) whether the PRO is a non-profit organisation or a for-profit compan
iii) whether one PRO or several PROs exist in competition (see Figure 20).

Experiences in European countries have shown that there is no singular mos success is determined through an effective and efficient organisation, finar of the system.

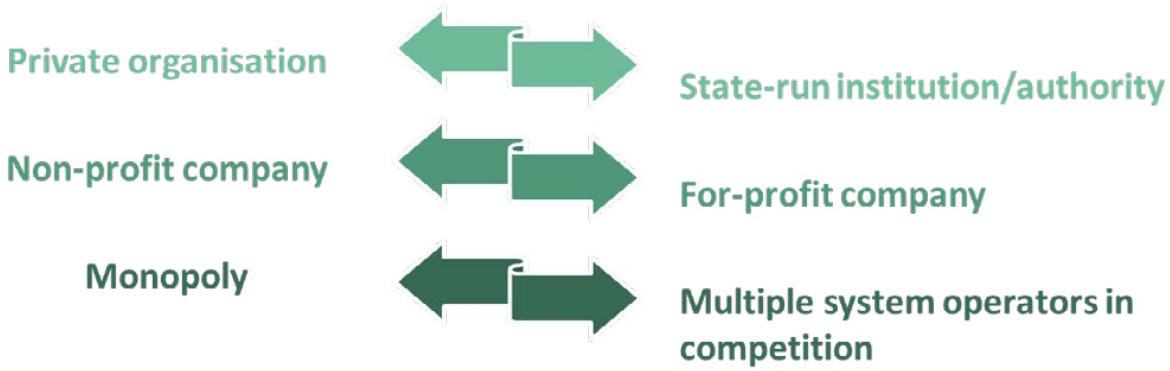


Figure 20: The different set-up conditions of the PRO

The most distinguishing characteristic is whether the PRO is set up as a

- PRO (system operator) as non-profit organisation: Such PROs are in the h industry, as for instance in Belgium, the Czech Republic, Ireland, Portugal and Spain. The obliged industry creates one common non-pro funding.
- PRO (system operator) as for-profit corporation: The legal framework can r several PROs instead of having a single monopolistic PRO. Such models e where the EPR systems have evolved from having a single PRO to competi
- Other distinctions can create the following PRO set-ups:
- Dual model: Industry has full operational and financial responsibility over collectio There is a separate collection system delegated to local authorities b Germany, Sweden).
- Sharedmodel: The responsibility is shared between industry and the local authorit agreements regarding collection. Municipalities are responsible for collection, packaging waste arising at the municipal level, while industry's financial respons to country (Belgium, Czech Republic, Italy, France, Netherlands, Slovenia, S
- Tradable Credits Model: There is neithera link between industry and municip commercial packaging and packaging arising at the municipal level (UK).
- Competing on the infrastructure: Every PRO offers its own container to i
- Each PRO in a separate district: Each PRO signs up with as many n according to market shares (Poland, Romania, Bulgaria, Slovakia, Malta, L

Who is obliged to pay?

The fees paid for the EPR participation are to be paid exclusively for th
only for the products that are consumed and will become waste within th
Kenya the fees only have to be paid for the products that will be c
therefore includes both domestically produced products as well as importe
a level playing field. However, products manufactured for export are not in
subsequently turned into waste in another country.

To determine who is obliged to pay for the operation of the E
to be determined. In most countries, this is the interface where a p
in the country as it will turn into waste in this respective country.

The fees that need to be paid are dependent on several factors, w
to be covered. These factors include:

- Type of collection system
- The waste composition
- Organisational structures
- Contractual constellations
- Financial contributions of the municipalities
- Recycling quotas
- Recovery and disposal infrastructure
- Existence of deposit-refund systems
- Distribution of costs across different material fractions
- Where applicable: modulation of costs reflecting the degree of recyclability (as ‘global examples and success stories’)

Roles and responsibilities of the involved actors

Although the set-up of the EPR systems and PROs are different in each responsibilities assigned to them are, in principle, the same.

Table 2: Roles and responsibilities in an EPR system

Stakeholder	Responsibility
Raw materials suppliers, manufacturers and converters of plastics	Should **enable reuse & ensure recyclability** of materials and use secondary raw materials where possible
Consumer goods companies (fillers and importers)	Obliged to **pay fees for the EPR system** proportional to which are covered by the EPR system
Distributors/retailers of packaged goods	Can be obliged to take waste back and to ensure Should also ensure that their suppliers are participating in system
Consumers	Have to be informed about strategies for waste reduct return or disposal of packaging; should buy as many and products as possible and reuse packaging as
Waste management operators	Receive funds from the EPR system for their service aging waste. Should try to recycle packaging according standards possible to ensure **high quality recycling**; includ mal sector
Government and other public authorities	Legislation & supervision of the EPR system
Municipalities or Counties	Linkages between consumers and waste management operat responsibilities for implementation of EPR on the organizing the collection

Thus, an operationalised EPR system can be outlined as outlined in

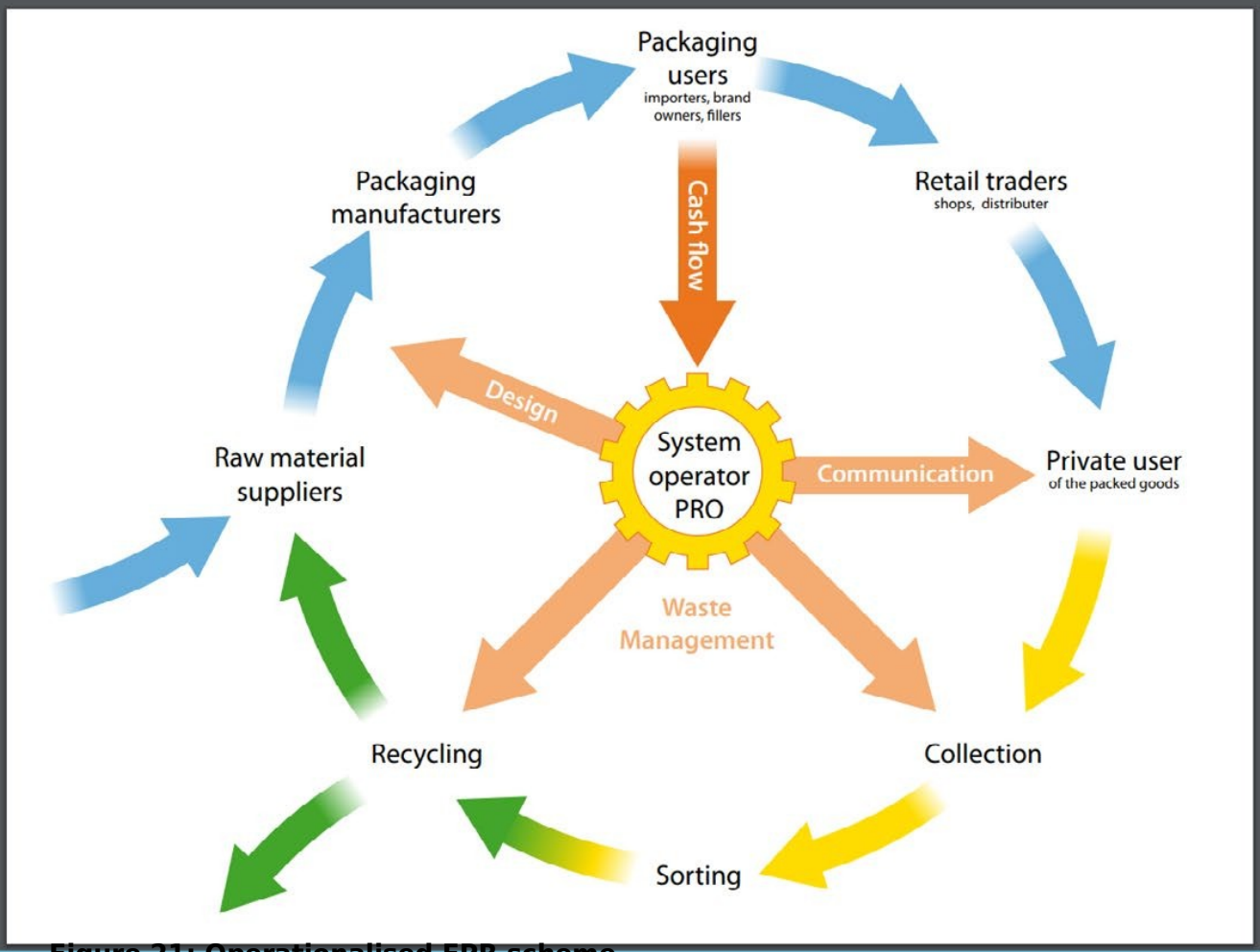


Figure 21: Operationalised EPR scheme

Legal basis

EPR systems can be operated on a voluntary basis only to a li
the preferred choice in light of effectiveness and efficiency to transition to
circular economy. A mandatory EPR system in turn requires a re
stakeholders, which is why a sound legal basis is a crucial element. As a
EPR system, voluntary systems are, however, a suitable measure to
commitment.

The legal framework is usuallyestablished on the national level through a
hence, the Ministry of Environment therefore takes a leading role. In p
down through environmental protection law, a specific packaging law o
the legal context. To ensure a successful implementation, the process o
all key stakeholders from the public and privatesector as well as from civil so

The legal framework should outline clear objectives, responsibilities, enforcement mechanism for implementation. In particular, the legal frame should determine:

- How to set up a PRO (as aforementioned)
- Which companies are legally obliged to take on responsibility
- Who is responsible for financing and organising the system
- Who registers all legally obliged companies
- Which items should be included in the system
- What are the requirements and quotas for collection and recycling
- What the role of the municipalities is
- How can the informal sector be integrated
- What kind of public supervision is required and how can this be organise

There are also some additional requirements which do not need to be mentioned by the PRO. This includes:

- **Upstream:** modulated fees based on recyclability (see chapter 5.2.1), recyclate u materials, preferred materials
- **Downstream:** Recycling and recovery processes, quota and how they are c collection infrastructure

What can be financed by an EPR system?

First of all, an EPR should cover all costs which will arise in the course of waste management. This also includes efforts for e.g. data management and administrat complementary measures could also be financed, such as:

- Linking plastic producers to recyclers in terms of design, recyclability, a guidelines)
- Coordinating, giving incentives to improve collection and recycling while keeping
- Educating recycling and collection businesses and actors
- Raising awareness, especially in the middle class (above the poverty line)
- Adapting school curricula; technical education at universities
- Running pilot projects (e.g. in certain geographic areas, special sectors like t
- Using labelling on products

The PRO can also contract third parties to carry out certain tasks, like awareness-

Measurements based on legal frame

The goal is to build an EPR strategy which is proactively discussed w
EPR system is a corresponding law. Through such a law, the fo

- Fair financial burden for all participants as the EPR fees are propo
  are part of the EPR system. Thereby, the competition on the mark
  is not impacted
- Enabling the implementation of nationwide solutions
- Requirements for a gradual system implementation and recovery targe
- Establishment of control mechanisms and penalties in case of non-compli

Thus, the setup of a legal frame is the preferred solution for the in

Voluntary measures

In smaller regions, it is possible to establish voluntary initiative
collect and utilise plastic waste. Aside from geographical boundaries, these pilot projects m
types of packaging, particular points of origins, specific brands and also o
importers and other stakeholders may work together to implement these voluntar
effectiveness of pilot projects is limited due to the following issues:

- Only a few companies (and not all) will participate in voluntary meas
- The financial contribution of each company is low compared to the
  an EPR scheme
- Extent of the single activities is small and usually comprises only smaller
- Impossible to establish a nationwide collection system based on volun
- No official controlling systems
- Voluntary initiatives may prolong important decisions regarding the setup

Voluntary initiatives should rather be used as a preliminary basis for the sy
to help develop the respective legal basis of the system. Voluntary i
experiences through pilot projects.

Global examples and success stories

As aforementioned, EPR systems can be implemented in many different w
30 countries that have implemented EPR in their legislation, with the industry
Outside of Europe, such organisations have been established as well, for in
Below the systems of Germany, France and the Netherlands are presented, w

In Germany, the legal framework allows a direct competition between several
monopolistic PRO. Since the PROs are private companies, they are not in the h
each obliged company has to contract a PRO of their choice for th
exact fees are not disclosed. Furthermore, the EPR system exists in parallel
and municipalities are not part of the EPR system.

This setup has achieved very good results with regards to collection, sorting and requires intense monitoring and supervising due to the complex and part some companies exploit this system to participate inadequately or avoid participatio Agency Packaging Regulation' was established after the passing of a new force in January 2019 as a new controlling authority.

In 2003, Germany established a compulsory deposit-refund system by law made from glass, plastics, metals or composite materials. From 2003 to 2006, the built on a direct relationship between consumers and retailers. Empty one-way returned at the original point of sale. After 2006, the deposit-refund syst law obliges every retailer to take-back deposited one-way beverage pack through their own product range. Thereby, Germany implemented a uniform, refund with clearing. As a clearing organisation, the Deutsche Pfandgesellschaft the German Retail Association and the German Food Association. Through emp the producers and importers of deposited beverages receive the record data packaging and reimburse the respective amount to the retailers. The retu was 98.4 % in 2015.

In France, Citeo (until 06/2017 named Eco-Emballages) was developed as the exclusively responsible for end consumer packaging. Eco-Emballages was founded industrial parties (manufacturers). A second EPR system, Adelphe, was esta industry to meet the take-back obligations for glass bottles. Today, Adelphe to operate as an independent company.

Citeo is a non-profit joint-stock company with approximately 240 shareholders from well as the print, services and related supply chain sectors. In total, Citeo The fees of Citeo are based on the weight of the packaging, a fixed price non-recyclable packaging (e.g. fees for non-recyclable plastics as packaging

The producers finance approx. 80 % of the system and the loca Moreover, the municipalities are also responsible for performing disposal services.

The system achieves good results with regards to collection, sorting and recy plastic foils are not included in the system throughout most areas in Fran to comprise all types of packaging waste by 2022.

In the Netherlands, the Afvalfonds Verpakkingen (packaging waste fund) was established and importers to fulfil the extended manufacturer responsibilities. It is a managed by a management board, which is itself appointed by producers and the maintenance of the waste management system, collaboration with communities and organise collection, and recycling of packaging. Other tasks are the mitigation and reporting on collection and recycling of packaging materials as well financial contributions from manufacturers and importers.

A noticeable feature is that the tasks of collection, sorting and transportati done by the municipalities. In turn, Afvalfonds pays compensation for the colle

Since December 2007, Nedvang, a non-profit organization, acts as mediator b
retailers as well as recovery companies, municipalities, and national a
packaging market and the recovery of packaging waste. Nedvang works fo
with municipalities regarding the reporting of packaging waste, which is collected
reviews this information and, following their review, dispatches approval th

Overall, this system achieves good results with regards to collection, so
are high compared to other EPR models.

Local examples and success stories

In Kenya, there is no mandatory EPR system. Thus, organisations that operate
the principles of an EPR system for selected materials only. These o
participation of their members. In particular, there are PETCO and Clean Green K

The PET Recycling Company Ltd. (PETCO Kenya) registered in December 2017 and st
2018 with its organisational scope being limited to PET beverage bottles. T
for the industry, PETCO aims to create value for post-consumer PET and e
and industry behaviour towards recycling PET beverage bottles which is su
employment possibilities in the recycling industry.

Currently, the organisation has 14 active members. The main financial sources
from retailers, plant owners and bottlers. The grants are obtained through

For the PET bottle collection, PETCO has contracted two companies as of n
Limited. The plan is that WEECO Limited collects and recycles 4
recycles 1,000 mt annually. Overall, PETCO aims, together with other partners
mt or 300 million PET bottles by 2019. Through its collaboration with retailers
members, PETCO Kenya aims to set up drop-off points to enhance the c

To raise awareness and promote consumer education, PETCO targets stakehol
returns to the consumer awareness programs. Some initiatives aim to c
recycling initiatives.

Clean Green Kenya (CGK) is also a voluntary system with the set goal o
awareness of proper waste management to all sectors and becoming a h
The companies Alternative Energy Systems Limited, RAMCO and King Plastics
NGO in 2017. The idea of CGK is to establish a platform through
across different industries can interact and create synergies.

Key activities include the collection of funds through a monthly 'E
waste management capacities. CGK also aims to secure collectors' supply chains based o
incentivises the collection of post-consumer waste. The organisation currently h
on a voluntary basis. These include manufacturers, recyclers and end c
monthly levy which is calculated based on their monthly plastics productio
for collection and sorting of waste plastics (done at dumping sites), pre-proc
cleaning and compacting of waste plastics) and educational campaigns and c

5.1.3 Comparing tax incentives and EPR

In many cases, measures are referred to and published under the label of tion of an EPR scheme, these are mostly green taxes and environmental char ronmental taxes or import duties are charged on raw materials and goods. In usually flow into the general public budget, so there is no producer resp system.

The following table compares the fees paid within an EPR system by the and environmental charges.

Table 3: EPR fees and green taxes in comparison

EPR fees for packaging	Green taxes / environmental charge
The fees are determined by the PRO or - in case of for-profit corporations - negotiated companies.	The tax is defined by law or thr with the obliged regulations and acts.
The PRO receives the fee.	The responsible public agencies receive the
EPR describes extending the producer responsibili- ty: Those who introduce certain goods to on mar- ket are also responsible for the subsequent management and disposal of the during waste.	Eco-taxes can be charged without bei related to a specific responsibility of arising packaging is fulfilled through payments.
The fees are precisely related to the products cov- ered by the EPR scheme, which the market of the respective will also turn into waste.	Eco-taxes do not have to be related are introduced on respective country. For inst tion in the country in which they can also be related to raw materials
There is a direct relation between the EPR fee and the quantities of arising waste in the respective country.	There is no relation to the arising pac the respective quantities in the respective country.
The EPR fees are meant to be exclusively used for collection, sorting and recycling of the waste. This also includes corresponding communication and public awareness work.	Eco-taxes usually contribute into the general budget, so there is no ‘polluter pay sense of an EPR system.

Generally, both EPR fees and green taxes can have a steering function. Gree materials and goods which are newly introduced onto the market; for instance based on ecological criteria such as the recyclability, usage of recyclates, or origi impact).

The steering function of EPR fees also covers the part when raw material introduced onto the market, but expands beyond this as EPR fees al system, meaning EPR can finance, amongst other things, infrastructure, co littering (up- and downstream impact).

Thus, EPR fees – if they can be applied to a specific product steering function.

5.2 Action Measures

5.2.1 Recycling and/or End of Life Options

The End of Life (EoL) options for waste plastics are geared to the w of priorities for the efficient use of resources and waste treatment, li option. Based on the waste hierarchy, the following EoL options exist for w

Prevention refers to measures taken before a substance, material or product reduce the quantity of waste (including through the re-use of products o reduce the adverse impacts of the generated waste on the environment a of hazardous substances in materials and products. **Prevention measures are t waste!** Examples for prevention measures include resource-efficient processi manufactured (thinner wall thickness of bottles, cans) or multiple use a the same or another task and therefore remain within the utilisation phase).

Preparation for re-use describes materials and items which have become waste, a remanufactured for reapplication.

Recycling means any recovery option by which waste materials are reprocessed in substances, whether for the original or for other purposes. It includes does not include energy recovery (which is part of recovery!). Recycling al production of flakes and agglomerates out of plastics.

Other recovery processes, e.g. energy recovery: For this purpose, the energetic co used to generate heat, cold and/ or electric energy; mostly through in

Disposal describes any operation which is not recovery, even where the operatio for the reclamation of substances or energy. Thus, disposal does not co **not mean littering or the landfilling in unsuitable locations.**

Generally, no comprehensive collection and, further, proper waste treatment (h is implemented in Kenya, especially with regards to plastics. Considering t (improper landfilling in terms of organizational and environmental aspects, paper, plastics, no relevant multiple use systems), the usage of resource reduced (prevention) to tackle the challenges (loss of resources, littering, in environmental impacts).

As a recommended, complementary first step, the development of a sy This also includes the treatment of plastics which are not recycled at suitable for recycling (see section recyclability).

Similar to Europe, the long-term goal should be to transfer the current, into a suitable form of treatment through planning and reconstructing (e.g. waterproofing, gas retention, waste water collection and purification).

This should go along with the requirement only to transport pre-treated waste to of 2006, there is a so-called landfill ban in Europe. It states that wast only have a very small amount of total organic carbon (TOC). This is acco

- Waste is already separated and collected at source
- Contained recyclable fractions are sorted
- Remains unsuitable for recycling are used energetically

The latter two points are key elements for a circular economy and shou the implementation of an EPR system (see chapter 5.1.2) and measures considered that even with a higher usage of plastic recyclates in production proc virgin materials, which e.g. are obligatory to fulfil certain quality criteria during manufactur

Moreover, the recycling processes should not be limited to Kenya location-wise as not established sufficiently; i.e. export of waste or secondary resources for proc an initial phase, be a viable part of the solution.

