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*Market Assessment for
Plastics Circularity in
Nigeria*

Draft report

10 February 2019

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1. Introduction

Plastics has widespread application and is being increasing used across various diverse sectors such as packaging, textiles, automotive, construction, healthcare amongst others. Imagining a world without the plastic is inconceivable. Plastics constitute close to 15% of a car by weight and around 50% of the Boeing Dreamliner. Use of plastic has become a key enabler in the growth of the sectors primarily due to the low cost, durability, versatility in the applications. The largest application is in the packaging industry which comprises of around 26% of the total plastic use. The increase in per-capita income will further attenuate the plastic consumptions over the coming decade, with the consumption projected to double over the next 20 years and quadruple by 2050.

Despite being a workhorse material for the modern economy, the use of plastic is confounded by the inherent drawback of the absence of reuse and recycling initiatives. For plastic packaging which is the predominant application of the plastic use – the application is mostly single use and of short lifecycle; with USD 80-120 billion lost to the world-wide economy due to the absence of the robust recycling practice. The amount of the plastic packaging waste that is not collected and which eventually ends up in the oceans clogging the marine environment is at staggering 32%.

Further, it is envisaged that over the coming decade, the transformation and growth of economies around the world will be characterized by the growing resource constraints. For the business continuity, organizations need to adopt sustainable resource consumption models and delink economic advancement from resource availability. The resource constraint can present a unique opportunity for the organizations to innovate and transitioning towards circular economy models and enhance the competitiveness of the manufacturing Inc. Enabling an efficient collection and recycling mechanisms and by promoting the circularity of plastics could not only aid environmental conservation but also help abate resource constraint.

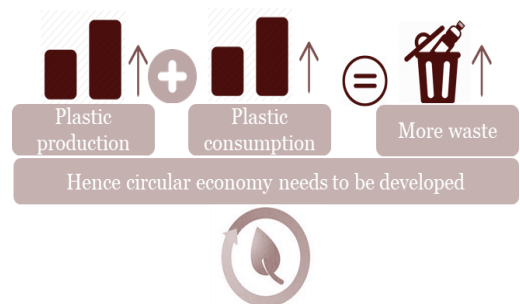
It has been found that **producing plastic products from recycled plastics could reduce energy requirements by 66%. Recycling 1 ton of plastic waste could also be equivalent to saving 2000 pounds of oil or 2 people’s energy consumption of one year.**

Nigeria faces a severe plastic pollution problem, as the nation does not have adequately designed waste disposal channels. Lagos alone generates 8400 metric tons of waste daily and more than 11% of the waste generated consists of plastics. The nation has had to face severe consequences of its plastic waste disposal problem – with the rivers and water bodies have become clogged with plastic pollution and as a result the population of fishes has decimated over the years. The fish population has declined tremendously, resulting in the loss of livelihood. Creating a circular economy wherein the plastic waste is adequately recycled and brought back to the ecosystem could help Nigeria solve its plastic waste problem.

In terms of nominal GDP, Nigeria is the largest economy in Africa. It is also the most populous country in Africa with a population of 190.9 million (2017). The country is privy to rapid urbanization with a growing urban population adopting certain lifestyle which promulgates the usage of plastic. The country is facing severe plastic pollution problem, as the nation does not have adequately designed waste disposal channels. Lagos alone



Figure 1: Main plastic resin types and their applications in packaging



generates 8400 metric tons¹ of waste daily and more than 11% of the waste generated consists of plastics. The nation has had to face severe consequences of its plastic waste disposal problem – with the rivers and water bodies have become clogged with plastic pollution and as a result the population of fishes has decimated over the years. The fish population has declined tremendously, resulting in the loss of livelihood. Creating a circular economy wherein the plastic waste is adequately recycled and brought back to the ecosystem could help Nigeria solve its plastic waste problem.

The nation’s per capita plastic consumption has also been steadily increasing at 5.9% per annum, from 2007 to 2018 – which is reflected in the growth of the plastic imports as well as increase in the domestic production². Nigeria is the largest importer in Africa of plastics in primary forms and the imports have increased at CAGR 5.2% from 2008 to 2017. It is estimated Nigeria is importing 63% of raw material (resin) from countries of Middle East, Europe and Asia and only 28% is produced locally. The production of plastics has also grown by almost 10.3% since 2007.