For a long-term success, structures outside of recycling need to be treatment for non-recyclable plastics. This generally happens through incin as the best option), as the resulting ashes are landfilled. Alternatively, the and the generation of fuel are conceivable for plastics but still in deve level; also in Europe where packaging waste is managed on a comparably high

The EPR system shall create financial incentives for more plastics recycling, current disposal options such as unsanitary landfills like Dandora or agricultural and protected areas are still the cheaper options compared to

The creation of recycling targets (such as a certain amount of used year) shall result in reduced attractiveness of unsystematic landfills and less The simultaneous implementation of a landfill tax promotes the shift to more chapter 5.1.1).

5.2.2 Segregation at source as best practice and waste collection

Segregation at source and the respective waste collection is a central part of and recycling. Since segregation and collection systems need to be tailored globally. Even in European countries with established EPR systems, the co packaging materials varies as shown in Table 4 below.

Table 4: Collection structures for packaging for the individual material fractions in five different with EPR systems

	Germany	France	Spain	Italy	Netherlands
Plastic foil (plastic [1] bags)	X[6]	[3]	X[5]	[4]	X[6]
PE and PP	X[6]	X[2)5)6)]	X[5]	X[2)5)6)]	X[6]
PS	X[6]	[3]	X[5]	[4]	X[6]
PET bottles	X[6)7)]	X[5)6)]	X[5]	X[5)6)]	X[6]
PET non-beverage bottles	X[6]	[3]	X[5]	[4]	X[6]
Mixed plastics (rigid)	X[6]	X[2)5)6)]	X[5]	X[2)5)]	X[6]
Mixed plastics (flexible)	X[6]	[3]	X[5]	[4]	X[6]
Beverage cartons	X[6]	X[5)6)8)]	X[5]	X[5)6)8)]	X[6]
Tin plate/ferrous metals	X[6)7)]	X[5)6)]	X[5]	X[5)6)]	X[6]
Aluminium/non-ferrous metals	X[6)7)]	X	X[5]	X[5)6)]	X[6]
Paper and cardboard	X[5)6)]	X[5)]	X[5]	X[5)6)]	X[5)6]

1) The target fraction is narrowed down (size > DIN A4) in order to
2) At the moment: only bottles and/or containers
3) Expected from 2022 onwards
4) It is expected that the collection systems of CONAI (Italy) will be the quotas for 2025 set in the EU packaging directive.
5) Drop off system/'bring it yourself'-system
6) Kerbside collection/pick-up system
7) Deposit system for beverage packaging
8) In France and Italy, beverage cartons are often (estimated 50 % to cardboard and not in the collection system of lightweight packaging

Generally, there are two distinct possibilities to collect waste: either at the h collection systems or on the streets through bring banks (also referred to systems). Some examples from four different countries are presented on th

In **Germany,** waste is usually separated into four fractions and collected at the household level through a kerbside collection system. Rigid packaging is usually collected through ... The costs arising from collection, sorting and recycling are covered by the PROs. The costs arising from the waste of the "paper, cardboard and carton" fraction are divided between municipalities and PROs as this fraction includes both paper packaging waste and other printed products for which there is no EPR scheme.

In **Spain,** collection is mainly organised via containers/banks. Glass belong in the bring banks. Rigid plastic, cans and ... belong in the yellow containers, and paper and cardboard belongs in the blue ones. There are over 573,000 yellow and blue ... available throughout Spain to collect packaging waste (very high density). From there, packaging is collected and transported to suitable plants that further segregate into more specific fractions.

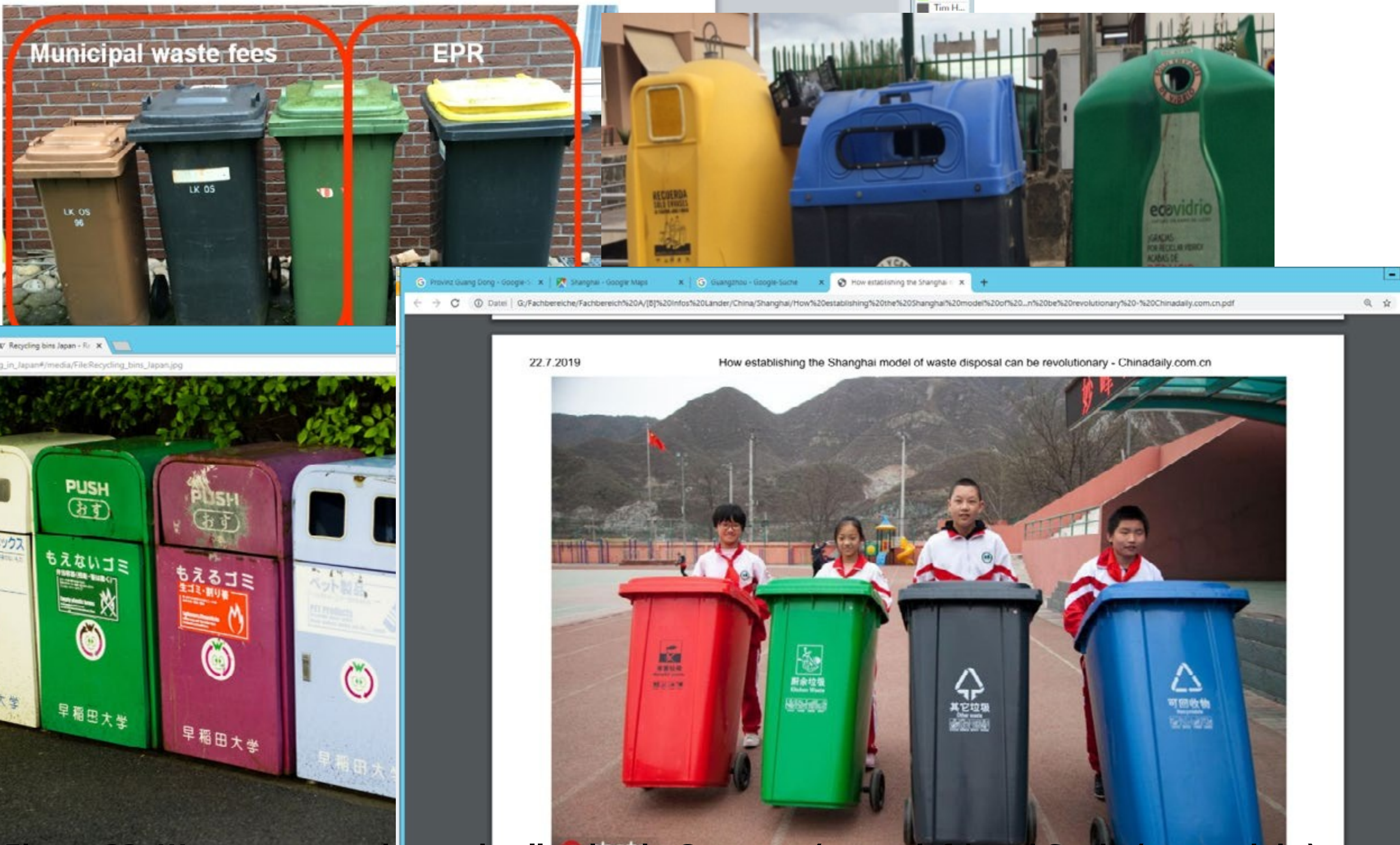


Figure 22: Waste segregation and collection in Germany (upper left) and Spain (upper right), Japan (bottom left) and Shanghai (bottom right)

The prevalent collection system in Japan is a ... system where the waste is sorted in ... Nevertheless, there are also some kerbside collection systems. In several places, the ... is complemented by additional collection ... group collections organised by residents. ... numbers of waste fractions, which are ... source, vary across Japan.

In Shanghai, China, a waste segregation and collection system has been introduced based on segregation at source, with four waste fractions: kitchen waste for composting, valuables for recycling, specific hazardous waste), and residual waste. The overall [illegible] Inhabitants will be penalised if they [illegible] segregate properly.

Problems arise when waste management operators do not fulfil the service fo
and the collection points are not appropriately taken care of as shown in th

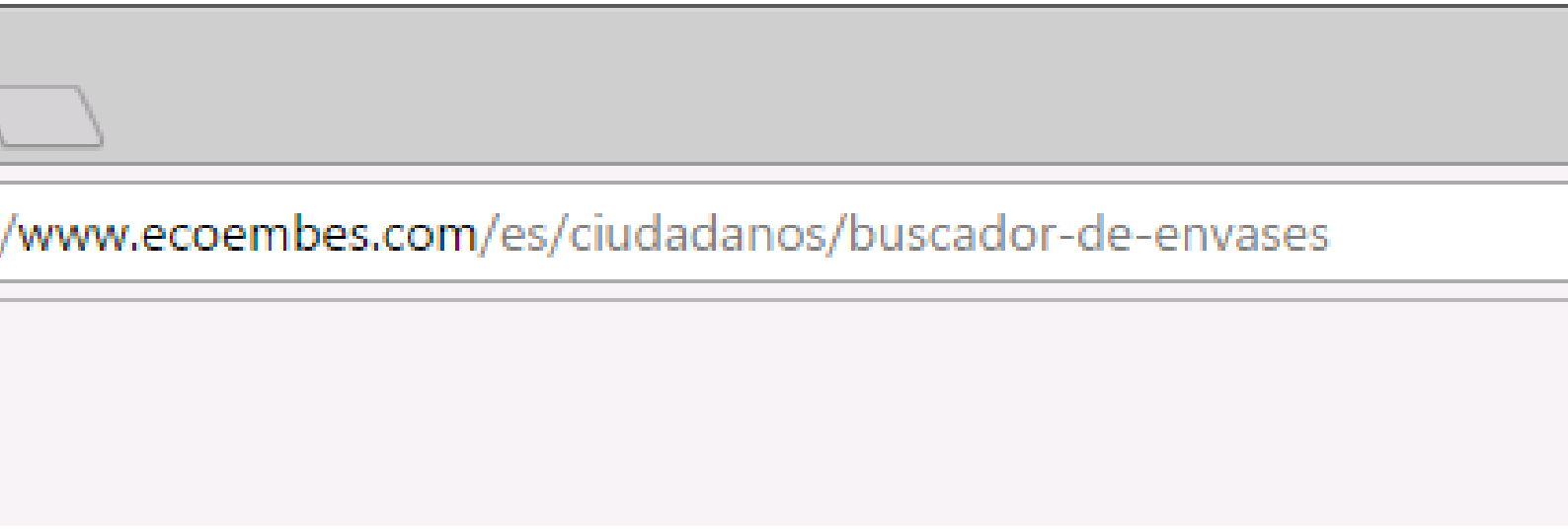
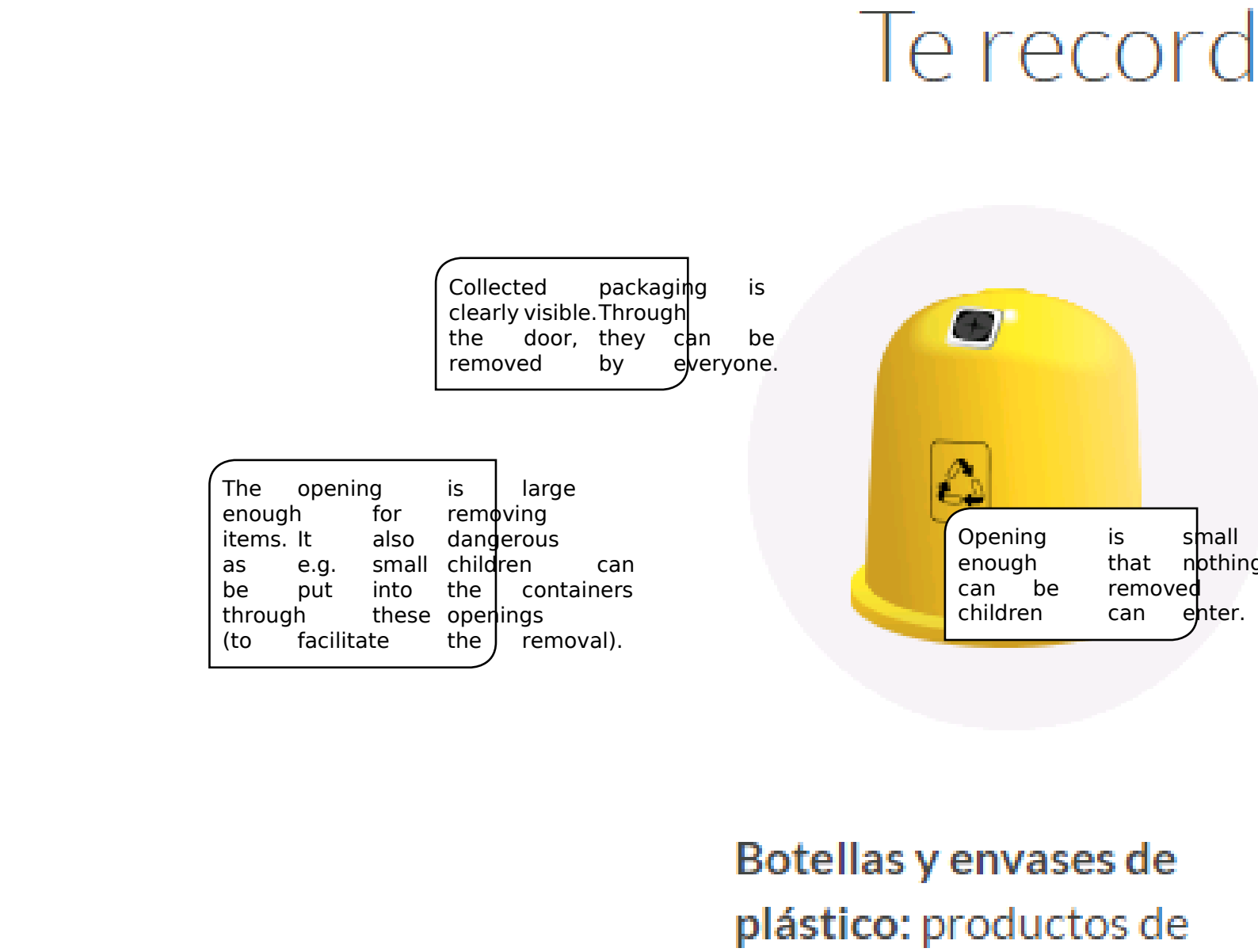


Figure 23: Waste collection in Palermo (left) and Tunis (right)



As the collection costs are covered by the PRO, the following disposal for waste collection:

- Establishment of an infrastructure for the collection of packaging waste
- Documentation of the collection
- Regular emptying of the containers
- Cleaning of the collection points
- Maintenance and care of the containers
- Establishment of infrastructure for the sorting and recycling of plastics w
- Documentation of recovery and recycling

5.2.3 Product Design for enhanced recycling

Recyclability is the key figure for the qualitative and quantitative behaviour of it determines it respective recycling process chain for primary raw mate possible that the products after use are collectable via existing collection manner. Its reprocessability must enable recirculation.

As aforementioned, the recyclability is determined by two factors:
i) the composition of the object, and
ii) the actual existing recycling options after usage, which is why a plastics actual recycling pathways exist. Otherwise, it remains 'ready for recycling'.

However, these two factors have a reciprocal connection since the composition of whether an object can be recycled through the existing recycling path existing recycling option can influence the composition and design of a plast which need to be considered when designing the product. They are illustrated

The decision about the recyclability is material-dependent – meaning that the applied to each material and the respective item design (bottle or tray).

Based on the prevailing collection and recycling structures in Kenya (see chap recyclables are aggregated on an item basis both through formal collectors as pickers and the subsequent, largely manual sorting.

Thus, technical requirements for plastics packaging as well as non-packaging their suitability for automatic sorting do not need to be considered. Neverthele trends on the recyclability have been already recognised in the Kenyan cont substitution of PE or PP as valuable and well recyclable polyolefin polymers Figure 25), which cannot be recycled by polyolefin existing recycling companies

Another development leading to reduced recyclability is the usage of filler the weight, which in turn causes the material to be sorted out as resid separation (a mandatory step in the recycling process annex 8.3). polyolefin; for

Also, material composites, which are hard to separate, should be avoided as the attached lid on bottles has to be cut off of the bottle and is of being recycled (see Figure 26).

Moreover, the combination of incompatible materials (PET bottles with full sleeves usage of fully coloured (opaque) PET material significantly lowers existing P

Thus, it is recommendable to create recyclable design standards for selected

Figure 25: PET substitution

Figure 26: Attached lids on Bottles

Modulated fees

Incentives like taxes or EPR fees. In France and Italy, for instance, the EPR participatio for an improved product design for increased recycling can be recyclability of the plastics packaging, meaning that the fees for non-recycla higher. Thus, using non-recyclable packaging is significantly more expensive for com onto the market. The criteria for recyclability and non-recyclability are clearly defi case of France, the EPR participation fee for non-recyclable packaging is plastic packaging.

The approach of modulated fees is being gradually implemented in other Euro incentives opposing the trend of non-recyclable packaging design and increase instrument is powerful for raising awareness among packaging and product desi and recycling, informing them and transferring knowledge about the issue of recy chain. A bonus on the EPR levies for recyclable product design is only gran of their recyclability. Usually, the recyclability is determined and certified by regulations and requirements set by the legal frame or PRO.

Moreover, modulated fees can also be applied for the usage of recyclates recyclates, a bonus lowering the EPR levies is granted. This can roughly quantities, annual usage of virgin materials and the annual usage of recyclates.

5.2.4 Consumer awareness – communication and education

Complementary to the actions which need to be taken upstream and dow the consumers in the transition to a circular economy has to be rates is dependent on changing the consumer attitude towards waste. Awa management as well as the adverse effects of an improper waste manageme In addition, a lack of awareness of waste, its effects on health and on to mismanagement of waste. From communities to schools and universities, to governments: All of them play a role in building a culture in which effec There are various means to raise awareness among consumers, such as:

- Guidelines and signs
- Printed media
- Digital media
- Environmental education programs in schools
- Events and campaigns
- Eco-labelling schemes
- Marketing
- Product fees

Consumer awareness starts on an individual level and can be raised through on the best ways to deal with waste and keeping them updated with the to waste and waste management can significantly change the way waste is hand global examples is presented in annex 8.10.

School education for long-term impact

One of the most powerful tools for management are environmental education at schools, as it is easier than that of adults. Children in the learning process by to their parents, close family, and children from an early age and term impact, because those children the knowledge, then pass it on

Schools can become main achieve a better waste management: to introduce informative curricula management, and the results of improp of waste, as well as the waste. Integration of waste management different classes such as science helps students to link mismanageme the effects it has on health and also instils in students' minds that from their lives, and that it can treated – a valuable resourc applications offering economic and social benefits, such as introducing different careers in the environment and waste manage

In addition to curricula, workshops, events, and campaigns are consider children on waste management. Engaging children in activities that combine will enhance their critical thinking and analytic and problem-solving s informed decisions about waste issues.

Successful examples in other Africancountries can be found, for instance, in

In Ghana, the NGO Environment360 works with schools through programs that focus on teachir children about the proper segregation of waste source; and introducing them to the green econo and green technology careers. They also collabo with the Ghana Recycling Incentive Program for Schools (GRIPS) to help schools save money by reducing their waste, and to earn rewards for pro waste segregation.

Moreover, Environment360 runs volunteering programs in which volunteers participate in the initiatives and activities organised by the organisation at schools and communities. An example is the annual Float Your Boat competiti where children design and build boats using pla bottles and then participate in a race in order to raise funds for environmental education progra in coastal and urban regions in Ghana. 'Float Yo Boat' also teaches students how to segregate wa and helps them discover exciting ways to reuse their plastic waste, thereby reducing the amoun of waste generated.

Product fees as customer incentive for reuse of single use plastics (SUP)

Single use plastics (SUP) are globally recognised as growing problem: d demand has been increasing; however, since they are usuallyonly used once a a very short in-life phase and generate significant quantities of waste. Solutions quantities of SUPs are in demand, such as charging a product fe reuse (one of the three key principles of circular economy) over a n usuallyminimal, it is enough to incentivise the reuse as means to sa countries with price-sensitive consumers.

Generally, it is possible either to increase the price when handing o give a discount for bringing one's own (reused) SUP (e.g. on coffee-to is Kenya introduced a full ban on the use, manufacture and import of a household packaging made of PE (see chapter 3.1). For other carrier bags w supermarkets collect a fund from the sale of these bags. Other types of SUP p as single-use coffee cups.

5.2.5 Biodegradable plastics

The term 'biodegradable plastics' is oftentimes (incorrectly) used in reference as biodegradable plastics. However, as described in chapter 2.1, bio-b sources such as sugar cane and processed into plastic polymers like PE. Bio-l like conventional plastics. In contrast, biodegradable plastics are characteris by microorganisms into water, carbon dioxide (or methane) and biomass unde biodegradable plastics can be manufactured from both fossil as well as rene

Biodegradable plastics are used for a wide range of applications, such as waste bags), and agricultural purposes (e.g. as films). They can be foamed into injection-moulded in modified conventional machines. Different types of fillers can be such as wood flour, lime, clay or the applications for which they are very short in-use phase. For instance, straws and coffee capsules made of plastics available [PlasticsEurope,

> The usage of biodegradable plastics does not pose an advantage over conventional plastics, particularly in comparison to sturdy and long-lasting materials such as cotton or thick plastics suitable for reuse which have more advantages. Repeated usage of the material through recycli is more environmentally friendly than the loss of the material through degradation. For their decomposition, biodegradable plastics require certain temperatures, oxygen content and humi which would be difficult to achieve outside a laboratory.

To ensure that biological treatment, is a sustainable waste management biodegradability and compostability resulting compost and digestate with the appropriate standards.

However, the critical side to biodegradable plastics is that these plastics temperatures, oxygen availability and humidity, and in the presence of cannot be guaranteed either during conventional composting or at landfills. Biodegrada just as much to litter and the existing waste problem as conventional plast collection, sorting, and recycling or composting infrastructure.

Even in case of a proper waste management chain, there are several critical issue plastics in composters:

- Most industrial composters are not able to create the specified environmental able plastics will not be degraded in them and will instead become 2018]
- The quality of degraded biodegradable plastics does not fulfil the requirem European standard EN 13432) leading to contamination [DUH, 2018]
- Biodegradable plastics do not hold many soil substances and merely degrade fore, from an environmental point of view, incineration with heat or electricit preferred option [DUH, 2018]
- Inaccurate claims over the compostability of biodegradable plastics might c them into thinking that littering these plastics is not harmful to th which is not the case, as was recently shown in research by the U ble plastics bags were able to hold shopping items even after three years o sea [Williams, 2019])

Another term, which is often brought up in relation to biodegradable
Oxo-fragmentable plastics are plastics which can be characterized by the fa
however, they are not decomposable. Therefore, the fragmented plastic particles
microplastics litter, contributing to environmental degradation.

5.2.6 Integration informal sector

Informal collectors and recyclers are increasingly recognised for creating va
contribute in form of lowering waste quantities, conserving resources, lowering
supplying the local value chain with recyclable material.

The same applies for Kenya, where informal waste pickers collect relevant a
formalised recycling. However, the situation is insufficient both for the p
as well as for the effectiveness of the waste management.

The situation for the informal collectors is highly exploitative as;

- their income is irregular,
- their social situation is insecure,
- they are exposed to high health risks,
- they are vulnerable to unfair business practices and
- they lack access to social security systems.
- from a waste management perspective, a mainly informal system is ineffi
- only valuables will be collected, while invaluable materials remain uncollected
  service),
- collection occurs only in areas with demand for recyclables (in proximity
- formal collection of remaining waste will become more expensive (because
- informal collection and separation often contribute to littering.

This is why informal workers should be integrated or formalised in w
EPR systems. In this context in Kenya, a few initiatives have already
Green Africa and Clean Green Kenya). Their implementation should be evaluated in
mechanisms for expansion all across Kenya. From a social sustainability perspective, it
involved persons keep their source of income.


7
2

6.1 Implementing the EPR system

As analysed before, the general waste management structure as well as structure in particular lack organisational and financial resources in K the implementation of an Extended Producer Responsibility (EPR) system. Th system were introduced in chapter 5.1.2, complemented by a few g implementing an EPR system in Kenya have already been initiated.

As previously explained, EPR systems allow for a proper and practical st through their steering function on material usage (upstream) and the o (downstream), especially collection and recycling. The first and foremost p EPR systemfor plastic packaging and other specified plastics items is defining create a sound Producer Responsibility Organization (PRO). The subsequent paragraphs ou of an EPR system in Kenya under the given contextual conditions in o for a policy framework for a transparent and fair system, which ensures management purposes and competition between the stakeholders along the supply ch For the waste management practice, this implies:

- Transition from picking and collecting valuables to cleanliness as a
- Transition from individual responsibility (take-back schemes) to collective actio

These transitions require that the following aspects are defined in d

What are the first important steps for implementing an EPR system in Kenya?

Against the Kenyan background system, it is crucial to establish a

i) based on an aligned understanding and planning throughout the priva
ii) robust enough to work, yet quick and easy to implement. Thus, it is includes all stakeholders in the supply chain, designates unambiguous rules to guarantees a level playing field.

As indicated in the name EPR, extending the producer responsibility is in all well-functioning systems, this obligation of the economy is accompa initiated and implemented by the privatesector. Also in Kenya, the first steps fa setup of an EPR system should be initiated by the privatesector, ideally o organizations (BMOs) such as Kenya Association of Manufacturers (KAM) or K (KEPSA), for instance. Moreover, they can ensure that all stakeholders along th process. This applies under the condition that there are external controla in that is the opportunity for the obliged industry not only to re local and economically viable conditions.

At the same time, political decision-makers need to be involved in th respective legal framework. As several branches are potentially affected – economics – it is important to include decision-makers from all o

actionsneed to be put in congruence and existing legislation clarified in providing sufficient details on concrete measures to be taken.

Adapting and passing a legal basis is a process which takes time. Thus PRO, potentially supported by the resources of an existing BMO such as or Kenya Private Sector Alliance in which companies and organisations can organise negotiate with the decision makers about the setup of the mandatory syst can be operated in order to gain first experiences. The participation in the the law has entered into force. Simultaneously, additional measures based on

Recommendation on financing the first steps

The first steps are financed through the voluntarily participating companies, whic value chain. As the process of establishing an EPR system is complex support the process (implementation of PRO, first measures and pilot proje through external third parties. Therefore, a projectshould be initiated whic Plan and advances it. Moreover, it is likely to receive funding part waste issue is currently a topic of high importance. The Kenya Plastic Action Plan for respective funding.

How should the EPR system be set up?

It is required to ensure the highest level of transparency possible for foundation of trust and acceptance. Against this background, it is recommend

- only one EPR system and one PRO or
- one PRO umbrella organisation uniting the existing schemes like PETCO and C

which, in the beginning, exclusively regulates the financing and organisation of complementing economic instruments, such as landfill taxes, should be implemented in treatment of plastics, covering areas that cannot be covered by the EPR

One industry owned PRO can be initiated within the organizational resources organization such as Kenya Association of Manufacturers or Kenya Private Sector Allia as part of its statutory purpose – a public service mission rega the plastics waste covered by EPR. In light of transparency issues, this PRO which acts as a superior institution independently from the individual com

The private industry is widely aligned to establish an EPR system whic and a PRO which is run as non-profit organisation; this reflects the idea fractions equally.

It is also possible to establish different PROs for different plastics of registration, controlling, monitoring and transparency. Moreover, it needs to be joint responsibilities (e.g. awareness-raising and education) and how to balance different plastic fractions. In addition, it needs to be defined how the the disposal of the residue originating from the mixed collection and subs disposal are divided between them.

How are the different stakeholders affiliated with the PRO?

The PRO is the most important stakeholder (organisation) within an EPR system. for setting up and developing the system. In order to transform their in fulfilled in Kenya through the various take-back schemes, to a c and fillers should give a mandate to the industry-owned PRO. Thereby, th fulfilment of all take-back obligations of the obliged companies as th

All stakeholders in the supply chain should participate in the PRO. Thus, they sh new organisation. There should be four different forms of participation:

i) **Obliged companies (more details below):** producers/ users, fillers, brand owners who packed goods and plastic products onto the Kenyan market. These comp is proportional to the amount in weight of plastic items they introduce finance all waste management services.
ii) **Members:** Companies which are part of the plastics supply chain. This includ packaging and product converters, designers, manufacturers, retailers and operators for collection and recovery, especially recycling. These companies to the PRO for the operation of the PRO.
iii) **Affiliated members (advisory board):** This includes offices of the National gover NGOs, and other authorities. None of the affiliated members have to pay and organisations impact the work of the PRO as an advisory board and recent developments, innovations and novelties, as well as similar updates.
iv) **Management (executive board):** The PRO needs an executive board to mana spending and controlling. This management can consist of one or several by the members or externally appointed. Generally, it is recommend

Which plastic items (packaging/ non-packaging) are covered by the EPR system

In most cases, EPR systems for plastics are set up for plastic packagin usually not covered by the EPR system. However, as EPR has the b downstream, it is recommended to include both plastic packaging as w in the EPR system to achieve better results in recycling and waste m include all sources of waste generation as it best reflects the K

Thus, it is recommended that all plastic based packaging (food, non-food, in well as composite packaging, which consist of plastics and at least one o how high the plastic content has to be to be obliged to take p suggestions include at least 50 % of the packaging having to be c are also possible. Since packaging items are consumed quickly and thus have a near-time waste generation, the preferred approach is to cover as many p the EPR system. In addition, the collection and recycling structure fo (PET, HDPE, PVC, LDPE, PP, PS, others) will be improved. Generally, it is systems for household waste and non-household waste (i.e. industrial and tr it is done for instance in other countries such as Germany.

In addition to the plastic packaging, other plastic items which can be covered included. This has to be decided on a case-by-case basis by designated particularly plastic items, which are similar to packaging, for instance plastic buckets, bags and single use plastics (SUPs) (see, for instance, the EU SUP Directive). to be clearly outlined in the legal frame.

It is recommended to clearly label plastic packaging and selected plastic item system and take part in it by paying the fees. Once an obliged com to their packaging and/ or products (comparable to "Green Dot").

Thus, companies introducing plastic packaging (sold to private households, agriculture, indu packaging) and/or other plastic items covered by the EPR system on to the legal frame, are obliged to participate (they are 'the obliged companies'). More applications are excluded from the EPR scope: packaging for hazardous content, materials and plastic items that cannot be covered by the EPR system like components such as pipes.

As mentioned, other non-plastic packaging is currently not included, while in generally all packaging materials are covered. This is meant to keep a materials and thereby avoid undesired, ecologically questionable substitution effects of materials.

Who are the obliged companies that have to pay for the EPR system?

In an EPR system, it has to be legally determined who has to pay these obliged parties can be identified. As aforementioned, the obliged com of which plastic items (packaging and non-packaging) are covered by the EPR termining requirement that these plastic items are put on the market in Keny will become waste in Kenya. Thus, these companies have to finance the oper services. In particular, this includes two groups (see also Figure 27):

- Users (producers)/ fillers for the sale of their packed goods in Kenya for c
- Importers for the sale of their goods in Kenya for consumption in Kenya

Through which interface can it be ascertained which packaged goods and other non-packaging products are being put on the market in Kenya?

The obliged companies (see definition above) comprise of:

- Plastic packaging which is filled in other countries and is imported to K
- Plastic packaging which is filled in Kenya and consumed in Kenya
- Other non-packaging plastic products which are imported to Kenya
- Other non-packaging plastic products which are produced, sold and consumed i

To measure the exact amounts of these items, the following criteria can be segment), mass (weight), number of items, filling volume, and area. In most the most practical measurement unit; some countries, such as Spain, also have an -based fees.

Figure 27 illustrates the most suitable interface for the steps in the su onto the market.

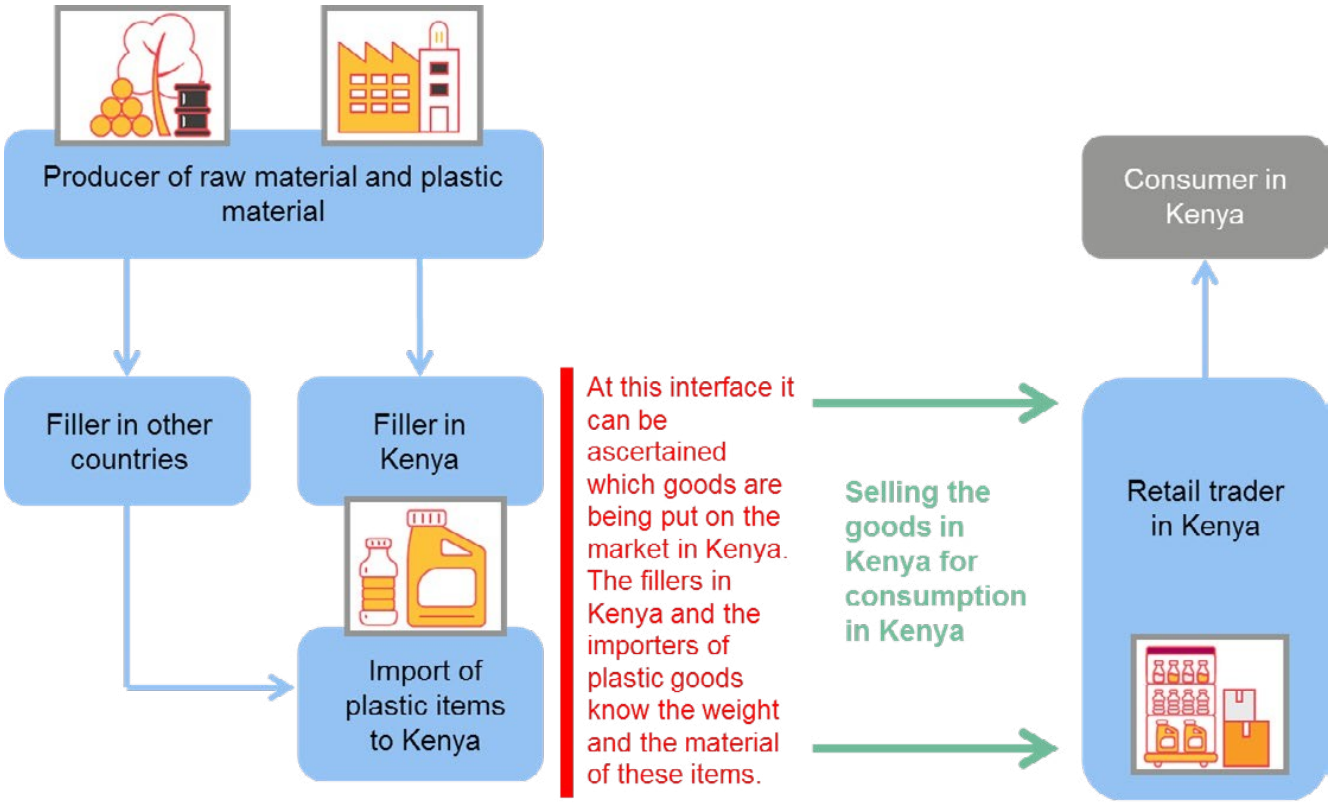


Figure 27: Interface for determining the obliged companies

How to oblige the informal packaging users?

Since the informal sector is not only limited to waste operators but also in to integrate these informal packaging users into the EPR system; it is the domestic packaging users belong to this group. Thus, it is crucial to fi covers these plastics quantities in the EPR system. One possible approacl are selling packaging material to these non-licensed packaging users to pay th informal businesses directly. This should be complemented by a definitior per year (e.g. 300 kg per year) per user. In turn, the manufacturers fo the non-licensed packaging users in form of a surcharge. This economic in users to integrate themselves into the system in the long run: if a verifies their participation in the EPR system, no surcharge from the m users pay their levies directly to the EPR system for the packaging u

How much should be paid by the obliged companies?

The exact amount that needs to be paid is proportional to the specific
of under- or overestimating the costs needed for the waste management task
as possible, it is recommended to pursue specific measures as goal
Since the PRO should be set up as a non-profit organisation, the total amo
should equal the expenses for all waste management costs. To calculate the cost

i) the amounts of waste which will arise from the plastics items covered b
ii) the costs needed for the treatment of these amounts of waste.

It is recommended to calculate a defined amount (per material
five years and adapted to developments and trends. It is also possible
steering function in regards to recyclable product design (see chapter

To provide an idea on the expected costs, an overview of current
that the underlying EPR systems are well established and in some cases com
Others also include commercial and industrial (C/I) packaging, as it is also
ultimately adapted to the prevailing conditions (including underlying infrastructu
costs, organisation and control).

Table 5: Plastic packaging fees in EU-28 EPR schemes [Watkins et al., 2017]

	Plastic (general unspecified)c		PET/ HDPE	Beverage cartons		Other/Composite Material	
	H	C/I	H	H	C/I	H	C/I
Austria (ARA)	0.6100	-	-	0.5800	-	0.6100	0.1000
Belgium (FOST-PLUS)	0.2823	-	0.2107	0.2455	-	0.2823	-
Bulgaria (EcoPack)	0.0800	0.0800	-	-	-	0.1000	0.1000
Croatia (Eko-Ozra)	-	-	0.0550	0.0550	0.0550	0.1000	0.1000
Cyprus (Green Dot)	-	0.0380	0.1060	0.1230	-	-	-
Czech Rep (EKO-KOM)	0.2060	0.0220	-	0.1580	-	0.2230	0.2230
Estonia (ETO)	0.4090	0.1090	-	0.1050	-	-	-
France (Eco-Emballages / CITEO)	0.3120	-	-	0.2470	-	-	-
Greece (HE.R.R.Co)	0.6600	0.6600	-	0.5700	0.5700	-	-
Hungary (Ökopannon)	0.1850	-	-	0.0620	-	0.1850	-
Ireland (Repak)	0.0892	0.0892	0.0892	0.0758	-	-	-
Latvia (Latvijas Zalais Punkts)	0.1490	0.1490	-	-	-	-	-
Lithuania (Zallasis taskas)	0.0810	0.0810	0.0810	0.1220	0.1220	0.1250	0.1250
Luxembourg (Valoriux)	-	-	0.3703	0.2835	0.2835	-	-
Norway (Gront Punkt)	0.3876	0.3876	-	0.1200	0.1200	-	-
Poland (Rekopol)	0.0046	0.0046	-	-	-	-	-
Potugal (Sociedade Ponto Verde)	0.2319	0.2319	-	-	-	-	-
Romania (ECO-ROM Ambalaje)	0.1330	0.1330	0.1330	-	-	-	-
Slovenia (Slopak)	0.1340	0.1340	0.0770	0.0100	0.0100	0.1340	0.1340
Spain (Ecoembedes)	0.4720	-	0.3770	-	-	-	-
Sweden (FTI)	0.2440	0.2200	-	-	-	-	-

> 5l: 0.1540

H = households; C = commercial; I = industrial; all prices are per kg

It is recommended to price all plastics that consistmainly of mono m
to this could be made for specialcases, e.g. PVC from household packaging, si
options in place in Kenya. The same applies for opaque PET packagin
balance packaging fees for beverages, it is also recommended to d
this could lead to unexpected substitution effects.

The price of composite packaging, meaning packaging made of different m
that cannot be manually separated and of which none of the used materials
total composite packaging weight) should be comparably high. This is due to
recyclable, both in quality as well as in quantity.

In an initiating phase of implementing fees, the same prices should be used fo
additional products as well as plastics packaging and additional products

Recommendation for modulated fees

Modulated fees are not the first step to be taken when implementing an E
approach has been in place for only three years. In the Kenyan context,
the recycling of plastics. Against this background, a regular forum sh
for recyclers and collectors to discuss recent challenges and problems a
increase recycling. This step is followed by developing standards for sp
followed eventually by modulated fees.

As a recommendation for practice, formalised and informal collectors a
identify the problems which they are facing in the daily business in re
5.2.3) and summarise them in a guide as a basis for discussion with th
a standard should be developed at a later stage. Please note that modulate
for different materials (as the example shows, see Table 5) – modulate
incentive to further advance recycling in an already well running a

What are targets of the EPR which should be fulfilled by the PRO?

The overall system of the EPR is the establishment of collecting, so
which are covered by the EPR system. To achieving this, several ty

a) **Quotas (collection quotas, recovery quotas):** These are the most common targe
systems. In the current Kenyan situation, the challenge arises that
as e.g. the absolute size of the marketed quantity is unknown
identify. Prospectively, the inclusion of a quota is possible with furth
b) **Rate of linkages to system:** This means that within a certain period of time, a
population should be linked to a waste collection structure (for exam
population must be connected to an infrastructure). Again, it is difficu
since a formal collection structure has not been achieved yet in large
c) **Specific waste management measures:** Alternatively, specific, measurable waste mana
can be specified for the abovementioned goals. They can be increased
This has the advantage that the costs can be calculated more precisely
the PRO), be better controlled and react more flexibly towards unexpected
system was initially implemented with such targets.