Mirroring the global trend, the significant use of plastic consumption in Nigeria is for packaging. The other users of plastic include construction, automobile etc. Studies also show that the demand for packaging has expanded by 40% in the last 5 years, as a result also driving the plastic consumption further up. At present more than 3000 plastic companies exist in Nigeria.

The increasing demand of plastic is leading to the plastic waste menace in Nigeria. It is estimated that the country generates 1.15 million tons per annum (TPA) of plastic waste. At present, only 60,000 TPA of PET and 10,000 TPA of Polyethylene (PE) and Polypropylene (PP) account for properly managed waste in the state. The rest of the waste ends up in either marine litter or landfills. Nigeria ranks 9th in plastic marine debris pollution depositing 340,000 tons of plastic in to the oceans every year.

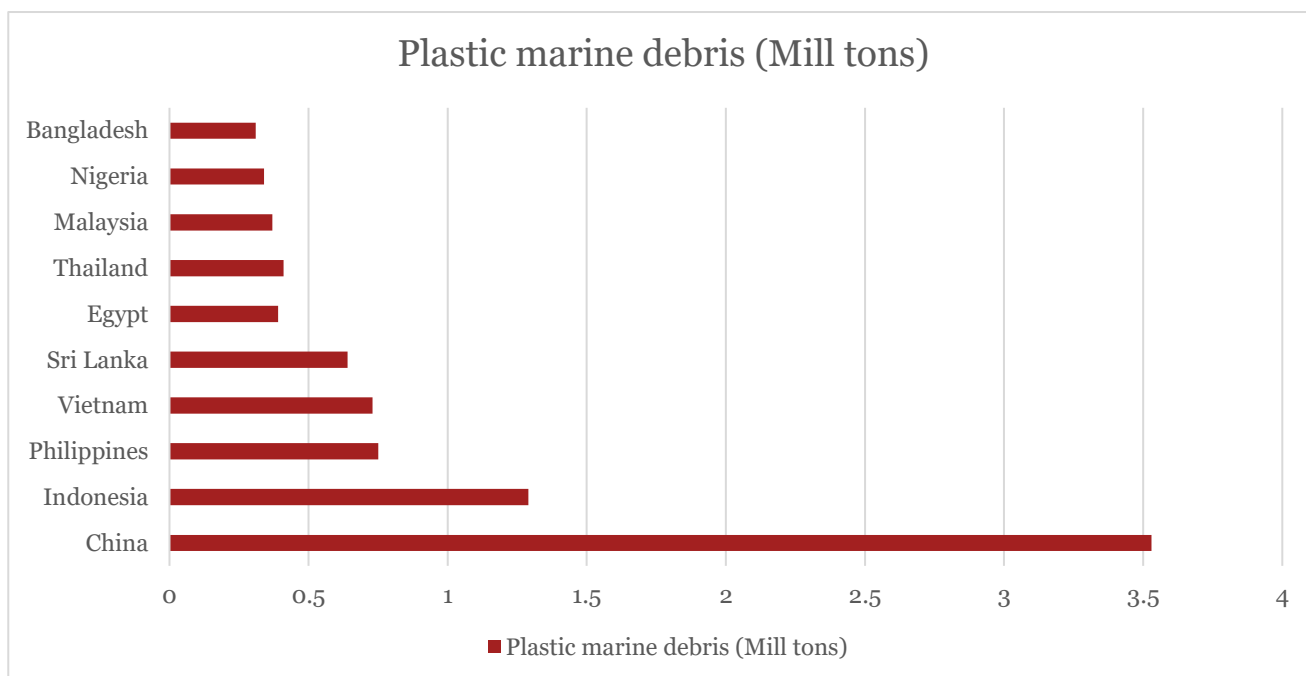


Figure 2: Country-wise plastic marine debris generation³

Thus, a good collection system is required to tackle the huge amounts of waste. A good collection system can also help stakeholders tap the opportunities of converting plastic waste into household items, fabric, oil etc. as explained in following sections.

In this regard, IFC has conducted a mapping study of plastic sector in the country. The mapping reviews the market situation and size of plastics production by the petrochemical industry from virgin, imports and recycled materials and their subsequent use in downstream applications. The study has been conducted considering the regulatory environment for plastics. Basis market and policy analysis, interventions to enhance circularity have been identified. The consecutive chapters present the as-is plastic sector and plastic waste management studied using a value chain approach. Subsequently, potential business cases have been developed to unlock various opportunities of import substitution, price competitiveness and meeting the global brand commitments.

¹ H. A. Salami (2018). Journal of Engineering Research and Reports. A Review on the Current Status of Municipal Solid Waste Management in Nigeria: Problems and Solutions

² <https://www.ppp-nigeria.com> accessed on 15 November 2019

³ <https://www.statista.com/chart/12211/the-countries-polluting-the-oceans-the-most/>

2. The plastic sector in Nigeria

Plastic is durable, low cost, water resistant, uses lesser energy and are light weight. The unique properties of plastic enable it to deliver superior performance compared with alternative materials (such as glass, paper and metals) along 3 critical dimensions



Lower cost of products for consumers. Also, plastic cost to consumer **3 times lesser** than various alternative.



High impact on Economy and Employment.



Higher alternative material requirement, energy and water usage, more fuel burnt during transport

Lower Green House Gas emissions

Due to such properties plastic is workhorse material for various industries such as automobile, packaging etc. Plastic being so important has significant consumption in Nigeria. The per capita consumption of plastics in Nigeria has grown by about 3.6% annually over the past ten years, from 4.0 kg in 2007 to 5.9 kg in 2018 and is estimated to be 6.8 kg in 2022².

The country is **predominantly import dependent** for meeting its plastic consumption – imports constituting 63% of the resins used for plastic product manufacturing. Plastic resin is the key input for manufacturing plastic articles. Virgin resin is produced from petrochemical industry.

The domestic plastic product manufacturing sector is also limited. The domestic production is concentrated around packaging and household items. The value add items of toys, plastic for automotive, construction are imported.

As on 2018, the imported value of 'plastics and articles thereof' stood at 1,384 USD million. From 2008 to 2017, imports of plastic raw materials saw a CAGR of 5.2%, increasing from 464 kt to 729 kt, thus making Nigeria one of Africa's largest importer of plastics in primary forms.²

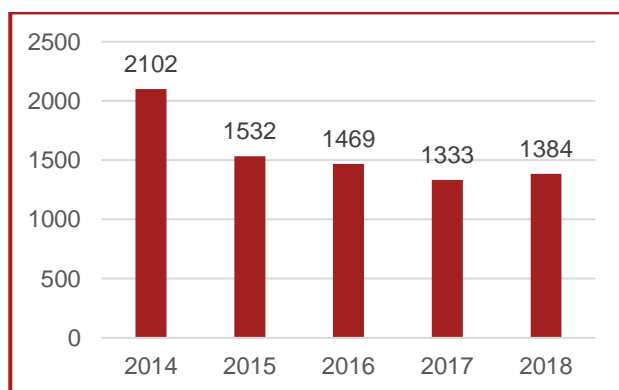


Figure 3: Imported value of raw plastics (39) in USD million⁵

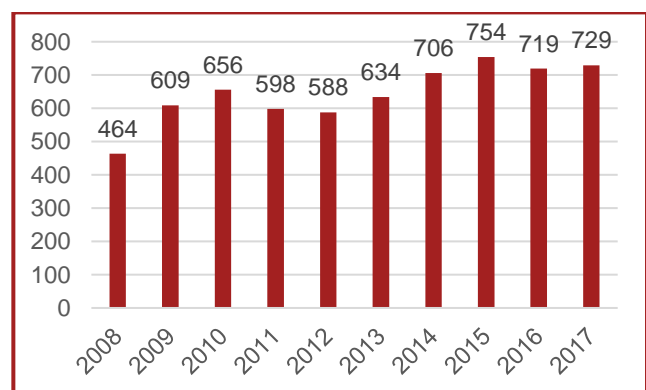


Figure 4: Import of plastic raw materials (kt)⁴

⁴ EUROMAP

⁵ Trademap

The plastic resin are used predominantly in packaging sector followed by construction and automotive sector.