For Kenya, it is recommended to use c) specific waste management mea
needs to be noted that some measures need to be reconciled with third part
recycling quota or the increase based on the status quo is not recommend
Therefore, determining a specific minimum (e.g. 50,000mt) of annually recy
achieved within a defined period of time, is more suitable (e.g. 3 a).

The establishment of a reliable reporting and controlling system as
system is essential. The controlling focuses on three dimensions:

i) **Fulfilling the operational services of the PRO:** The PRO structure needs to be transpar
visibility on potential misconduct of single deciders within the organization a
be adapted accordingly (particularly important in the initial phase).
ii) **Prevention of free riders among the obliged companies:** An effective measure is t
companies to report their amounts of plastic packaging and additional plastic it
system. In other states, it has been proven successful to publish the r
website). This way, free riders can be identified by the authorized controlli
Furthermore, with the published data it is possible to validate plastic a
knowledge about the sector and revenues of the single companies.
iii) **Fulfilment of operational performance by waste management operators:** It is importa
(collectors, sorters, recyclers) which provide services to the PRO are p
registered and licensed. This also includes a general suitability assessm
the mass flows which are handled by them as part of their operative b

Who is controlling and which instruments are suitable?

It has to be anchored in law who is responsible for the success
mechanisms can be distinguished. It is recommended to regard all three elem
correspond with the interests of controlling parties:

i) **Self-assessment**: This control is based on the principle that every deviation f
distortion (if one party does not fulfil their responsibilities and duties, a
bear the resulting disadvantages, e.g. free riders). Thus, registration, data g
accounting of the funds should be in the hands of the PRO. The PRO i
on self-interest, which specifically focuses on the prevention of free riders.
ii) **Control by a public agency (defined by the state):** The responsible controlling agency h
named in the law and needs to be staffed with knowledge and finances. T
fulfilment of the operative task of the PRO with regards to achievin
recycling). This can be done through both random on-site controls as w
of the PRO in terms of the fulfilment of the targets.
iii) **Public control:** This describes well informed consumers, who can recognise n
mistakes of the operative management.

For developing a legal framework, only the control by a public agency has
authority has to be specifically named. In most cases, a new section
responsible for the EPR act. They control and validate e.g. reporting by the
the EPR aim.

Which taxes/ levies should be implemented additional to the EPR system?

In case of a well-running EPR system, no further taxes or levies in th
and fillers of packaging as well as for additional plastic products are n
payment. The monetary steering function of an EPR system is p
products and packaging items are significantly more expensive.

For economic impacts that currently burden the Kenyan recycling, it
or levies in the long run. This means limiting the possibilities of cheap la
disposal needs to be penalised and the gate fees of existing landfills
to be used aimfully for redeveloping measures of landfills and dumpsite
in general. This strategy can only lead to successes if illegal dumping

How can the Counties/ local authorities be included?

**A close partnership between the Counties/ local authorities and the industry-owned EPR organis
a relevant condition for the success as well as the economic and environmental sustainability of
compliance scheme.**

Municipalities/ local authorities have several key roles to play, as they

i) Help to set up the collection points
ii) Agree with the EPR organisation on the most appropriate collection system, particularities and the conformity with national requirements.
iii) Cooperate with the EPR organisation in regards to:

- local public communication and awareness programmes
- data gathering and monitoring
- controlling the waste management operators and
- tendering for collection services and pilot projects

How can the licences and fees for waste collectors and recyclers be harmonised

**A fair and transparent EPR system requires the equal treatment of all participating stakeholder
wide.** This also includes licences and fees for collection, transportation a
needed with the competent authority granting these licenses upon EPR in
respective entity is most likely the National Environment Management Authority (N
and requirements will inevitably lead to imbalances in the waste management a

At the same time, the already existing registration system for collector
EPR system. For instance, it is possible that only registered compani
equal treatment and harmonization as well as countrywide integration and fo

In case different fees apply, they have to depend on legal framework c
of employees), processed amount and/or turnover are possibilities to be d

Which responsibility does each stakeholder have in the proposed EPR system?

The following Table 6 summarises the role of all involved stakeholders in

Table 6: Role of each stakeholder within the proposed Kenyan EPR system

Stakeholder	Role
Manufacturers of packaging material or of packaging and additional plastics products	• should enable reuse and ensure recyclability of packagin and should use secondary raw materials where possibl • exchange (forum) with collectors and recyclers recyclability and standardisation
Consumer goods companies (users, fillers and importers)	• obliged to pay fees to the EPR system fo terial of their packed goods and additional plastic product • need to be registered with PRO
Distributors/retailers	• can optionally be obliged to take packaging and back and to ensure their proper handling
Consumers	• have to be informed about strategies for w er collection (incl. participation in pilot projects collection) • public control
Waste management operators	• receive funds from the EPR system for their services packaging waste • need to be registered with PRO/ authority
Public institutions	• legislation and supervision of the EPR system • registration of waste management operators • support pilot projects
Counties and municipalities	• support collection and recycling or collect th • inform consumers • take part in pilot projects

6.2 Implementing voluntary measures

As the setup of an EPR system is the central element for creating proposed measures based on chapter 5.2 are connected to the propose

For stakeholders along the plastic supply chain, especially companies proposed to b participate right from the start as this offers them the possibilities to

i) Actively shape the system which will become mandatory
ii) Be connected with the public authorities
iii) Be well prepared instead of only reacting
iv) Give them an indirect benefit compared to their non-participating competit

In order to do so effectively, it is recommended to **found an orga to the PRO (so called PRO pre-organisation). Voluntary participation is, however, not limited to companies** – developing a tailored system should be done by **all companies supply chain.**

The following measures should be organised, prepared and financed by th funds are independent from the fees which are paid within a mandatory EPR sy

Implementing a pre-organisation is a lengthy process with several ta development of the pre-organisation through international funds should be discusse the implementation of a suitable legal status of the organisation as w internal sections and departments.

Which measures on a voluntary basis are recommended?

Prior to the formalised implementation of and EPR system it is recommended to first gain pra experiences on a voluntary basis; these will then be evaluated in regards to are voluntary projects and have to be clearly defined in order to k This is crucial for the voluntarily participating companies. Suitable pilot projects improvement of collection, recycling and monitoring, e.g.

- Separate collection and recycling of plastics or recyclables in gene universities, retailers/malls, eco-tourism etc.) and/or areas (rural touristic areas, inner as a role-model character to scale up nationwide.
- Increase sorting, e.g. through providing technical plants, space and/ or conditions.
- Increase of technical equipment and knowledge for the respective opera optimise transport processes.
- Increase environmental education and communication, e.g. through creat campaigns with a focus on middle income households.

Promote segregation at source as best practice and waste collection

As waste segregation at source is only done to a very limited extent, it waste segregation to start gaining first experiences and introduce the consumers Such pilot projects can be introduced in various fields, as shown below:

- Waste segregation in schools and universities: Schools and universities are i segregation at source as the children and students can be well educate home and their community, and ensure a long-term impact if educated at a schools and universities offer less anonymous environments. Segregation should b instance, by collecting all dry recyclables (plastics, paper, metals) and t have already been initiated in Kenya in several schools (see Mr. C collected at the schools needs to be regularly collected by either t companies and verifications about the collected quantities, sorted and recycled c finances. Simultaneously, a corresponding sorting needs to be developed.
- Companies, organisations, ministries and other public agencies: Similar to the set-up a waste segregation projects can also be initiated at companies, organisations, n agencies, which are willing to become role models in this field and e Also here, these sites offer less anonymous environments (compared to for instance material segregated and collected needs to be regularly collected by e or private companies and verifications about the collected quantities, sorted and r revenues and finances.
- Eco-tourism: In the field of eco-tourism, waste segregation projects can be w additional focus to reduce plastics as much as possible (where suitable) a waste and forward it to suitable sorters and recyclers.
- Waste collection at the household level in urban areas: It is recommended segregation at source and collection with bring banks, where the containers are s is important to set up these containers in sufficient numbers within a comparably short walking distance for the inhabitants so that separating w Moreover, the inhabitants of this district need to be properly informed a waste segregation. Additionally, a few sites for piloting kerbside collection is
- Waste collection at the household level in rural areas: Establishing central point f which the waste is collected by trucks and the recyclables directly sorted c
- Integration of the informal sector in collection: It is important to e valuable) is collected opposing to collecting only the valuable waste a bottles) while non-valuable waste (e.g. mixed plastics) as well as waste, which is wrappers), remains littered, i.e. a transition from material picking t collection is mainly in the hands of the informal sector, it is importa instance, it is possible to divide a certain area/district and assign parts o which are tasked to collect all littered waste and sort is subsequently after c cleanliness of the area instead of the amounts of recyclables they c equal the revenues they would make from picking valuables. It is importa pilot projects require a very high amount of organisation and controlli provided.

In regards to the collection at the household level, it is targeted to establish regular collection r
through formal collection. Therefore, both the Counties / municipalities as w
collection services need to be included in this.

In case of mixed waste collection, it is important to ensure suitable sc
need to be identified in collaboration with the counties / municipalities,
These spaces should be located close to the following treatment steps and e
The technical steps of the sorting should be complemented through manual
separating particles with a size < 40 mm, which should include mainly o
magnetic separators for removing the ferrous metals is recommended; however
done. Generally, the sorting should regard the existing recycling and marketing p
generate a residual waste stream, which contains as less valuables as

To increase the effectiveness of the transportation, baling machines that ca
be utilized on site. By making use of these, the volume of th
transported per vehicle. In turn, this requires transport vehicles which ar
weight and additional equipment to load the bales up on the vehicles a

Last but not least, collection can become also legal defined target of th
collection bins should be set up within a defined period of time in th

Recommendation on integrating the informal sector

The informal sector plays an important part in Kenya for the collection a
These pre-recycling activities should be integrated into the EPR system. The a
not lose their source of income. Furthermore, these workers are experienced re
possibilities to market the recyclables as well as challenges and problems a
companies that need employees for collection, sorting and/ or recycling. The p
context should be higher than their revenues from selling recyclables informally. A
conducted for this report, their individual revenue marginally exceeds the cu
it is recommended to implement respective pilot projects to gain ex

As a functioning EPR system offers reliable organizational structures as
integrating informal workers into the system offers many benefits. Generall
the informal worker can be integrated: either as an employee (see Table 7
them the possibility to remain independent as a person but formally cooperat
organisations (see Table 8).

Table 7: Integration of the informal sector as employees

Informal sector	Integration as employees
Irregular income	Regular income
Insecure social situation	Improvement of the social situation
High health risk	Minimisation of health risks
Vulnerability to unfair business practices	Reliable and fair business partners
Lack of access to social security systems	Access to social security systems

Table 8: Integration of the informal sector as business partners

Informal sector	Integration as business partners
Uncertain commercial base	Fixed service agreements
Uncertain marketing conditions	Reliable acceptance of recyclables
Uncertain situation for employees	Improvement of employee situation
High operational risks	Risk minimisation
Vulnerability to unfair business practices	Controlled business practices

Waste collection will become formalised through the implementation of a increase the pressure on informal workers to integrate themselves into they face the risk of having limited access to the waste. Thus, it is crucial to an early point onwards and inform them on possibilities and solutions. In part crucial for the integration:

- Confidence building, trust building and highlighting potential benefits,
- Information and professional support,
- Legal advice,
- Employment contracts for employees,
- Service contracts for business partners

Promote recycling

By increasing the amounts and effectiveness of collection and sorting of plast quantities of recyclable plastic waste become available for recycling. To supp it is possible to apply for grants or support for e.g. equipment (fun applications need to be approved by an independent body and consider usef

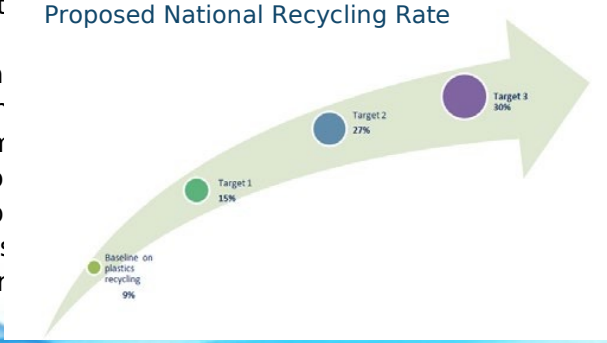
Moreover, it is recommended to identify which plastic converters would use food packaging and other non-food items as food-grade applications for recyclates as recycling capacities for plastic waste are not fully developed within Kenya, it recycling possibilities abroad as an intermediate solution (until the recycling capa increased). Please note that **it is recommended to only export sorted plastic fractions which are prepared for recycling, but no mixed waste.**

Promote product design for enhanced recycling

In light of the current Kenyan situation, it is recommended as before measures like modulated EPR fees are introduced. Against this background established which offers a platform for exchange between recyclers, aggregators and product designers and converters in order to;

i) share insights on recyclable product design,
ii) discuss current developments a
iii) jointly develop strategies and solutior recycling. Moreover, it is recomm guidelines which entail the insights o These measures should be financed b contact for exchanging with recyclers 'The Kenya Association of Waste Recycler

Proposed National Recycling Rate



From a mid- and long-term perspective, this should be followed by the d
product and packaging groups as well as a modulated fee once the E

Recommendation on biodegradable, bio-based and oxo-fragmentable plastics

The usage of biodegradable plastics is seen as problematic and is o
purposes including those which are in a direct connection with organic a
remaining in the environment). It is crucial to ensure that these biodegradable
given climatic conditions within a short timeframe. For all other applications, th
regarded as suitable, as they can only be degraded effectively under la

The usage of bio-based plastics is not affected by this. However, it
materials for manufacturing these bio-based plastics competes with farming
equal fossil-based plastics in the sense that they are not obstacles to re

Since oxo-fragmentable plastics fragment into plastic particles, which remain in th
litter and contribute to environmental degradation, it is highly recommended
plastics for any application; or even enact a ban on them.

Promote consumer awareness

The EPR compliance scheme should involve a strong collaboration with all st
authorities to inhabitants and waste operators – each with a designated ro
put down in the law that the PRO needs to inform the inhabitants and al
suitable way by using various forms of media and publishing on a re
which can be used for promoting consumer awareness, including social media.

It is also possible to initiate campaigns on different scales (national, re
a national clean-up day or "waste week"-campaigns in schools. Waste W
schools tackle waste and recycling both on campus and in the classroo
to comprehensively educate and help students see the difference they ca
work towards Eco-Schools accreditation (a formal award). The campaign has u
the classroom and eco-teams – students are informed, inspired and e
change. In 2018, over 1,800 schools took part in international Waste Week. A
success;

- 84 % of schools said it helped raise students' awareness of the
- 70 % of teachers said it helped encourage students to take actio
- 98 % of Primary students and 91 % of Secondary students
  the environment.

6.3 Implementation Matrix

Specific measures to start action need to be continued based on the a
of the Kenya Plastic Action Plan. The central element for the implementation is
chapter 6.1). This revolves around a complex process in which multiple

Based on the experiences from other countries, it is also a process whic
orientation. Thus, we recommend starting with a group of stakeholders working
the establishment of a legal frame. For participating companies and organisatio
advantageous as they can actively engage and therefore shape the implementa

Accordingly, implementation of a mandatory EPR scheme requires three mair
following tables:

i) **Establishing a legal basis for a mandatory EPR system** (see): It is recommended
system is established through a corresponding law. This requires a
competent authorities and the privateindustry.
ii) **Establishing a pre-organisation on a voluntary basis** (seeTable 10): To initiatethis process,
voluntary basis should be established as a pre-organisation for a later m
into force. Although such a voluntary system is limitedin performance a
in establishing the organisational and regulatory foundation and controlmechan
pre-organisation has to fulfil self-set targets (e.g. annual amount of p
organisation will conduct essential projects and measures to gain experien
measures in a Kenyan context (e.g. in terms of collection and r
controlmechanisms, determining the fees etc.).
iii) **Improving an optimising mechanism when the mandatory EPR system comes into force** (see T
Even after a legal framework has been established and a mandatory EPR s
taken to ensure that the EPR system and the PRO are continuously being c

Short term measures: describe actions that can be taken immediately
entail, with respect to the legislative framework, enacting bans and
put into place by the privatesector, possible within the current fram
behaviours and business practices. Starting projects, discussions and
long term measures are also part of this category.

Medium term measures: describe actions that need preparatory time in
set-up of a new institution with its tasks, its organizational struc
framework is included here. It also refers to processes of coor
and responsibilities in between different organizations and institutions.

Long term measures: build on discussions started as short term meas
organizational set-ups initiated as medium term measures. In
have to be built in order to achieve incremental change and

(see Table 11): Even after a legal framework has been established and a man
must be taken to ensure that the EPR system and the PRO are continuousl

Table 9: Establishing a legal basis for a mandatory EPR system

No.	Objective	Activities	Target	Actor	Time frame
1	Prepare for legal framework	Present and discuss outcomes of Action Plan with stakeholders of supply chain	Align understanding of Kenya Plastic PRO and KPAP with all relevant parties involved (private plastic industry)	KAM (optional with other aligned associations)	Short-term (should start immediately)
2	Prepare for legal framework	Present and discuss outcomes of Action Plan with national and local authorities	Align understanding of Kenya Plastic EPR scheme and plan across all relevant parties involved	KAM (optional with other aligned associations)	Short-term (after launch of KPAP)
3	Prepare for legal framework	Set up a competent control body in order to reaching the objectives of mandatory EPR scheme	Prepare for EPR put into force a governing body (government)	National authority (being ideally coordinating with the initiating private sector)	Mid-term
4	Prepare for legal framework	Establish knowledge, human and structural resources of the competent body	Prepare for EPR put into force by a government body	National authority (being ideally coordinating with the initiating private sector)	Mid-term
5	Tailor EPR framework to Kenyan conditions	Define - Responsibilities and obliged companies - plastics covered by EPR - targets - control by competent body - exemptions	Create a mandatory EPR scheme that practical, clearly defined, substantial and measurable	Competent body in cooperation with private industry	Mid-term
6	Tailor EPR framework to Kenyan conditions	- Coordinate with parallel legislation to avoid double payment - Harmonising existing (environmental) law (e.g. transport) - Use existing laws for licensing/registration - Laws to support recycling in general (e.g. landfill tax) - exemptions	Create a mandatory EPR system that doesn't conflict with but is ideally supported by laws	Competent body	Mid-term
7	Tailor EPR framework to Kenyan conditions	Evaluate drafted legal framework and its impact on the private sector	Insights on benefits, upcoming issues and potential future consequences for the private sector in order to observe these after implementation and act accordingly	Competent body	Mid-term
8	Roll out of EPR framework	Put developed legal framework into force	Mandatory EPR system	National authority	Long-term

Table 10: Establishing a pre-organisation on a voluntary basis

No.	Objective	Activities	Target	Actor	Time frame
1	Present and discuss a pre-organisation on a voluntary basis	Present outcomes of Plastic Action Plan with relevant stakeholders of plastic supply chain	Align understanding of Kenya EPR schemes across KAM and relevant KPAP parties involved (private industry)	KAM, PRO (optional aligned associations)	Short-term (should start with immediately)
2	Set up a voluntary pre-organisation on basis	Identify, connect and combine relevant Stakeholders and companies that are willing to participate Establish parameters for a pre-organisation	Create an organisation that participates actively in the development of a legal framework (see)	KAM, other (optional aligned associations)	Short-term (should start with immediately)
3	Set up a voluntary pre-organisation on basis	Define - Responsibilities - Targets and aims - membership - membership fees - reporting	Prepare a pre-organisation that is meant to become the mandatory PROS	KAM, other (optional aligned associations)	Short-term
4	Initiate a pre-organisation	Establish knowledge, human and structural resources competent body	Prepare a pre-organisation that eventually becomes the PRO	KAM, other (optional aligned associations)	Short-term
5	Initiate a pre-organisation	Public relations work and acquisition of members	All companies along plastic supply chain become member in voluntary PRO, the future obliged companies. Developing tailored system should be done by companies and organisations along the plastic supply chain.	KAM, other (optional aligned associations)	Short-term
6	Start pre-organisation	Establishing and pre-Organisation	Implement an institutional framework that actively participates in the development of a legal framework (see)	KAM, other (optional aligned associations)	Mid-Term
7	Run pre-organisation	Run pilot measures to develop projects in and proper plastic collection and waste cling and evaluation gathering, of insights	Create a waste management structure that can through a recycling approach be multi-step and data basis for implementation	Pre-organisation together with supply chain partners of be national	Mid-term

8	Run pre-organisation	Run pilot measures and projects in order to develop a sound mandatory PRO. This would include: - registering obliged companies - calculating their fees and establishing a controlling system to avoid free riders or false reporting - measures for mass flow validation - raising awareness - integrating informal sector - reporting to measure goal progress	Create necessary mechanisms to prepare for transition to a mandatory PRO	Pre-organisation together with the partners of supply chain	Mid-term
9	start mandatory PRO	Transition from a voluntary pre-organization to a mandatory PRO	Create a proper, well-prepared mandatory PRO to achieve aims of the EPR framework	Pre-organisation	Long-term

Table 11: Improving an optimising mechanism when the mandatory EPR system comes into forc

No.	Objective	Activities	Target	Actor	Time frame
1	Run mandatory PRO	- Collect fees - Run registration system - Run waste management practices by using fees - Run controls - Report regularly - Raise awareness	Fulfil requirements of legal framework	Mandatory PRO	Long term (after EPR framework is in place)
2	Optimise mandatory PRO	Use modulated fees to give financial incentives to strengthen recycling	Fulfil requirements of legal framework, optimising recycling amounts	Mandatory PRO	Long term (after EPR framework is in place)
3	Optimise mandatory PRO	Raise the demand for recyclates by giving incentives (financial and/or quota/amount)	Fulfil requirements of legal framework, optimising recycling amounts	Mandatory PRO	Long term (after EPR framework is in place)
4	Optimise mandatory PRO	Harmonise and formalise collection schemes for Kenya	Fulfil requirements of legal framework, optimising collection amounts	Mandatory PRO	Long term (after EPR framework is in place)
5	Optimise mandatory PRO	Optimise internal control mechanism Formalise informal packaging waste user and operators	Close financial and organisational gabs	Mandatory PRO	Long term (after EPR framework is in place)

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8.1 Annex 1: Background to Plastics

The term 'plastics' describes a huge group of polymers. The main distinction thermoplastics comprising all plastics which will melt when heated and hardenwhe manner. Polymers of this group are for instance, polyethylene (PET), polypropyle chloride (PVC), and polyethylene terephthalate (PET). On the other hand, there are the which entails all plastics that will change their chemical structures when heat dimensional network. This change is irreversible meaning that these plastics hardened. Examples for thermoset polymers are polyurethane, silicone and epox

Through a process called polymerisation the monomers are chained toge polymers are usuallyvery heavy molecules as there are composed of thousands combination, the chemical binding of different elements and compounds to additives, and the use of crystallizability yield plastic fractions with different be meltedto form many different plastic products allowing for this vast rang [American Chemical Council, n.y.].