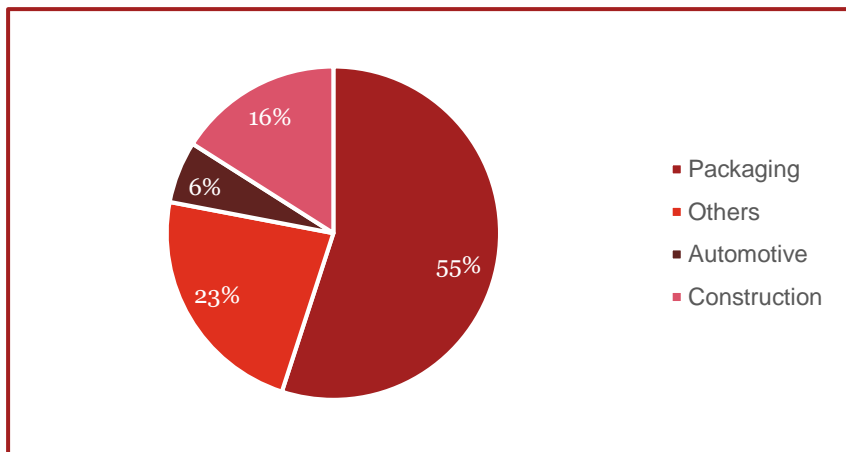


Figure 5: Plastic consumption by application (2018) ⁴

The key polymer applications in each of the sectors is provided below:

Name of Polymer	Industry	Product
PET	Food and beverages, Textile	PET preforms, packaging containers, PSF
HDPE	FMCG	FMCG product packaging such as Shampoo bottles,
PP	Food and beverages, household goods, Construction	Household items, Cement bags, packaging containers and films
PS	Automobile, Electronics	knobs, instrument panels, trim, energy absorbing door panels and sound dampening foams
PVC	Construction, Footwear	PVC pipes, PVC door and window frames

Domestic manufacturing is dominated by the packaging sector which has been in existence since the 1960s and started with about 50 plastics companies. Over time, this sector has grown in size, to over 3,000 companies, and has become increasingly sophisticated with new technologies introduced to the market.

The plastics and packaging sector comprise of different subsectors, which include plastics, plastics flexible packaging and polythene bags. The packaging industry comprises of 55% of the total consumption. The packaging industry includes packaging used for bottling beverages, i.e. PET bottles, bottle caps, milk containers, etc. It also includes single use plastics bags commonly used in Nigeria to package goods. Construction sector is the second largest consumer of plastic in Nigeria. Polymers like PVC and PP are used to manufacture plastic pipes, fittings, plastic boards, doors and door frames which are used in the construction sector.

A value chain approach was used to study the sector in detail. PET, PE and PP polymers have significant consumption and local production – either through petrochemical industry or through recycling.

Value chain assessment involved end to end accounting – from the inputs through all the interlinkages to the output for each of these recycled products. It also facilitated in identifying the key actors in the collection of plastic waste, the aggregators or scrap dealers at different levels, and the buyers of plastic waste and the linkages between them. Value chains were mapped for PET, PP and PE polymers to understand:

- Material flow of these polymers from source to final usage
- Identification of various stakeholders and interlinkages between the stakeholders
- Identification of challenges that are constraining the growth of the sector
- Interventions required to increase the uptake of recycled plastics and improve plastics circularity.

2.1. PET Value chain

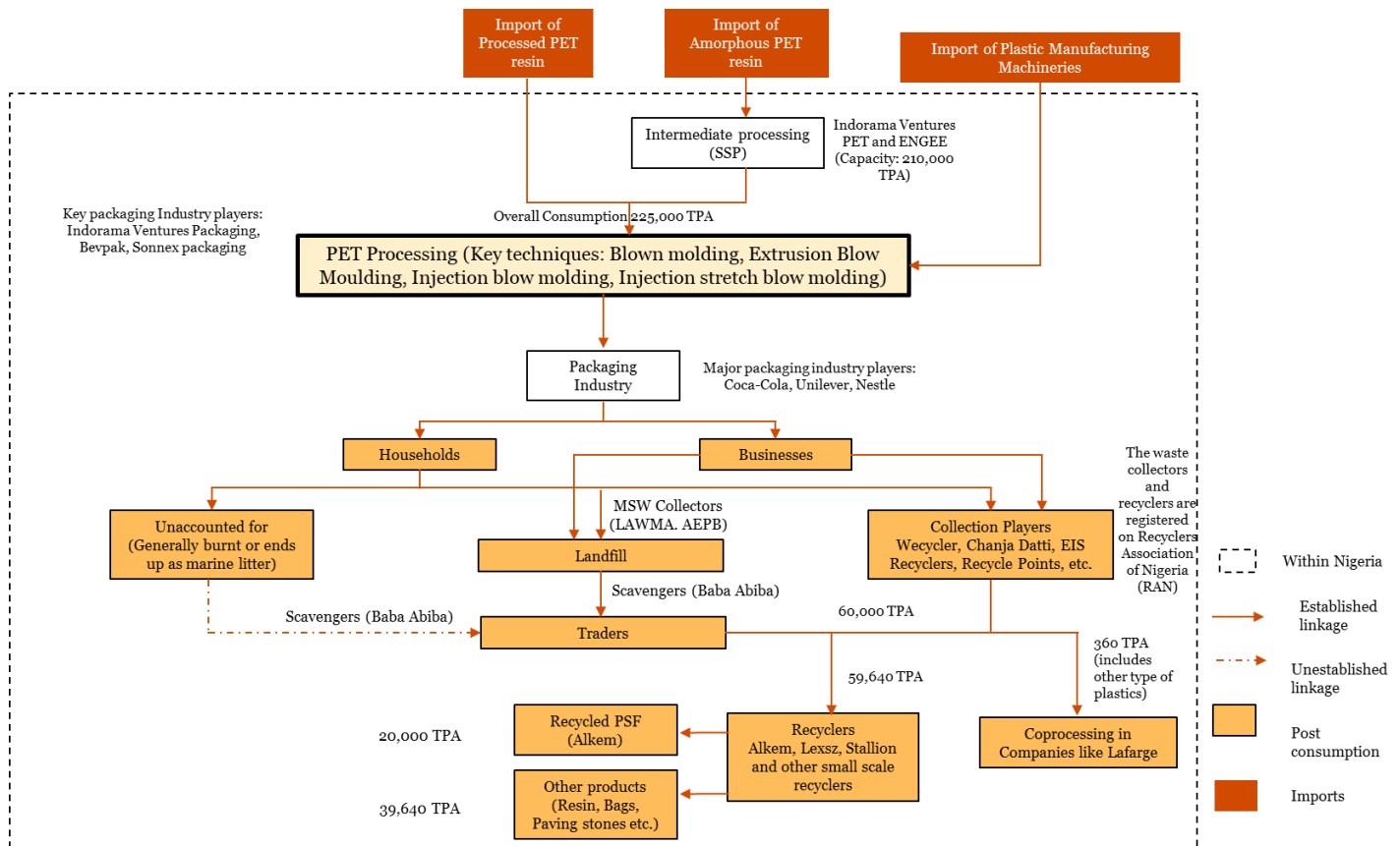


Figure 6: Nigeria's PET value chain

Supply of PET:

Nigeria lacks local manufacturing of PET resin. It relies on import of PET resin for its consumption. Amorphous PET resin is imported from various parts of Asia. The current price of amorphous PET is USD 950 - 975 per ton.

Intermediate processing:

Large amount of amorphous PET resin is imported from Asian countries such as China. Amorphous resin is not suitable for food grade resin production. For processing this resin to be suitable for food grade applications, Solid State Polycondensation (SSP) process is adopted.

Indorama Ventures PET and ENGEE process amorphous PET resin into food grade PET resin by increasing the IV value using SSP. They have a combined production capacity of 210 kTPA. Indorama Ventures PET (Nigeria) Limited produces bottle grade PET resins through Solid State Polymerization (SSP) technology. The facility has a capacity of 90,000 tons per annum. The resins are sourced from the company's facilities in Asia (China) and shipped to Nigeria for final processing.

PET processing:

Various processing techniques are used to process the PET resin into forms that are suitable for consumption in the user industry. Key techniques that used for processing PET include Blown molding, Extrusion Blow Molding, Injection blow molding, Injection stretch blow molding. Most of the PET resin is consumed in production of PET preform.

Some of the key players are Indorama Ventures Packaging, Bevpak and Sonnex packaging. Sonnex packaging is assessing the feasibility of establishing a PET recycling plant.

Indorama packaging ventures

The Company manufactures PET preforms and caters to the requirements of large beverage companies. Through the Economic Community of West African States (ECOWAS), the company is also able to service customers located in other ECOWAS countries in West Africa. The facility has four state-of-the-art Husky injection molding machines. These machines can produce PET preforms at high speed and of consistently high quality. The capacity of their facility is 17,000 tons per annum.