The production of plastics is mainly concentrated in Asia, which accounted for plastics production in 2017 – Middle East and Africa only accounted for 7.1 2018). This is also reflected in Kenya's import of plastics material in which the import strongly dominated [Ipsos, 2019].

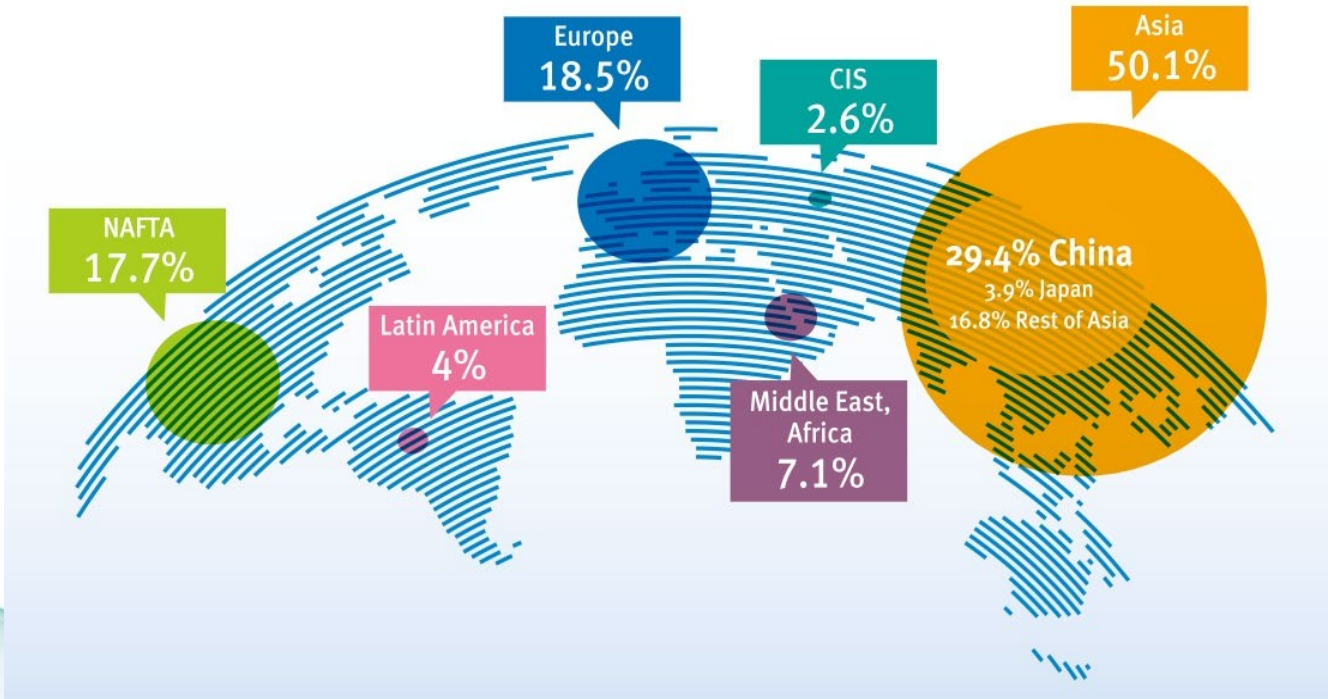


Figure 28: Distribution of the global plastics production, 2017 [PlasticsEurope, 2018]

However, plastics are not necessarily consumed where they are produced. W
manufacturing globally, the consumption ranges between 0 to 0.2 kg p
consumption takes place in Germany (0.48 kg per capita per day), Guyana (0
Kuwait (0.69 kg per capita per day).

On a global scale, the produced plastics quantities and the generated w
in the research of Geyer at l. [2017]. A visualisation of this ta

**Table 12: Quantities of produced primary plastics and generated waste acc. to sector, 2015 [Ge
2017]**

	Produced quantities in 2015 [Mt]	Waste quantities in 2015 [M
Packaging	146	141
Building and construction	65	13
Other sectors	62	43
Textiles	47	38
Consumer & industrial products	42	37
Transportation	27	17
Electrical/electronic	18	13

8.2 Annex 2: The polymer types

Each industrial sector uses several polymer types. In the following, the most presented following the international seven plastic codes.

PET is a thermoplastic polymer, which originates from the group of polyesters. of ethylene glycol with terephthalic acid or dimethyl terephthalate and a subs Through a moulding process, the eventual PET product is then crea which stands out through properties such as great tensile strength and chemical weight, elasticity, and stability over a wide range of temperatures (-60° to made of PET were introduced on the markets as early as in the 195 production of PET started to increase dramatically in the 1970s as it's packaging had been discovered. Today, PET is used as packaging material for drinking water bottles), electronic components and as fibres in clothes [Plas assigned number is 1.

HDPE (high density polyethylene) is polymer made from PE, which is derived into ethylene (and hydrogen) when heated. Through a subsequent low pres polymer is formed. Moreover, polyethylene is also the basis for LPDE as ethylene glycol [Posch, 2011]. Due to its lower degree of branching, HDPE proc stiffness and chemical resistance in comparison to LDPE. Thus, HDPE is an and rigid packaging such as bottles for milk and household chemicals. Other com duty items like pellets, crates and intermediate bulk containers as well as num applications [Emblem, 2012; Sastri, 2010]. The internationally assigned number is

PVC was one of the earliest plastics discovered and until now is still globally. It is created from vinyl gas, which is derived from salt (57 is polymerised through free radicals in suspension, bulk, emulsion or solu two forms of PVC: rigid and flexible. PVC is generally very durable, light insulating properties and a low permeability. Through the combination with addi be found in all kinds of sectors. For instance, it is commonly used floor and wall covering, and linings for tunnels), coatings (such as rainwear automotive applications, as well as medical products (including blood bags, surg tubes) [PlasticsEurope, n.y.]. The internationally assigned number is 3.

LDPE (low density polyethylene) is a polymer derived from PE as afore but high pressure process is like HDPE resulting in a product with a LDPE as a material is more flexible and has a higher clarity than HDP resistance. It softens around 100 °C, which makes it unsuitable for cock-in attractive to process. Thus, LDPE is widely used for packaging applications such food and non-food purposes and as a protective film on other materials [Bayer et al., 2017; Sastri, 2010]. The internationally assigned number is 4.

PP is the polymer, which is generated through the catalytic polymeri
chained polymers of propene. There are two processing methods:

i) low pressure precipitation polymerisation, and
ii) gas phase polymerisation, which is the more common one.

As a subsequent step, the powder is processed into granulate. PP is
This is due to its ability to replace both conventional materials, like g
polymers at lower costs. PP has an excellent strength, low surface e
is relatively easy to process. It resembles HDPE in many regards. H
exhibits a higher stiffness and resistance to creep as well as high te
a wide range of applications. It is used in films and multilayer applicati
packaging, labels, stickers, personal hygiene and construction films. Moreover, it
represents the single largest use. These fibres are used for instance in carpetin
[Massey, 2007; Sastri, 2010]. The internationally assigned number is 5.

PS consists of a monomer styrene, which is a liquid petrochemical.
available in two forms: rigid PS and foamed PS. It has an excellen
poor barrier properties in regards to moisture vapour and gases, which is
'breathable' films. Typical applications of PS are packaging, take-away food ca
consumer electronics products, building and construction and medical applicati
The internationally assigned number is 6.

Number 7 is given for the group 'others' and comprises all other p
as for instance nylon, polycarbonates or mixed plastic, which is a m
Differentiating according to these seven polymer groups, the global primary
per polymer in 2015 is as follows (Table 13):

Table 13: Quantities of produced plastics and generated waste acc. to polymer, 2015 [Geyer et

	Produced quantities in 2015 [Mt]	Waste quantities in 201 [Mt]	Percentage of waste quanti in regards to production
PET	33	32	97 %
HDPE	52	40	77 %
PVC	38	15	39 %
LDPE	64	57	89 %
PP	68	55	81 %
PS	25	17	68 %
Others	127	86	68 %

The table above shows that the plastics fraction which are mainly used for p
significantly shorter in-use phase than those which are also used for applications in
construction, as for instance seen in PET and LDPE in comparison to P

8.3 Annex 3: Recycling the different polymer types

Recycling plastic polymers is highly dependent on the purity of the waste poly of contaminants from other waste materials as well as other polymer types as compatible to create recyclates. Another important factor for recycling is the and thermoset as **only thermoplastics can be mechanically recycled** due to their abili chapter 2.2, [Hopewell et al., 2009]. The typical steps in mechanical recycling labels), grinding, washing and re-extrusion, in which the material is melt fibres. Moreover, there are often filtration steps in the recycling process to contaminating polymers [Plastic Recyclers Europe, n.y.].

PET is a polymer, which can be well mechanically recycled: the simplest is the re-extrusion in which the PET waste into fibres or granules for fibres in the nonwoven and textiles industry as well as PET bott fact, PET is the only polymer yielding recyclates which can be reused for require specific processes to yield very high-quality recyclates. Feedstock recy albeit being significant more expensive due to the energy-intensive process of methanolysis or glycolysis [Park & Kim, 2014].

Just as PET, **HPDE**, **LDPE**, and **PP** are polymers which can be well mechanical to manufacture several typical HDPE applications, such as pipes, films and sheets, applications such as bottles (although not for food-grade packaging) [Garrian et is used to produce piping, trash bags, sheeting and films for building and lumber, and other products [Plastic Recyclers Europe, n.y.] while PP recy for instance battery cables, rakes and bins, bottle caps or auto case batteries. be chemically recycled through a thermal pyrolysis at temperatures >70 recycling of PET, the process is consumes great amounts of energy [Ach

Also **PVC** is a polymer, which can be both mechanically and chemically recy the building and construction industry, a great share of the PVC waste is waste, which is why the PVC waste is relatively pure and less contaminated with critical to recycle PVC separate from other polymers as the high chlorine hazardous additives added to the polymer to achieve the desired mat recyclates of other polymers. In the mechanical recycling process, PVC is the other polymers. When different kinds of PVC waste are mechanically, it is product's leading to problems as most PVC products require a spec is more suitable for post-industrial waste than for post-consumer waste. For hydrolysis and heating are used to convert the waste into its chemical sodium chloride, calcium chloride, and hydrocarbon products are used to manufacturing processes or as fuel for energy recovery. The advantage is PVC waste. However, chemical recycling is associated to very high costs [Rub

PS – being a thermoplastic – is also recyclable: As many PS products are (EPS) foams, a critical step in the mechanical recycling is the compacting, dens foam contains a significant share of air. After this step, the EPS is filter (depending on the previous step) and can be used for non-food packaging that at present, it is more economical to produce new EPS foam prod currently not recycled in Kenya [Eunomia, 2018].

As aforementioned, there is a great difference in regards to recycling group 'others' is an umbrella for all other polymers, as well as m regarding the recycling can be made which is applicable for all plastic in

8.4 Annex 4: Recyclate usage

The 'European Plastic Converters' analysed the usage of recyclates across sectors 2017]. Please note that the percentage numbers represent the number of p recyclates (Figure29) as well as the number of plastic converters using a

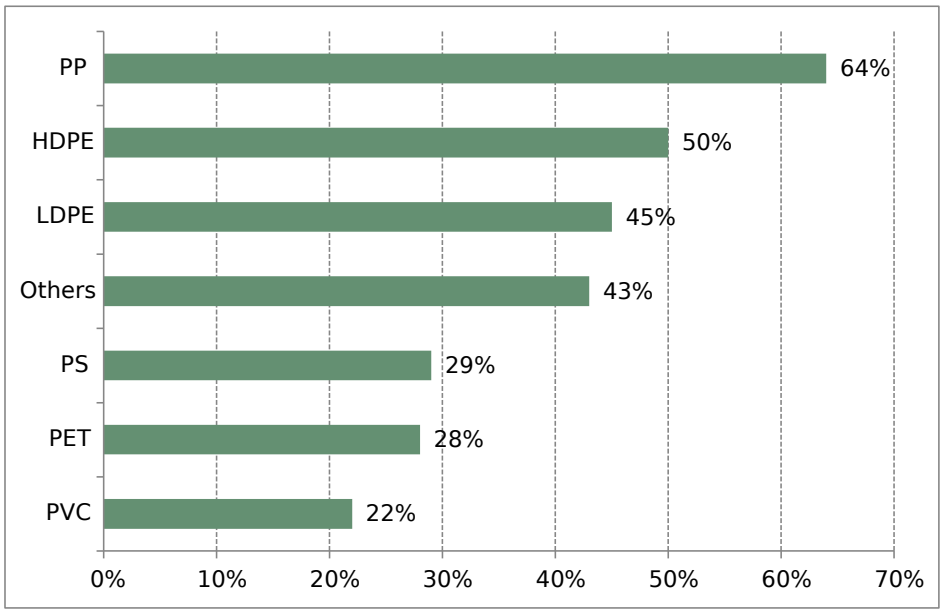


Figure 29: Recyclate use according to polymer fraction [based on EuCP, 2017]

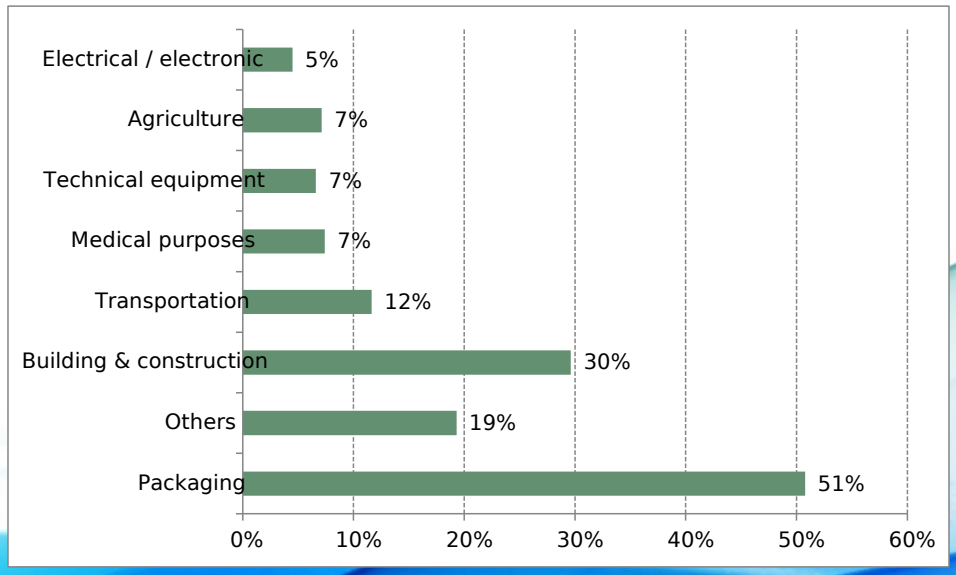


Figure 30: Recyclate use according sectors [based on EuCP, 2017]

Additionally to that, a German study carried out by Handelsverband Deutschland (German Trade Association HDE e.V.) in 2018 examines the usage of recyclates, in particular what and with the usage of different types of recyclates stemming from different type Germany. The study [GVM, 2019] identifies obstructions in five dimensions: availability, ecology.

To identify the overall results of the recyclates, the study assembled a char are no obstructions to the usage of recyclates and 10 meaning that the were summarised in five fields: 0-<2 equal no or very little obstructions, 2-<4 scores moderate obstructions, 7-<9 mean large obstructions, 9-10 mean very large obst 4-<7 equal

The results of the study show that packaging segments with the fewest obstruction such as boxes, palettes, plant pots, non-food cans and barrels, transportation packaging segments which provided the largest obstructions were those used in conn such as foam plastics used for food, compound foils, plastic bags, containers and largest obstructions are related to the availability of high-quality recyclates, the in terms of odour or missing transparency, and the insufficient physical and of recyclates currently available [GVM, 2019].

In Germany, approximately 3.2 million tons of plastic packaging are used, of or little obstructions for the usage of recyclates. The rest of the market obstructions (~45 %) and of large to very large obstructions (~45 %) [GVM, 2019

The study states that plastic recyclates will always provide worse technical characteris virgin materials. Requirements such as durability are significant obstructions for plast feasible, only be resolved by mixing recyclates with primary materials. In with new materials will inevitably have a negative impact on the quality of

Political regulations or stakeholder commitments for the usage of recyclates wou recyclates and set directions for the market development. At the same time, howe would be intensified through such a procedure. Due to the rising demand the rather favourable material costs will immediately become more expensive. More quality standards, the quality of the material life cycle would diminish [GVM, 2019

Sustainable improvements for the usage of recyclates would be the introduction the quickening and de-bureaucratisation of the approval of recyclates being in increase of consumer acceptance of recyclates and the resulting consequenc not need to be transparent [GVM, 2019].

As mentioned above, binding regulations and stakeholder commitments could enforce on the market of recyclates. Mandatory quality standards should ensure that recy so that they may be used on par with new material. Correct labelling of manufacturers and consumers to use recyclates for their packaging and materials. In that sense, it would be recommendable to establish the requ the introduction of such regulations. As compound materials are rarely recycled, be made of mono-material.

8.5 Annex 5: The circular economy concept in detail

The circular economy offers a more efficient resource use, which has e benefits. Economic benefits are the result of the decreased resource d less import dependency as well as the creation of employment possibilities. M and disposal of waste also offers significant ecological benefits, since the e extraction and disposal will be reduced if the cause is removed. La as the threat for human health driven by environmental impacts of extractio need to reintroduce resources into the economic system instead of d possibilities [Stahel, 2014; Wilts, 2016].

The circular economy is based on three overarching principles: reduce, re Wilts, 2016]. As the name implies, the reduction principle pursues the m energy demand, which are needed for production as well as waste that is or consumption. This can be achieved by improving both the production a developing more efficient technology, downsizing the packaging material or cl & Yan, 2007; Su et al., 2013].

The reuse principle describes that products or components of products, th they have turned into waste – are prepared for reuse [Ghisellini et al., 2 benefits as it decreases the resource and energy demand since the p et al., 2015]. The last principle, the recycle principle, refers to any p reprocessing the material or its chemical constituents thereby making it processes [Ghisellini et al., 2015, Hopewell et al., 2009].