Bevpak

Bevpak is one of the largest manufacturers of PET preforms in West Africa. Their products cater to leading brands of soft drinks and mineral water and major bottlers throughout Nigeria. The total volume of Bev Pak is close to 23,000 TPA. Major buyers of resin is NBC, Rite foods for their Carbonated Soft Drink (CSD) production.

Sonnex Packaging

The company is a PET and HDPE packaging manufacturer in Nigeria and supplies its packaging to large players such as Coca-Cola, Unilever. They are also working towards recycling of PET and HDPE. They have conducted a pilot using imported pallets from South Africa.

User Industry:

PET resin is processed in forms such as preforms and subsequently used to manufacture PET bottle. PET is primarily used in packaging industry for applications such as PET bottles, containers used in sectors such as food and beverages and FMCG. Overall consumption of PET is 225,000 TPA.

The key players using PET packaging are Coca-Cola, Nestle and Unilever. These players are active in encouraging circularity of plastics. Coca-Cola and Nestle are part of FBRA which is driving post-consumer packaging waste recovery within the food and beverage sector.

Coca-Cola

Coca Cola has entered into several partnerships and collaborations to move towards circular economy for its plastic waste. The company has collaborated with its supplier (Sonnex) to recycle PET bottles and convert into rPET. Coca Cola in partnership with Standards Organisation of Nigeria (SON) to developed standards for food grade PET. Coca-Cola through the FBRA has also partnered with Recyclers Association of Nigeria.

Post-consumer:

PET products are consumed by households and businesses. Approximately 230,000 TPA of PET waste is generated post consumption. Post consumption in households, the PET waste is 1) collected by authorities such as LAWMA and AEPB as part of Municipal Solid Waste (MSW), 2) collected by organized players such as Wecyclers, Chanja Datti or 3) unaccounted and ends up as marine litter or burnt openly. Businesses rely on organized waste collectors and MSW collectors for disposal of their PET waste. Scavengers, also called as Baba Abiba, indulge in informal collection of PET waste from landfills. They sell the collected PET waste to informal traders who in turn sell it to recyclers. Around 60,000 TPA of PET waste is being recycled or co-processed.

Key recyclers of PET include Alkem Nigeria Ltd, Lexsz Plastics Limited and Stallion Plastic Industries Limited. Alkem Nigeria Ltd. recycles approximately 20,000 TPA PET bottles into PSF. Rest of the PET is used to manufacture PET resin, bags etc by various recyclers.

2.2. PE and PP Value chain

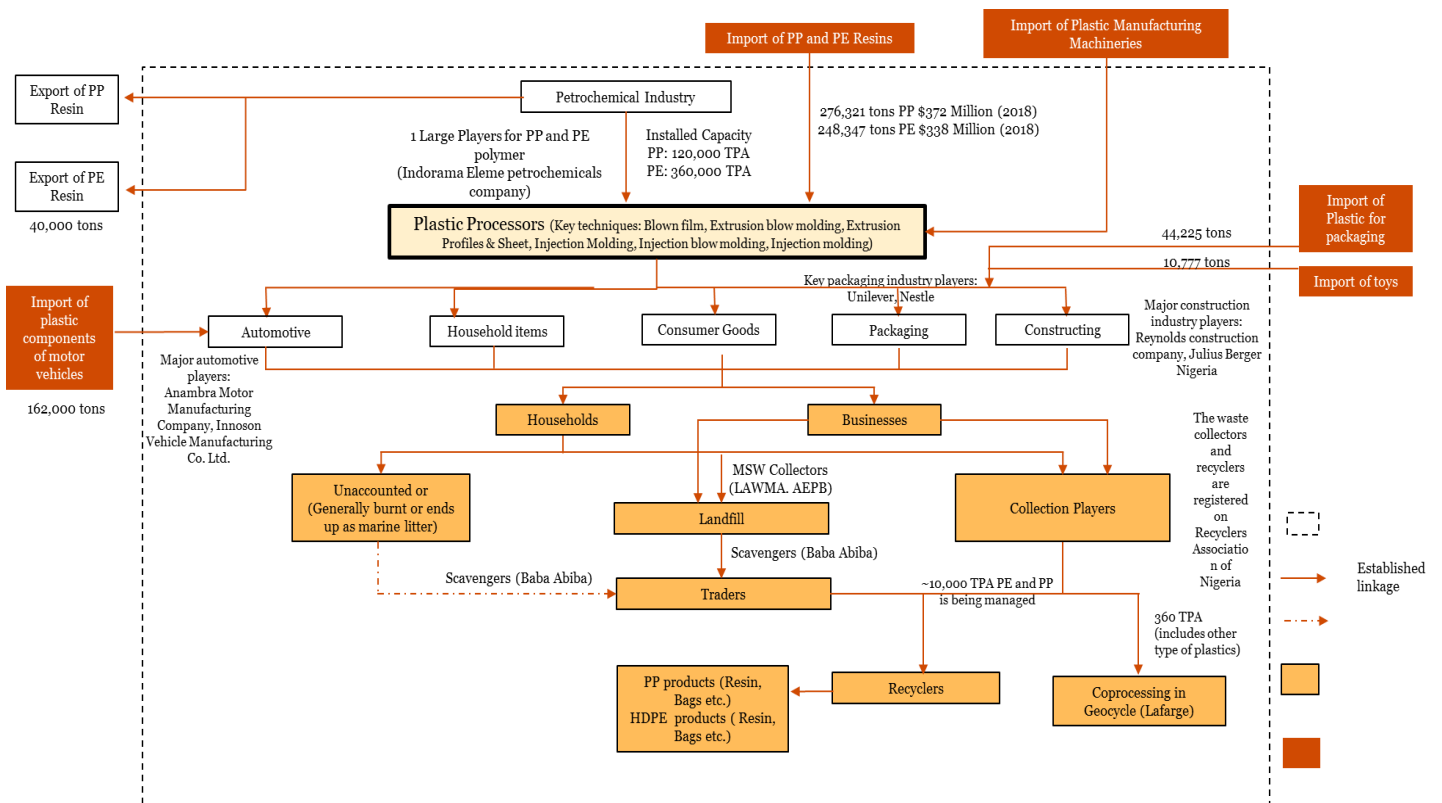


Figure 7: Nigeria's PE and PP value chain

Basis stakeholder consultation PE and PP value chain was developed.

Supply of PE and PP:

Indorama Eleme Petrochemicals Company (IEPC) is the only domestic supplier of PE and PP resin in Nigeria. IEPC plant produces Polyethylene (PE) and Polypropylene (PP) with capacity of 120,000 TPA and 360,000 TPA respectively.

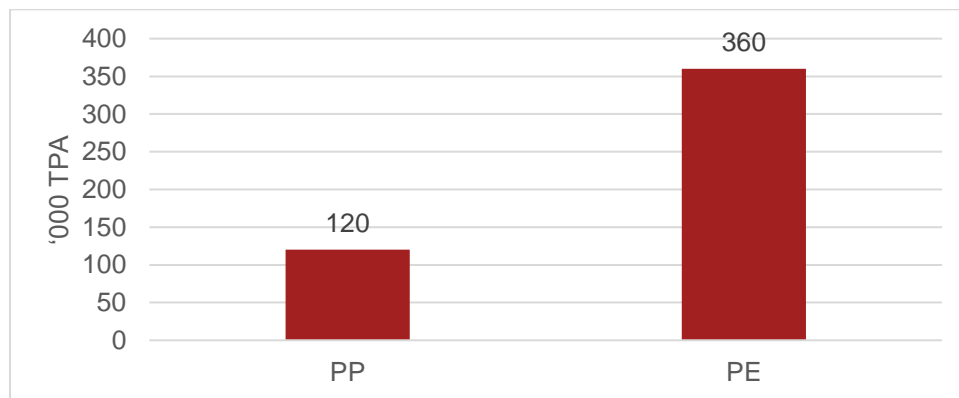


Figure 8: Installed capacity at IEPC

In addition, 248,000 TPA PE and 276,000 TPA PP is imported⁶.

PE and PP processing:

Various processing techniques are used to process the PE and PP resin into forms that are suitable for consumption in the user industry are blown film, extrusion blow molding, extrusion profiles & sheet, injection molding, injection blow molding, injection molding.

User Industry:

⁶ <https://comtrade.un.org/data/> accessed on 3 October 2019 (data for year 2018)

PE and PP is primarily used in sectors such as automotive, construction, household goods, consumer goods, and packaging.