Shifting to a circular economy as a response to the current by reducing the overall amount of plastics used where possible, e.g. fo products, substitution with other materials or banning certain products where m materials exist, and increasing the recycling and preparing for reuse of th the amount of plastic waste that is disposed and to prevent littering

A circular economy has important implications for all steps of the va a broader field than just waste management measures and are operationalised a complementing fashion (Figure6). However, this is usually not the ca promising, remain fragmented and measures across scales are often not well aligned this, a good coordination and collaboration between the actors of the various vital. An important prerequisite for that is to align various measures is outside the waste management and eventually broadening of the circle of th from the industry are important to include as e.g. their product de reused or at least recycled [Silva et al., 2017; Wilts, 2016]. Moreover, a st influence on circular economy measures is also important as they u which can be reused or recycled, or not, as well as if and how w role if reusing or recycling is even possible [Wilts, 2016]. Thus, a w including and cooperating with multiple actors from all sectors.

The following Figure 31 illustrates the three main principles and ten correspond economy.

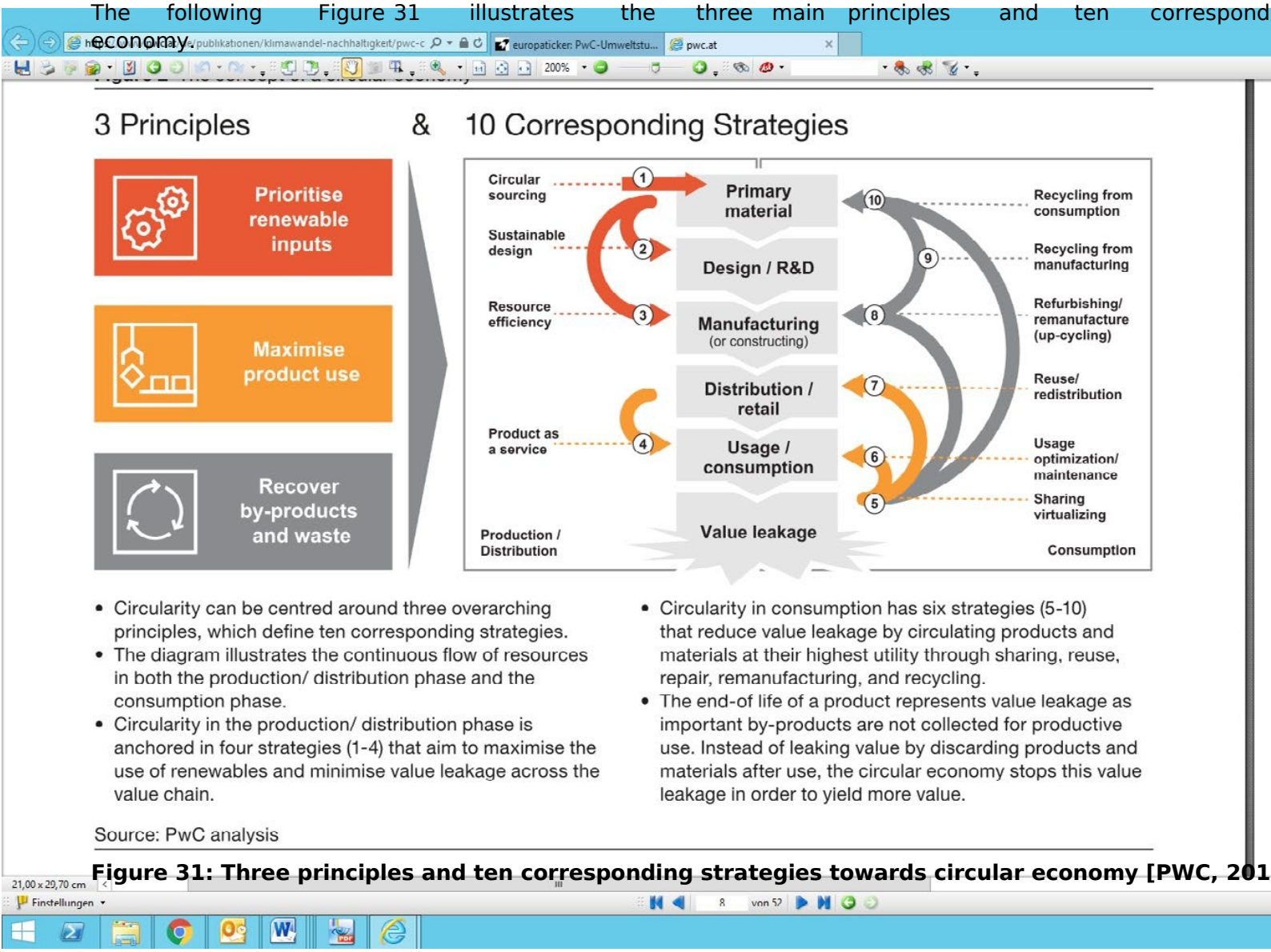


Figure 31: Three principles and ten corresponding strategies towards circular economy [PWC, 201

8.6 Annex 6: Global trends

To push circular economy also on a global scale, there are several gl
as well as privatesector initiatives to transit to a waste-free circular p
in this chapter. In particular, emphasis is put on the G7 Oceans
(SDGs) as well as 'The New Plastics Economy' published by the Ellen M

Government driven initiatives – G7 Ocean Plastic Charter

Marine littering poses a serious threat to t
Based on the urging need to address t global
commitment, five of the G7 countries adopted Charter
on June 9, 2018 to demonstrate their commitm g
marine littering problem by taking concrete s a
eventually solve the issue (Figure 32). Canada, F
and the UK thereby committed to a n in th
usage of plastics [Government of Canada, 2

As envisioned, the Ocean Plastics Charter b such
as local governments, businesses and civil rights n
action and move toward a more responsible, sustaina
To put this into practice, the Charter f resourc
efficient approaches in the management of plastics:

Figure 32: G7 Ocean Plastic Charter

1) **Sustainable design, production and after-use markets** to create 100 % reusable,
plastics by 2030, reduce single-use plastics (SUP), creating secondary plasti
plastics through green public procurement, policy measures and international incen
with the industry – reduce microbeads in cosmetics and personal care
2) **Collection, management and other systems and infrastructure** to significantly increase
through collective actions with the industry and local governments, increase
to reduce leakages, shift to a whole supply chain approach towards great
increase public-private funding and capacity development for waste managemen
areas including small islands and remote communities
3) **Sustainable lifestyles and education** to support industry lead initiates and
existing alliances and platforms, strengthening preventive measures for marin
choices through labelling and promote sustainable consumption particularly
youth a leadership role in this regard
4) **Research, innovation and new technologies** to promote research and developmen
technologies, design and production methods by the privatesectors and innov

- reducing the plastic leakages at all steps of the value chain,
- removing plastics and micro plastics from the marinehabitat, and
- assessing the impact on human health, analyse the currentplastic consumption by the G7 monitoring methods

5) **Coastal and shoreline action** to raise public awareness through campaigns, collec
to remove debris from coasts and shorelines, accelerate the implementation
and programmes as for instance the 2015 G7 Leaders' Action Plan to
Regional Seas Programs [Government of Canada, 2018].

By now, 21 governments, including Kenya, and 63 business and organisations, like 2019] joined the G7 Ocean Plastics Charter.

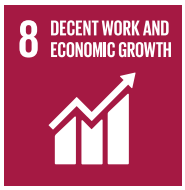
Additionally in June 2019, the G20 member states declared during their meeting litter and committed to develop a comprehensive approach preventing and the marine habitat. Moreover, they announced to share their best practices with measures are on a voluntary basis [Zeit, 2019].

Government driven initiatives – Sustainable Development Goals

Described by the UN as a 'blueprint to achieve a better and more Development Goals (SDGs) are 17 interconnected goals to address global challenges standards by 2030 [UN, n.y.]. To work towards these identified goals, the conc identified as a central element in regards to SDG 7 on energy, cities, SDG 12 on sustainable consumption and production, SDG 13 on climate SDG 15 on life on land. In particular, this means for the respective SDG

Figure 33: The 17 SDGs of the UN

Circular Economy and SDG 7 (Affordable and Clean Energy): The current s
production depend on non-renewable resources such as coal, c
global electricity demand rose by 4 %, which was met to a
from coal and gas-fired power plants increased significantly which in i
emissions form the sector by 2.5 % [IEA, 2018]. Transforming to a
shifting the focus on enhancing and increasing the efficiency of the cu
main source of energy, instead of a subsidiary one as well as d
energy to satisfy the demand with as less waste of energy as possible.



Circular Economy and SDG 8 (Economic Growth): As mentioned, the linear e
currently the dominant economic system, is built on the p
grants only limited sustainability since the resource availability is limited a
are lost after becoming waste. Within a circular economy, this
the principles of reduce, reuse, and recycle. The circular e
secondary materials and end-of-life applications, which will create jobs a
more specialised fields of study and development adding to the growth of the e

Circular Economy and SDG 11 (Sustainable Cities): Industrialized growth
urban population and density as well as the consumption. The
deeply influence the development of cities around the world. According
urbanized population increased from 14 % to 54 % betwee
to rise to 66 % by 2050, which will put tremendous pressu
The situation also calls for better ways on how to address
the negative effects related to an improper waste management, thus, highlight
Economy [WEF, 2018]. This approach will change cities by improving the li
(see previous SDG).

Circular Economy and SDG 12 (sustainable consumption and production): As
are limited, the current economy will face an inevitable
industrial sector and all related sectors. Circular economy
by using secondary materials as resource and less virgin materi
recycling and reusing. Moreover, a circular economy also
management along the value chain, e.g. through design for recycling,
longer periods and to avoid waste in production, supply, use, and disposal
consumption and production [Ministerial Conference Page, 2019].

Circular Economy and SDG 13 (Climate Change): Climate Change is
in earth's temperature due to the greenhouse gas emissions. 62
emissions — excluding those from land use and forestry —
processing and manufacturing of goods to serve society's needs
through its three principles of reduce, reuse, and recycle,
solution to cut down the effects of climate change and
emissions through decreasing the need to constantly extract and produce
form the natural environment.

Circular Economy and SDG 14 (Life below Water): The UN estimates that 40 are significantly impacted by human activities, including pollution, over habitats. According to the UNESCO, over 220 million tons of plas but inappropriate disposal of plastics is often not addressed as micro-plastics end up in seas and oceans threatening the marine ecosystems Circular economy is a solution to this problem as leak of the value chain but also particularly leakages of waste would be dramaticall recycled and not lost to the environment.

Circular Economy and SDG 15 (Life on Land): According to UN, around 1.6 on forests for their livelihoods, 2.6 billion people depend dire [UN, 2017] and until now, there are around 7.7 billion humans living in economy and waste disposal are endangering lives of species livin waste (especially plastic and micro-plastic) in land and soil as for exa can release harmful chemicals into the surrounding soil, which can or other surrounding water sources, and also the ecosystem. This can cause a effects on the species that drink the water' [UNEP, n.y.]. Circular economy prov more resources and materials for as long as possible in use. This can including increased product durability, reuse and recycling.

Private driven initiatives – Ellen MacArthur Foundation (EMF)

In 2010, the EMF was launched as a charity with the mission to acce on a global scale. One of their key topics is the so-called 'The New Plast economy in which plastics never becomes waste but remains a resource. Economy frames six key points through which such a circular economy coul

1) Elimination of problematic or unnecessary plastic packaging through redesign, i models is a priority.
2) Reuse models are applied where relevant, reducing the need for single-u
3) All plastic packaging is 100 % reusable, recyclable, or compostable.
4) All plastic packaging is reused, recycled, or composted in practice.
5) The use of plastic is fully decoupled from the consumption of finite resource
6) All plastic packaging is free of hazardous chemicals, and the health, safety, a are respected [EMF, n.y.].

The first report 'The New Plastics Economy – Rethinking the future of plas In light of the question of how to initiate the system effectiveness of the global plastics packaging value chain and material flow- The first report prop mind-set by approaching plastics as an integral part of an effective the circular economy principles. As key findings, the report highlights that

i) the predominant share of 95 % of plastics is only used once, which e billion annually, and
ii) plastic packaging generates severe, negative environmental impacts. This i forecast that in a business-as-usual scenario 'there may be more plastic t by 2050' (EMF, 2016, p. 29).

As a conclusion, the report urges to create an effective after-use economy the environment and decouple plastics from fossil fuels [EMF, 2016].

Following up in this report, 'The New Plastics Economy: Catalysing action' w action plan to transition towards 70 % reuse and recycling of plastic p and innovation for the remaining 30 %. Thereby, this report delivered a captured through five mutually reinforcing building blocks for;

i) cross value chain cooperation ('Dialogue Mechanism'),
ii) cross value chain developments for a design shift enhancing the recycling ('Global Plastic Protocol'),
iii) two innovation challenges for the proposed fundamental redesign ('Innovation
iv) assessing the socio-economic impact on the marine habitat ('Evidence B
v) broad stakeholder exchange to accelerate the system shift ('Stakeholder Enga

In 2018, the EMF launched the 'Global Commitment' in which more than 400 st good companies, packaging producers and packaging designers which collectively a the produced plastic packaging worldwide committed to change how plastics the latest update in June 2019, the report highlights the commitment of consume to increase the recycled content from 2 % (current global average) and reuse scheme in 50 retailer and brands and the publicly reporting production and use, including major consumer packaged goods companies and re Cola Company, Unilever, Carrefour, Colgate Palmolive, Danone, L'Oréal, a

Other private sector driven initiatives

In January 2019, 27 companies from all value chain initiated The Alliance to End Plast r initiative to push actions on reducing aquatic environment by combining their expertise, resources and outreach to create a global vision and a respective strategy. In particular, the a

i) the infrastructure development for waste collection and proper waste management to
ii) innovation for waste minimising technology, better plastics recycling and creat
iii) education and engagement of all stakeholders including governments from all communities, and
iv) clean-ups of already polluted habitats. In July 2019, the number Alliance to end Plastic Waste, 2019].

Moreover, there are also several privatesector initiatives founded in several circular economy measures in their respective countries. Examples are for

- **PARMS:** The Philippine Alliance for Recycling and Material Sustainability; Philippines, Nestlé Philippines, Pepsi-Cola Products Philippines, Procter & Gamble Philippines [PARMS, n.y.].
- **PRAISE:** The packaging and Recycling Alliance for Indonesia Sustainable E Nestlé Indonesia, Coca-Cola Indonesia, Tetra Pak Indonesia, Unilever Indonesia, T SuksesMakmur [1PRAISE, n.y.].
- **GRIPE:** The Ghana Recycling Imitative by privateEnterprises; members include Nestlé Ghana, Coca-Cola Ghana, Unilever Ghana, Voltic, Fan Milk Ghana, Cussons Ghana [GRIPE, n.y.].
- **TIMPSE:** Thailand Institute of Packaging and Recycling Management for a include Nestlé Thailand, Unilever Thailand, Coca-Cola Thailand, Pepsi-Cola T [TIMPSE, n.y.]

Nevertheless, it needs to be acknowledged that the successes of these initia who are working voluntarily on this issue, are competing with those companies an initiative in the respective country.

8.7 Annex 7: Questionnaire for online survey

Questionnaire for online survey

1. Plastic Value Chain

Please tick in which part of the value chain your company activity takes place. If you are active on several parts, please tick all of them and indicate clearly what information below relates to which activity.

- Importer of raw materials/ virgin or recycled plastics
- Manufacturing/ processing of plastics
- Plastic used for packaging of locally manufactured or imported goods
- Distributor/ Retailer of goods packed in plastics
- Consumer of goods packed in plastics
- Collection/ Segregation of plastics
- Recycling of secondary plastics
- Other, please specify

2. Briefly describe your company's activity, indicating precisely your plastic usage.

3. Which of the following plastic fractions are you using?
- LDPE
- HDPE
- PP
- PET
- PVC
- PS
- Others

Can you specify on the respective volumes you purchase e.g. per month or per year?

4. Are there challenges faced by industry at county and national level in the implementation of a sustainable waste management practices? Can you briefly describe, if applicable?

5. Has your company put in place a take back scheme for your packaging products? If so, please give a brief description.

8.8 Annex 8: Circular Economy and The Big4 Agenda

Circular economy represents also a tool which can contribute to achieving expansion in the blue economy, agro-processing, leather and textile industries:

Circular economy and blue economy:

The Blue Economy encourages a better stewardship of the ocean's or 'blue reduction of environmental risks for and ecological scarcities of the mari n.y.]. Based on a circular economy approach, recycling of plastic waste wou economy as plastic litter is a serious threat for the marinehabitat.

Circular economy and agro-processing industry:

Food-processing is a sector of the agro-processing industry that includes to transform raw ingredients into food for humanconsumption. The relationship betw sector is complicated: More than 50 % of food waste takes place in households during processing. Plastic packaging contributes in preserving food by preventing dam and extending shelf life, which help reducing food waste. That makes it hard to industry. At the same time, improper disposal of plastic packaging is the environment [Dora & Iacovidou, 2019]. Thus, redesigning plastic packaging that it is (if possible), reusing packaging where possible and a comprehensive colle - or other environmentally sound treatment method if packaging waste cann a circular economy, is important.

8.9 Annex 9: Alternatives to plastics

Kenya has currently no comprehensive waste collection and treatment infrastructu plastics in particular. In light of the prevailing waste management conditions structure for glass, plastics and paper, no relevant reusable systems), the form of packaging should be reduced as much as possible in order to deposits with the associated ecological consequences. From a resource con development of an orderlyand comprehensive recycling structure is the pref dealing with plastics and plastic waste is developed in the Action Plan. This following alternatives to plastics.

The results for three different material comparisons are based on the insights situation (see chapter 0). The following comparisons have been made:

i) water bottles (which also apply for cooking oil and yoghurt cups, see Table 2
ii) grocery carrier bags (see Table 22), and
iii) construction pipes (see Table 26).

Plastics are utilised in many areas in which other materials are used to raw materials utilized in the further processing will be compared in rega their production as well as other environmental aspects, if available. The Global Warming Potential (GWP). The GWP is a substance's / material's pote greenhouse effect. This contribution is portrayed as an equivalent in relation For evaluation the figures GWP100 are utilised, which identify the contributio material averaged for a time span of one hundred years. The lower the is the potential impact on global warming and the relating environmental

Table 14: Global Warming Potential for different raw materials

Category	GWP_{100} [kg CO_2 equi.] per kg	Database
Plastics		
ABS	3.76	Bath Uni via [Carbon Footprint
ABS	3.10	[PlasticsEurope, 2019]
(Expanded) Polystyrene (EPS)	3.29	Bath Uni via [Carbon Footprint
(Expanded) Polystyrene (EPS)	2.37	[PlasticsEurope, 2019]
Polystyrene (PS)	2.25	[PlasticsEurope, 2019]
HDPE	1.93	Bath Uni via [Carbon Footprint
HDPE	1.80	[PlasticsEurope, 2014]
Recycled HDPE	0.93	[Liebich, 2016]
LDPE	2.08	Bath Uni via [Carbon Footprint
LDPE	1.87	[PlasticsEurope-A, 2014]
Recycled LDPE	1.41	[Liebich, 2016]
Polypropylene	1.63	[PlasticsEurope, 2019]
PP, Injection Moulding	4.49	Bath Uni via [Carbon Footprint
PP, Orientated Film	3.43	Bath Uni via [Carbon Footprint
PP	1.63	[PlasticsEurope-B, 2014]
Recycled PP	0.95	[Liebich, 2016]
Polycarbonate	7.62	Bath Uni via [Carbon Footprint
PVC	3.10	Bath Uni via [Carbon Footprint
PET	5.56	Bath Uni via [Carbon Footprint
Glass		
Primary Glass	0.91	Bath Uni via [Carbon Footprint
Secondary Glass	0.59	Bath Uni via [Carbon Footprint
Aluminium		
Aluminium Cast products (primary)	13.10	Bath Uni via [Carbon Footprint
Aluminium Cast products (secondary)	1.45	Bath Uni via [Carbon Footprint
Aluminium Cast products (typical)	9.22	Bath Uni via [Carbon Footprint
Aluminium Extruded (primary)	12.50	Bath Uni via [Carbon Footprint
Aluminium Extruded (secondary)	2.12	Bath Uni via [Carbon Footprint
Aluminium Extruded (typical)	9.08	Bath Uni via [Carbon Footprint
Aluminium Rolled (primary)	12.80	Bath Uni via [Carbon Footprint
Aluminium Rolled (secondary)	1.79	Bath Uni via [Carbon Footprint
Aluminium Rolled (typical)	9.18	Bath Uni via [Carbon Footprint
Steel		
Steel Bar & rod - Primary (100% hypothetical virgin)	2.73	Bath Uni via [Carbon Footprint
Steel Bar & rod - Secondary	0.45	Bath Uni via [Carbon Footprint
Steel General Steel - World Typical - 39% Recy.	1.95	Bath Uni via [Carbon Footprint
Steel Coil – Galvanised (100% hypothetical virgin)	3.01	Bath Uni via [Carbon Footprint
Steel Coil – Galvanised (typical 35.5 % Recy.)	2.12	Bath Uni via [Carbon Footprint
Paper		
Paper (primary)	0.96	[Raschke, 2016]
Paper (primary)	1.28	[Ifeu, 2018]
Recycled Paper	0.68	[Raschke, 2016]
Recycled Paper	1.14	[Ifeu, 2018]
Concrete		
General Concrete	0.11	Bath Uni via [Carbon Footprint
Concrete – depending on composition	from 0.10 till 0.15	Bath Uni via [Carbon Footprint
Concrete (Precast Mix 1)	0.214	[Marceau et al., 2007]
Reinforced Concrete	0.204	[Struble, Godfrey, 2004]

Information: These figures serve the purpose of orientation and classification of each result from surveys which do not explicitly consider the Kenyan frame cond to the basic processing technique, utilised electricity mix. However, these base portray the contribution to the greenhouse effect, such as aluminium which has compared to plastics or paper.

Table 14 clarifies, that the GWP of;

- Glass ranges within the scope of approximately 1 kg CO2-equiv. per kg,
- Paper ranges between approximately 1 to 1.3 kg CO2-equiv. per kg,
- Plastics range from approximately 1.7 to 3.4 kg CO2-equiv. per kg (
- Steel ranges from approximately 2 kg CO2-equiv. per kg (depending on t approximately 2.7 kg CO2-equiv. per kg (for primary material),
- Aluminium ranges of the scope of about 9 (depending on the portion o equiv. per kg (for primary material).

It also becomes evident that the usage of recycled or secondary mate regards to each particular type of material. Furthermore, through a com pipes) one many take into consideration that the GWP is largely related to the the usage of materials (e.g. plastics vs. glass), as well as the user beha aligned waste management or recycling opportunities.

Bottles (for water): PET-bottles substituted by glass, aluminium can or liquid packaging board

Beverages like water are generally sold in different types of packaging, amo aluminium cans and drink cartons. Especially usage, as well as the transport environmental performance evaluation.

The manufacture of glass bottles and aluminium cans is energy-intensive, which mea performance evaluation only results positively, if these products are used multiple of a circular system) and are not transported over long distances. This considered when making an environmental performance evaluation on item leve

Information: Due to the greatly differing frame conditions, in which the following it is important to illustrate the functional mechanisms which occur in the disposal, as they do not exist in Kenya in such an adequate form. Thus insights which may apply to Kenya in a similar manner, so that resulting be distinguished.

This kind of comparison was intensely examined in Germany conducting the Getränkeverpackungen II / Phase 2' [Schonert et al., 2002]. Detzel et al, results. During this examination different scenarios were created, according to performance evaluations. These also include analysis in relation to transportation and Specifically, PET bottles (single use incl. recycling) and glass bottles (single-use and mult with a filling volume of 1 l were compared. The following Table 15 category qualitatively next to each other, acc. to which reusable water bottles are one-way PET bottles and one-way glass bottles.

Table 15: Ranking of different water bottles related to selected environmental criteria [Schonert

Criteria	Glass multiple use	Glass single-use	PET single-use
Aquatic eutrophication	1	3	2
Terrestrial eutrophication	1	3	2
Depletion of resources	1	3	2
GWP kg $_2$ CO per 1 l	1	3	2
Acidification	1	3	2

A further examination compared PET single-use systems to PET multiple u
et al. [2002] the environmental impacts as shown above from single-use w
multiple use system, however, slightly exceeds the impacts of re

Glass multiple use bottles provide a better environmental performance compare
cans for a filling volume of 0.5 l (see Table 16) meant for immedia

Table 16: Ranking of different beverage packaging for immediate consumption related to selected e criteria [Schonert et al., 2002]

Criteria	Glass multiple use	Aluminium can single-use	Steel can
Aquatic eutrophication	1	2	3
Terrestrial eutrophication	2	1	3
Depletion of resources	1	2	3
GWP kg $_2$ CO per 1 l	1	2	3
Acidification	1	2	3

Similar examinations have been done in Austria with the research 'Ökobilanz von G
Österreich Sachstand 2010' [Kauertz et al., 2011]. A comparison is possible
different arrangements without the influences of the following chain mechani
of the different functional mechanisms were classified in categories (such as
production). Thus, the GWP of the production of a 1 l glass bottle (w
is approximately 22 kg CO2-equiv per 1 l and the GWP of a
and caps is approximately 39 kg CO2-equiv per 1 l.

Acidification and fossil resources depletion resulting of the glass bottle producti
for the PET bottle production. If the distribution afterwards is taken into c
following Table 17 identifies which categories have negative effects.

Table 17: Phase depending negative effects for different beverage packaging relating to selected en criteria [Kauertz et al., 2011]

Criteria	Glass multiple use	PET single-use
Global Warming Potential (GWP)	Distribution Filling Hollow-glass production	PET production Distribution Disposal
Fossil resources depletion	Distribution Production of labels and caps Filling	PET production Distribution Production of packaging for sale a transport
Acidification	Distribution	PET production Distribution

On closer examination, these two sectors of the functional mechanisms responsible system load. The biggest influential factor for the results of the PET sing from the sector PET production.

These studies are widely confirmed by the study 'Studie Life Cycle Assessment of PET bottles and other packaging alternatives' [Schmidt et al., 2000]. During the comparison potentials, in which credits from the following chain mechanisms for the recycling that single-use PET bottles 1 l with 123 to 160 kg CO2-equiv per 1,00 than returnable light glass bottles (70.1 kg CO2-equiv), or returnable PET bottles (59.5 credits for the secondary materials are taken into account as a 'net calc examined materials, especially for PET bottles, which continue to provide (98.2 to 120 kg CO2-equiv per 1,000 l).

The goal of this examination 'The Global Warming Potential analysis of beve Paqualino et al., [n.y.] was to evaluate the contribution of packaging to cycle (beverage production, transport, packaging production and final disposal). The are landfilling, incineration and recycling, and the packaging types are aseptic can and PET, and their sizes are from 200 ml to 8 l. Recycling was disposal option for all the packaging alternatives compared, and landfilling was option. The packaging options with the lowest environmental impacts were asep (for sizes greater than 1 l). The influence of beverage production on of beverage. Global Warming Potential has been considered as the environmen Caps and lids). The following arrangements were examined, which parallel a fillin

- Liquid packaging board (aseptic carton), size 0.2 l (50 g/l) till 1.5 l
- Aluminium can, size 0.33 l (67.9 g/l) till 0.5 l (34.7 g/l)
- Glass brown, size 0.33 l (722.7 g/l) till 1.0 l (468.8 g/l)
- Glass white, size 0.33 l (722.7 g/l) till 1.0 l (492.2 g/l)
- HDPE, size 0.2 l (91.1 g/l) till 1.5 l (32.7 g/l)
- PET, size 0.33 l (42.4 g/l) over 1.5 (19.3 g/l) till 8.0 l (17.5 g/l)

Also according to other studies(i.a. [Schmidt et al. 2000], the specific w
to the following list (Table 18).

Table 18: Masses of different packaging types

Packaging type	Mass per 1 l
PET (one way)	Approx. 33 to 46 g
Beverage carton	Approx. 35 g (highly depending on size)
Alumnium can	Approx. 35 to 68 g (depending on
PET (returnable)	Approx. 71 g
Glass (light)	Approx. 470 to 490 g
Glass (heavy)	> 700 g

Contrary to the mentioned studies, this analysis focuses on the e
(landfill, incineration and recycling):

- Landfill: includes the dump infrastructure, the use of land, the effec
  to the soil, air and groundwater released by waste disposed of in
- Incineration: covers the incineration plant infrastructure, the incineration process,
  and the disposal of residual ashes (to landfill). Electrical energy recov
  environmental load.
- Recycling: takes into account the recycling plant infrastructure, the sortin
  products obtained and the wastes generated. The products obtained from
  to displace virgin raw materials and are thus an avoided load.

The first result is that larger packages always have a lower environmental in
optimal packaging sizes guarantee minimum product losses and maximum e
in Table 19, beverage cartons and plastic packaging (for sizes greater
three disposal methods. Except for glass, the GWP figures of an existing re
However, the GWP of disposal of aluminium in a landfill was significa

Table 19: GWP of different packaging types relating to different disposal scenarios [Paqualino e

Type	beverage	Landfill	Incineration	Recycling
Beverage carton (1.5 l	Juice	200 ml) 0.057 to	0.091 0.069 to	0.104 0.048 to 0.074
Glass white (1 l to	Juice	330 water ml) 0.557 to	0.772 0.729 to	0.976 0.352 to 0.513
PET (8 l to 330	Water	ml) 0.079 to	0.224 0.130 to	0.311 0.036 to 0.101
Aluminium can (500 ml	Beer, also applicable to	330 ml) water 0.039 to	0.054 0.058 to	0.895 0.039 to 0.077

For India, a comparable LCA for glass and PET bottles was conducted [Stichling, chosen reference scenarios for glass bottles (focus on 100 %), following func compared (Table 20).

Table 20: Comparison of PET-bottles with glass-bottles according to [Stichling, Sing

Criteria	PET-bottle compared with glass-bottle (same functional ur
Acidification Potential [kg SO2-equiv.]	Lower (60 %)
Eutrophication Potential [kg PO4-equiv.]	Lower (69 %)
GWP100 [kg CO2-equiv.]	Lower (57 %)
Human Toxicity [kg DCP-equiv.]	Higher (123 %)
Photochem. Ozone Creation Potential [kg Ethene-equiv.]	Higher (136 %)
Terrestic Ecotoxicity Potential [kg DCB-equiv.]	Higher (246 %)
Primary energy demand from ren. And non ren resources [MJ]	Lower (54 %)

The study 'Comparative Life Cycle Assessment of Tetra Pak® carton packages and alter for liquid food on the Nordic market' comissioned by Tetra Pak International SA comapred with competitive liquid food packaging made of PET and HDPE for the Norwegian market. A considerable role for these generally low environmental the renewability of their paperboard components and a high use of renewable use of renewable materials and energies in the production processes. Espe main component leads to low impacts compared to the use of plastics

In general the examined beverage carton systems analysed for these mark impact categories than their competing systems. These impact categories are

- Climate change,
- Acidification,
- Photo-Oxidant Formation,
- Ozone Depletion Potential,
- Terrestrial Eutrophication,
- Aquatic Eutrophication,
- Particulate Matter,
- Total Primary Energy,
- Non-renewable Primary Energy,
- Use of Nature,
- Water use (related to water input).

An exception to this occurs in some categories if the carton contains a The use of bio-based polyethylene, though does not deliver such an unambiguo bio-based PE instead of fossil-based material leads to lower results in 'Clim production of this bio-polyethylene, including its agricultural background system, impacts in all the other impact categories regarded.

A comparsion of the different material solutions is shown in Table 21.

Table 21: Comparison of different materials for bottles for water

	Comparison: Bottles for water			
GWP	+ Relatively low GWP, returnable, relatively than glass bottles	0 Light If glass bottles smaller higher GWP than gle-use PET, but than reusable	- Highest GWP, compared to sin- PET, glass large pack PET	0 Relatively low GWP, and nearly tetra par with glass bottles, depend- ing on whether are reusable
Water footprint	+ smallest water foot as PET is made resources	- A print, lot of in from the fossil manufacture glass, more than manufacture of	- Water is lot needed of ture of the manufacture for aluminium, more PET than PET	-- Water lot of needed water needed to produce then cardboard, which is then coated to liquids
Use of renewable resources	- The resource for sil based; a finite can possibly change bio based plastics such corn starch, may result competition over cultiva- ble land and higher demand water	+ In PET large is portions fossil is resource made of available into in as in	+ One of glass the sand; abundantly which is available elements on however, may found in many minerals; yet finite source	0 In most large portions from cardboard and Earth; paper fibres, also which be manufac- other from cutting down trees is a
Use of secondary material	0 Although PET bottles are recyclable, the PET oftentimes are not turned into new PET but the plastic fibres processed for a purpose	+ Today glass manufac- ture bottles uses a glass being to mix the bottles manufacture glass are items; it of different and	0 If the aluminium lot made of up waste with materials during such of pounds, new the is waste a may mix new glass different (down cycling)	0 It is can difficult to different recycled materi- als is com- used for aluminium packaging boards, as they recycled are no labels indicating purpose it
Health aspects	0 May be used multiple times, but needs to be fore reuse, as bacteria infest the bottle	+ Easier to clean no washed health- hazards can	0 The reuse, should for tops cleaning, before know germs leaching avoid the water into out pouring	+ Manufactured and filled at high tempera- ture, no information germ infestation
Safety aspects: handling, usage	+ Do not break easily, weight	- Breakable, also straight from the may cause harm is damaged knocks against teeth; heavy weight may difficult for disabled elderly people to	+ Does not break drinking create dents, bottle weight, needs small if storage space glass or be or handle	+ Does not break easily, lighter weight, com- pared to glass

Economics (world-wide)	**0** Production requires amount of resources, made from fossil	**--** Production process is longer, requires more resources, also transportation is more intensive as they are in comparison heaviest and PET, aluminium packaging boards, this also counts for collection	**-** Production process is longer, requires more resources, also transportation is more energy intensive as they are heavier, this also counts for collection	**-** Production process is longer, requires more resources, also transportation is more energy intensive as they are heavier, also counts for collection
Economics (price)	**+** Usually cheaper than aluminium cans and packs, especially considering filling volume, biggest filling volume	**-** Most expensive, but glass, many volume extra across sides PET has	**0** Less filling expensive glass, more expensive than tetra packs PET, and considering filling volume	**0** More expensive than PET and cans, but glass and the
Consumer aspects	**0** Light weight, thus easy transport and carry more difficult to	**+** Heavy to weight, thus many more around difficult transport, may look to aesthetically pleasing, easier to	**0** Single-use, refilling not dosing work, small units, filling volume, may clean for alternative they elling need as much space	**+** Can be disposed of insmall the plastic waste; recyclable, single-use, heavier weight than PET, but lighter than glass not
Waste management	**0** Returnable PET bottle system not available where yet, adequate management infrastructure needs to be established	**0** Returnable glass bottle system not available everywhere yet; adequate waste management infrastructure needs to established	**0** Returnable aluminium can system not everywhere available yet; adequate infra-management structure needs established	**--** Tetra pack technically recyclable, but in specific which are mills available every therefore be disposal waste-paper should as avoided cannot mills liquid packaging boards; adequate management infrastructure needs to be established

The same principles apply to the comparison for cooking oil (HDPE vs. metal vs. liquid packaging board and glass).

Carrier bags: LDPE vs. paper, cotton and non-woven PP

As mentioned (see chapter 3), the Kenyan government passed a ban on the importation of flat plastic bags for commercial and household packaging, which includes all plastics of reduce the amount of littered plastic bags as well as the provide the environment. However, many concerns have been voiced after that are indeed better from an environmental perspective.

The Danish Ministry of Environment and Food published the 'Life Cycle Assessm
2018 [Bisinella, 2018] researching the life cycles and environmental impacts o
as well as how many times they needed to be reused to break even w
LDPE plastics grocery shopping bag.

The study examined the following types of carrier bags available in stores in

- LDPE, four types: average, soft handle, rigid handle, recycled
- PP, two types: non-woven, woven
- Recycled PET
- Polyester (of virgin PET polymers)
- Starch-complexed biopolymer
- Paper, two types: unbleached, bleached
- Cotton, two types: organic, conventional
- Composite (jute, PP, cotton)

A Life Cycle Assessment (LCA) takes into account the potential environmental
which are necessary to produce, use and dispose of the product. T
that may occur during the disposal. To assess the carrier bags and their environn
materials as shown above were compared to the characteristics of an a
in Danish supermarkets.

End-of-Life scenarios for carrier bags

The study examines three main end-of-life (EOL) scenarios for the different ty
be incineration of the carrier bag. After serving its primary function (c
another destination) the bag is disposed of, collected and incinerated. T
incineration allows for avoiding the production of electricity and heat from a

The second EOL is recycling of the material. After disposal with se
the collected waste is sent to material recycling. The recycled seconda
of the same amount of material from primary sources. The residues
which results in the production of electricity and heat, which allows for avoiding
electricity from other resources.

The third EOL is the reuse as waste bin bag. After serving its primary
another function, which is collecting residual waste. This practice allows a
of a traditional waste bin bag. The electricity and heat produced during in
production of the same amount of electricity and heat from other resource

Factors not included in the study

This Life Cycle Assessment does not consider behavioural changes or conseque
measures. Also economic consequences for retailers and carrier products a
Moreover, this report does not include the effects of environmental littering.
and decommissioning of capital goods such as infrastructure and machinery, nor d
capacities or new capacities requirements.

Environmental indicators examined in this study

In determining the carrier bag with the smallest environmental impact, the different types in relation to recommended environmental indicators as These indicators were:

- Climate change
- Ozone depletion
- Human toxicity, cancer effects
- Human toxicity, non-cancer effects
- Photochemical ozone formation
- Ionizing radiation
- Particulate matter
- Terrestrial acidification
- Terrestrial eutrophication
- Freshwater eutrophication
- Marine eutrophication
- Ecosystem toxicity
- Resource depletion, fossil
- Resource depletion, abiotic
- Water resource depletion

In the study, the different types of carrier bags were examined in relation shown before.The indicator climate change was also viewedseparately for the This indicator includes factors such as global air temperature change or conc

Results of Life Cycle Impact Assessment

In almost all categories, grocery bags made of LDPE provided the lowest envi examined. Overall, light carrier bags such as LDPE, paper and biopolymer were the provided the lowest environmental impact. Heaver multiple-use carrier bags such obtain the highest environmental impacts across all impact categories. Therefore, many times a type of bag needs to be reused to lower the environmental to values comparable to lighter carrier bags. Thus, the study also calculated how man carrier bags would have to be reused to provide the same environmental perf

- All environmental indicators considered, a recycled LDPE bag would have t used as a waste bin bag and then disposed of.
- Non-woven PP bags should be reused 52 times, before being recycled.
- Woven PP bags need to be reused 45 times, and then recycled, to break e
- Bags made from recycled PET would need to be reused 84 times to have t LDPE bags, before they are being recycled.
- Polyester PET needs to be reused 35 times and then recycled.
- Considering all indicators, bags made from biopolymers need to be reused 42 t used as a waste bin bag or incinerated.
- Unbleached paper bags should be reused 43 times before they are either used as w incinerated.
- Bleached paper also needs to be reused 43 times, until it is either used a
- Organic cotton should be reused 20,000 times before it is either used as a w break even with LDPE bags.
- Conventional cotton needs to be reused 7,100 times, before it is used as a w
- Composite bags should be reused 870 times before they are used as waste bin b

The comparable study 'Life cycle assessment of supermarket carrier bags: a review o commissioned by the UK Environment Agency and published in 2006 [E similar conclusions as the 2018 Danish report.

In the Life Cycle Assessment, grocery carrier bags available in UK superma contrary to the 2018 study, the UK Environment Agency then used conventi they were the average bags being handed out for free in grocery st study was to determine a life cycle inventory of environmental impacts and disposal of lightweight carrier bags. Another goal was to compare th lightweight plastic carriers to those caused by alternatives. In this st taken into consideration. These include the consequences of carrier bag ta to and willingness of consumers to change their behaviour, any adverse recycling streamand potential economic impacts on the UK industry.

Environmental impact indicators as used in the research

To determine the environmental impact of the different types of carrier b nine environmental indicators:

- Global warming potential
- Abiotic depletion
- Acidification
- Eutrophication
- Human toxicity
- Fresh water and aquatic ecotoxicity
- Marine aquatic ecotoxicity
- Terrestrial ecotoxicity
- Photochemical oxidation

The indicators as shown above are largely comparable to the set of environm study used in their 2018 life cycle assessment report.

Results of life cycle assessment

The study concluded that conventional HDPE bags provided the lowest environmental in eight out of nine environmental impact categories.

- LDPE bags need to be reused five times in order to reduce their environment conventional HDPE bag.
- A paper bag would need to be reused four times to reduce its global warm conventional HDPE bag. However, many reuses are unlikely due to its low
- Cotton bags provided a greater environmental impact than conventional HDPE categories. 173 reuses are required to reduce the environmental impact below bag with average secondary reuse impact.

Overall, when compared to a conventional HDPE bag which is disposed of use as, e.g. a waste bin liner, then a paper bag needs to be reused 3 times, a non-woven PP bag should be reused 11 times and a cotton bag need their environmental impact to that of a conventional HDPE bag.

Both studies that were used as a reference concluded that grocery shopping provided overall lower environmental impacts than paper, cotton und non-woven PP important to consider that factors such as environmental littering were not life cycle assessments as both studies analysed the different materials for angle. A comparsion of the different material solutions is shown in Tabl

Table 22: Comparison of different materials for carrier bags

	Comparison: Grocery carrier bags			
	LDPE	**Paper**	**Cotton**	**Non-Woven PP**
GWP	**+** Overall best climate change performance	**-** More impact than LDPE, PP and non-woven due to trees being cut down, longer processing of fibres, heavier weight	**-** More impact than LDPE, paper and non-woven PP, due to cotton production	**0** More impact than LDPE but better than paper and cotton
Water footprint	**+** Overall smallest water footprint, resource for conventional plastic is fossil-based	**-** Bigger water footprint than for LDPE, much water is needed in production of paper fibres	**--** Bigger water footprint than LDPE and paper, water is needed to produce yarn and fertilizer production	**0** More water is used than for LPDE bags, but less than for paper and cotton bags
Use of renewable resources	**-** Resource for conventional plastic is fossil-based, a finite resource, possibly changed into bio-based Plastics such as corn starch, may result in competition over cultivable land and higher water demand	**0** Made out of renewable resources, but trees cut down to be made into paper fibres, can result in deforestation; usage of fertilizers in cultivation may result in terrestrial and freshwater eutrophication, higher water demand	**0** Made of renewable resources, but deforestation due to gain land for cotton plants; demand for fibres and therefore cotton plants; usage of fertilizers result in high terrestrial and freshwater eutrophication, plants need large amount of water to grow	**-** Resource for conventional plastic is fossil-based, a finite resource, can possibly be changed into bio-based Plastics such as corn starch, may result in competition over cultivable land and higher water demand
Use of secondary material	**+** Highly eligible for use of secondary material, already done in many cases	**+** Highly eligible for use of secondary material, also already done in many cases	**-** Normally no use of secondary material	**+** Highly eligible for use of secondary material, already done in many cases
Health aspects	**-** LDPE has slightly more human toxicity	**0** On par with non-woven PP, provided human toxicity	**--** Cotton provided the most human toxicity, may become habitat for bacteria, fungi and mould	**0** On par with paper, provided the least human toxicity
Safety aspects: handling, usage	**--** LDPE bags fly away easily, littering, potentially dangerous (wildlife), breeding for mosquitoes	**0** Paper bags tear easily, especially when wet, difficult to clean, more space than plastic	**+** Not sanitary when wet, handling difficult, generally takes up more space than plastic, meant for multiple use, washable	**+** Generally meant for multiple use, sturdy, durable

Economics (worldwide)	**-** **0** to Bags used world-wide, banned in some places, customer incentive in favour of multi-ple-use	**0** Generally available for fee, commonly used in supermarkets, yet some retailers give them for free	**-** Usually available for purchase, but production requires resources related to manufacture of (textile) fibres	**0** In places with bans against single-use plastic bags, tote bags are commonly used, usually available for purchase
Economics (price)	**++** Price for LDPE cheapest, retailers make profit when they sell bags e.g. 20 ct	**0** More expensive than LDPE bag but cheaper than cotton, less durable	**-** Most expensive compared to non-woven PP bag/paper bag	**+** Generally less expensive than cotton bag, but more expensive than LDPE and paper bags
Consumer aspects	**-** **0** to Meant for single use, multiple use, flexible, lightweight	**-** Multiple-use is difficult because has low durability, especially when wet, recycling often easier	**0** Meant for multiple use, does not tear easily, washable, repairable, sanitary (attractive design)	**0** Meant for multiple use, sturdy, usually large capacity, some stores give discounts for edibles, when such a one shops with bag
Waste management	**-** Collection with other PE, plastics hard to collect, flies away, danger of littering, pollution, recyclable	**+** Can be collected with other paper waste, degradable in environment, recyclable	**-** Cloth-textiles can be collected if proper environ-...	**N/A** Can be collected with existing textiles if proper recycling

Construction Pipes: Plastics vs. (galvanised) steel and concrete

Construction pipes are used in areas such as sewerage and drainage or w
For the following examination it is assumed that the pipes, which are m
equally suitable for the required utilisation, as they are subject to

The table identifies the GWP100 of the different types of pipes in Ta
lie within a comparable range at a GWP value of 1.94 (steel) to 3.23 (P

Table 23: Selected GWP100 for construction pipes

Category	GWP$_{100}$ [kg CO_2 equi.] per kg	Database
HDPE Pipe	2.52	Bath Uni via [Carbon Footprint Ltd,
PVC Pipe	3.23	Bath Uni via [Carbon Footprint Ltd,
Steel Pipe - World Typical World 39% Recy.	1.94 -	Bath Uni via [Carbon Footprint Ltd,
Steel Pipe - Galvanised (typical 35.5 % Recy.)	> 2.12	Bath Uni via [Carbon Footprint for pipe Uni coil plus steel contribution constru

Different surveys examined the environmental performance evaluation of d
multitude of possible types of piping system, usuallycomparable applications a
as follow: The survey ‘Polypropylene Materials for Sewerage & Drainage Pi
Footprints’ Wassenaar [2016] compares the environmenteal impact in terms of G
demand (NRED) of innovatively produced PP pipes (based on high modulus
mineral modified propylene [MD]) with standard block copolymer [B] PP p
study has been conducted according to the international ISO 14020 and 14021 st
claims, particularly their accuracy. The compliance of the LCA with these standard
external independent auditor.

The functional unit is 1 m of installed plain wall pipe with a ri
a DN of 250 mm for plastic pipes and the closest equivalent concrete p
results from the functional unit is pivotal for further examination:

- PP-MD (DN 250 mm): 8.0 kg per m
- PP-HM (DN 250 mm): 5.9 kg per m
- PP-B ((DN 250 mm): 6.6 kg per m
- Concrete (DN 225 97.6 mm) kg per m

It is evident that the specific weight of concrete compared to P
many times higher (12 to 16 times). If the diameter is bigger, this proportio
for plastic pipes and 750 mm for concrete pipes, the proportion ranges at se

In comparision, the following results appear: Concrete pipes have a higher GWP materials (nearlytwice, see Figure 34). Generally, the raw materials production acco comparable to the raw material production of PP, as well as the relat taken into consideration, the GWP results in a higher figure for concrete pipe specific weight.

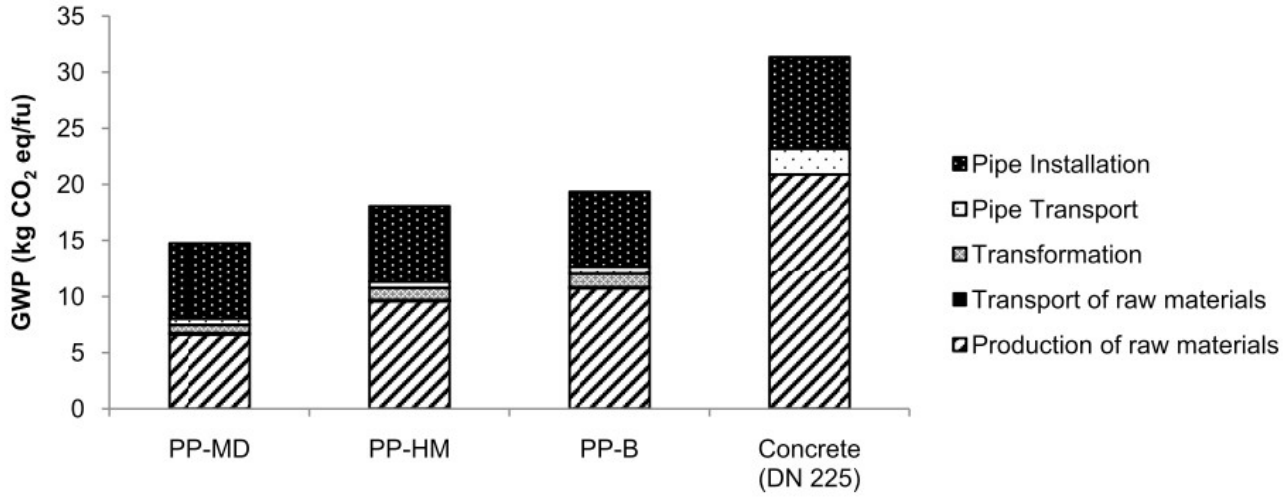


Figure 34: GWP for 1 m of installed plain wall sewerage and drainage pipe [Wassenaar, 2016]

Contrary to that, plastic pipes generally provide a higher NRED due to the contributor to NRED is associated with the internal energycomponent of the

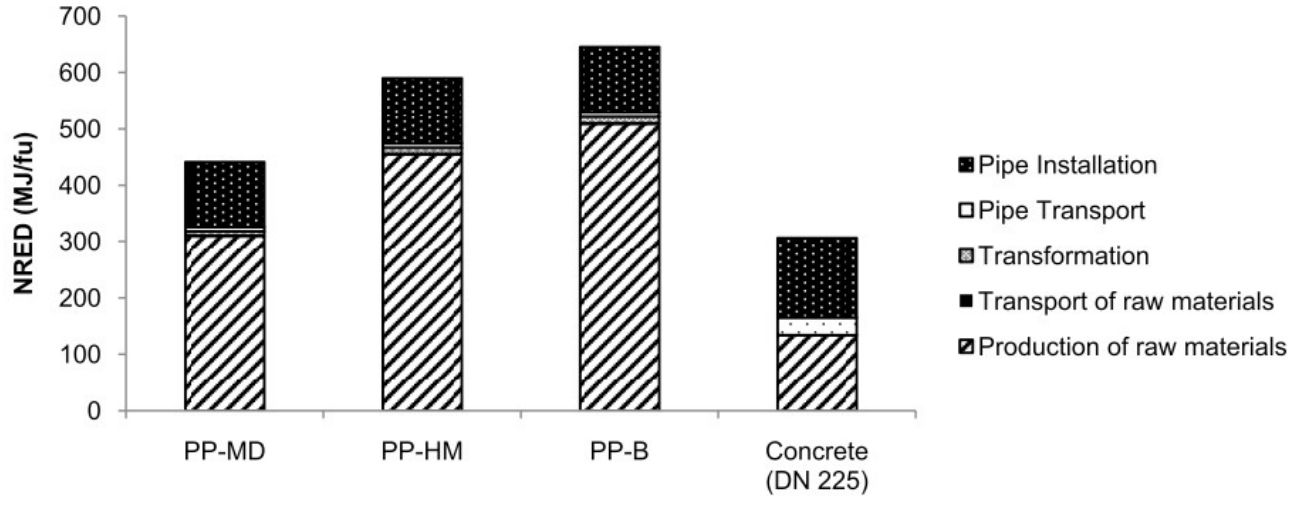


Figure 35: NRED for 1 m of installed plain wall sewerage and drainage pipe [Wassenaar, 2016]

The survey ‘Life Cycle Analysis for Water and Wastewater Pipe Materials’ [Du et
damages of six commonly used pipe materials (PVC, ductile iron, cast iron, H
The function unit is a 12-inch pipe (30.5 cm) per km. Table 24 io
different phases. The installation phase for iron is highest due to th
phase is highest for concrete, due to its weight. Both of these p
because the highest GWP contributions result from the production.

Table 24: Phase-Dependent and Total GWP per km of 30.5 cm (12 in.) diameter pipes for differe [Du et al., 2013]

Pipe materials (12-in. pipe)	Total GWP (10^3 kg CO_2/km)	Production phase (10^3 kgCO_2/km)	Installation phase (10^3 kgCO_2/km)	Transportation phas (10^3 kg CO_2/km)
PVC	318	315	2.81	0.26
Ductileiron	472	468	3.28	0.88
Concrete	68.3	63.1	2.91	2.26
HDPE	218	215	2.81	0.17
Reinforced concrete	152	146	2.91	2.47
Cast iron	353	349	3.28	0.84

For the 12-inch diameter example, iron pipes contributed the greatest in
pipe materials compared. Concrete pipe had the lowest GWP, despite the e
production. This is contrary to survey of Wassenaar [2016], as mention
data was used for the examination of concrete pipes (main reference Marceau
[2013] identifes that PVC yields the greatest GWP per unit pipe legnth at d
seeming anomaly arises from the material-dependent schedule of pipe thickne
for plastic water pipes of diameter greater than 61.0 cm (24 in.).

Appropriate to EPA [2000] the different types of pipe systems provide a

Table 25: General advantages and disadvantages of plastic, concrete and steel/iron pipes [EPA, 20

Category	Plastics	Concrete	Steel / iron
Advantages	• Very lightweight • Easy to install • Economical • Good corrosion resistance • Smooth surface reduces friction losses • Long pipe sections reduce infiltration potential • Flexible	• Good corrosion resistance • Widespread availability • High strength • Good load supporting capacity	• Good corrosion resistan when coated • High strength
Disadvantages	• Susceptible to chemical attack, particularly by solvents • Strength affected by sunlight unless UV protected • Requires special bedding	• Requires careful installation to avoid cracking • Heavy • Susceptible to attack by acids and H_2S when pipes are not coated	• Heavy

A cost comparison identifies that concrete pipes per meter are generally the offered with larger diameters. Plastic pipes are usually cheaper than comparable stell, Rafferty, [2]1998].

A comparsion of the different material solutions is shown in Table 26.

Table 26: Comparison of different materials for construction pipes

	Comparison: construction pipes		
	Plastics	**Concrete**	**Steel / iron**
GWP	**+** Provide smallest GWP	**-** Provide highest impact compared to plastics and also, but not only larger specific weight	**0** Provide higher impact than plastics, but lower than co because of steel,
Water footprint	**+** Smallest water footprint compared to concrete	**-** Largest Water footprint compared to steel and used manufacture	**0** Larger water footprint than plastic, but not as large as concrete

Use of renewable resources	- Resource for conventional plastic is fossil-based (a finite resource), can possibly be changed into bio based plastics such as corn starch, may result in com-petition over cultivable land and higher water demand	- Manufacture requires energy, sand as is not abundantly	- Manufacture requires a lot of energy; one of the bases is iron ore, which is available resource
Use of secondary material	0 If made from mono-material technically possible to recycle them, otherwise down cycling possible	0 Generally recyclable if free of contaminants; concrete can be used in the manufacture of concrete	++ Generally high recycling rate; secondary steel is commonly used in today's steel manufacture
Health aspects	0 Do not rust; drinking water from plastic pipes older than 1970s could potentially be harmful; solvents may attack pipe	0 Do not rust; acids may damage pipes	0 If galvanized, it does not harm; acidic and alkaline water dam-ages them
Safety aspects: handling, usage	+ Light weight, corrosion resistance; good resistance to electric current; relatively easy to repair / replace; infiltration reduces strength potential, affected by sunlight unless UV protected, special bedding requires	0 Heavy weight, corrosion resistance; high strength and long durability, supposedly long resistance 35 to 50 years; easy repair	- Heavy weight; corrosion resistance when coated; high strength, supposedly last ten years; can be easily cutting, bending and threading is easy; higher potential for damage at larger diameter
Economics (world-wide)	+ Easy to install; smooth surface reduces friction losses; flexible	+ Widespread availability; good load supporting ca-pacity	+ Relatively easy to install, heavy as concrete
Economics (price)	+ Generally cheapest compared to steel and concrete	- Pipes generally offered at larger diameter	0 Cheaper than concrete, expensive than plastic pipe
Consumer aspects	+ Economical, easier to transport and install	- Transportation is more dif-ficult compared to plastics because of weight	- Longevity may be needed to consider, as steel is threatened by corrosion
Waste manage-ment	0 Industrial waste oftentimes provides more mono-materials as household waste, therefore recycling is theoretically possible at larger scale, but adequate waste management infrastructure needs to be established	0 If free of contaminants such as wood or paper, can be recycled to be used in manufacture of concrete; adequate waste management infrastructure needs to be established first	+ Steel can technically be recycled without any loss of material; however, adequate waste management infrastructure needs to be established

8.10 Annex 10: Global examples of education and awareness programmes

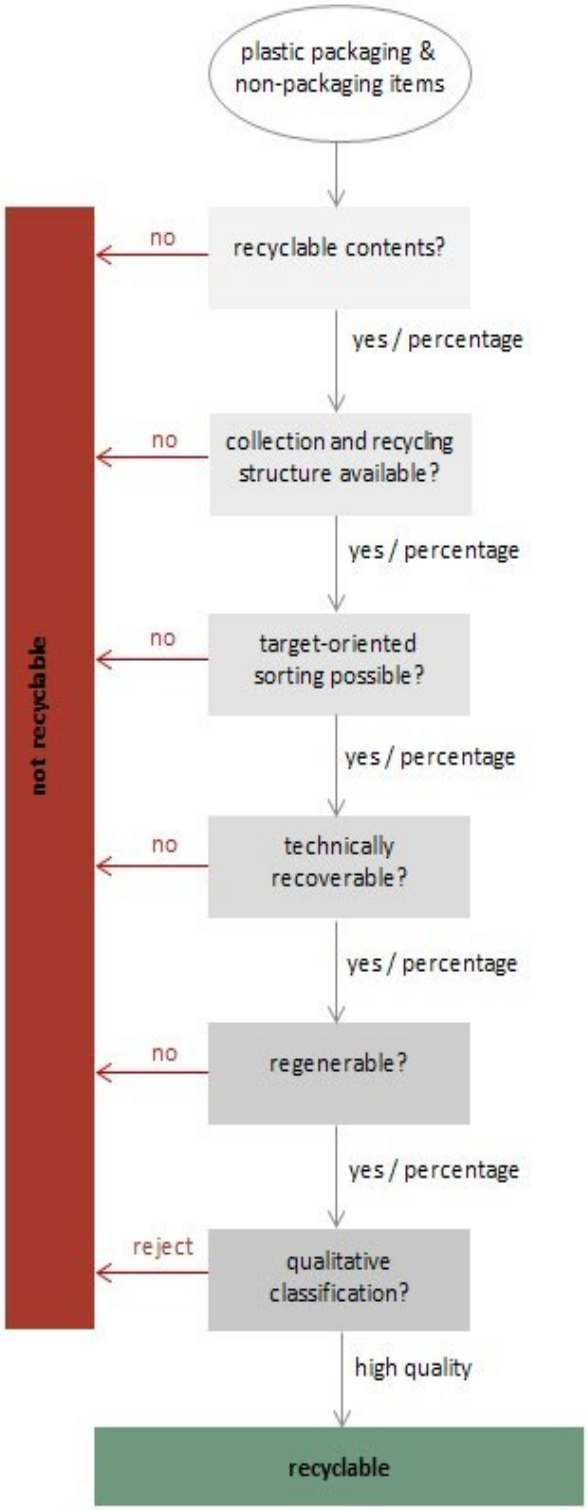
In California, the California Education and the Environment Initiative exists. The (California's Department of Resources Recycling and Recovery) Office of Education programs that aim encourage environmental literacy among all California stud grade. The initiative provides curricula that combine the environment with the subjects such as science, history, English language, and arts. Some of about earth and its resources, the history of the impact the human behaviour had critical environmental issues the modern world faces [California Education and the

One more example is the 2012 cooperation between the Paper Recycling Asso and the Department of Education to incorporate recycling in the maths curri integrated in the syllabus of grades R through seven. In partnership with curriculum-based educational resources, the recycling-focused lessons are found in on the website. More content has also been developed to integrate recy and English for Grade one to six, using paper products as examples. Recy that learners grow up with an awareness of waste and the importance of

Fostplus, Belgium (the Belgian PRO) launched multiple campaigns that targ with the support of the Fevia and Comeos sector organisations, Fostplus sign Walloon and Brussels authorities to tackle the problem through campaigns Nettoyage de Printemps (Great Spring Clean) campaign in Wallonia in April 2016 cleared plots of land, streets and parks of litter. Another campaign was the 2016. 1,100 shops in Flanders and Wallonia participated in the Retail Clean-Up up the area within a radius of its premises. A surface area equivalent of more than 25 m football fields. There are other campaigns launched awareness in communities about the correct way of sorting waste, and to stress the its positive impact on the environment and future [Fostplus, n.y.].

Another example of is the Orange Bin Campaign in Israel: Recycling all of Israel launched the online campaign to raise public awareness about recy The campaign used YouTube as a platform to spread its message by combining extreme sport with garbage collection to eliminate the negative video went viral gaining around 900,000 views. And according to a statistic for Environmental Defense and Migal, a Galilee research institute, over 300, and wet waste, representing a 400 % increase in two years (Weißenbacher,

8.11 Annex 11: Flow chart for determining the recyclability



Notes


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Inner back cover

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