Automobile market is dominated by imported vehicles. Size of imported automobile market in Nigeria is USD 1.06 Billion whereas domestic manufacturers contribute USD 0.2 Billion⁷. These automotive companies source some of the assembling parts like tires, belts, windscreens, etc. from local manufacturers. Average import of plastic in form of automobile components is approximately 162 kTPA. Key manufacturers include Anambra Motors and Innoson Vehicle Manufacturing.

PE and PP (and other polymers such as PVC) are used to manufacture pipes, windows, doors, finishes, expansion joints and other structural elements in the construction sector. The key player in the sector are Reynolds construction company, Julius Berger Nigeria, International Building Products, J&L Energy Plastic Industry, Manwb Nigeria Limited, Purechem Manufacturing Limited, United Window and Doors Company and Polystyrene Industries Limited.

Nigeria is import dependent for its domestic textile needs. Currently, Alkem Nigeria Ltd produces approximately 20,000 TPA of rPSF. Household goods are produced locally by players such as Rida plastics, Ok Plast, Sunplast, Stallion Plastics. In addition to the local packaging manufacturers, approximately 44,225 TPA of plastic is imported for packaging.

Unilever

Unilever has announced its commitments to increase the recycled content upto 50% in the packaging by 2025. At present 60% of their packaging portfolio comprises of non-recyclable flexible packaging, MLP's. In Unilever's experience, there is no offtake of recycled HDPE in Nigeria thus the company is finding business cases to move towards recyclable materials.

BASF

BASF has launched a Waste 2 Chemical project which focusses on maximizing social impact through waste in Nigeria. BASF is focusing on chemical recovery from plastic such as PET bottles and water sachets because these products have the highest oil yield and this oil is useful in the petrochemical industry. BASF is also collaborating with key stakeholders like Recycle Point and Wecyclers on how they can effectively source large volumes of plastic waste.

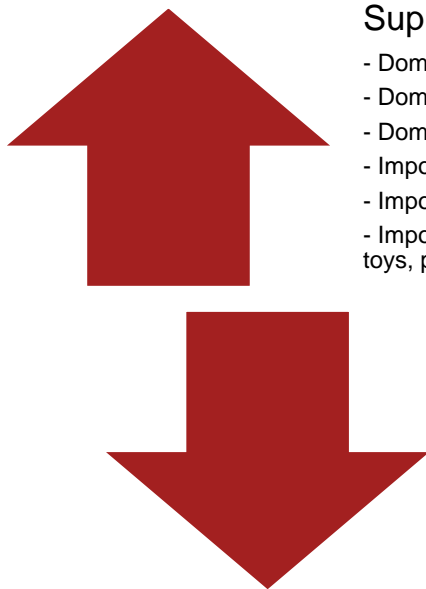
Post-consumer:

PP and PE products are consumed by households and businesses. Approximately 260,000 TPA of PP waste and 430,000 TPA of PE waste is generated post consumption in Nigeria. Post consumption in households, the waste is 1) collected by authorities such as LAWMA and AEPB as part of Municipal Solid Waste (MSW), 2) collected by organized players such as Wecyclers, Chanja Datti or 3) unaccounted and ends up as marine litter or burnt openly. Businesses rely on organized waste collectors and MSW collectors for disposal of their PP and PE waste. Scavengers, also called as Baba Abiba, indulge in informal collection of plastic waste from landfills. They sell the collected waste to informal traders who in turn sell it to recyclers. In total, 10,000 TPA of PE and PP waste is being recycled. Key products produced out of recycled PP and PE include resins and bags.

2.3. Supply demand assessment

The basic framework to understand the overall landscape consisted of supply demand framework.

⁷ <https://www.export.gov/article?id=Nigeria-Automobiles> accessed on 19 November 2019 (data for year 2018)



Supply

- Domestic production of virgin polymers
- Domestic plastic waste supply
- Domestic production of recycled polymers
- Import of polymers in primary/virgin form
- Import of plastics as waste
- Import of plastic as plastic products such as toys, packaging etc.

Demand

- Consumption of plastics in domestic industries
- Export of plastics as part of plastic products
- Export of polymers as recycled polymers
- Export of polymers as virgin polymers
- Export of plastic as waste

2.4. Supply assessment

Plastic production can be through either (a) import of virgin resin (b) leveraging the domestic petrochemical industry (c) use of recycled resin. Currently, recycled resin is a marginal contributor (<7%) to the plastic production in Nigeria. Therefore, primarily plastic demand in Nigeria is met by local petrochemical industry and imports.

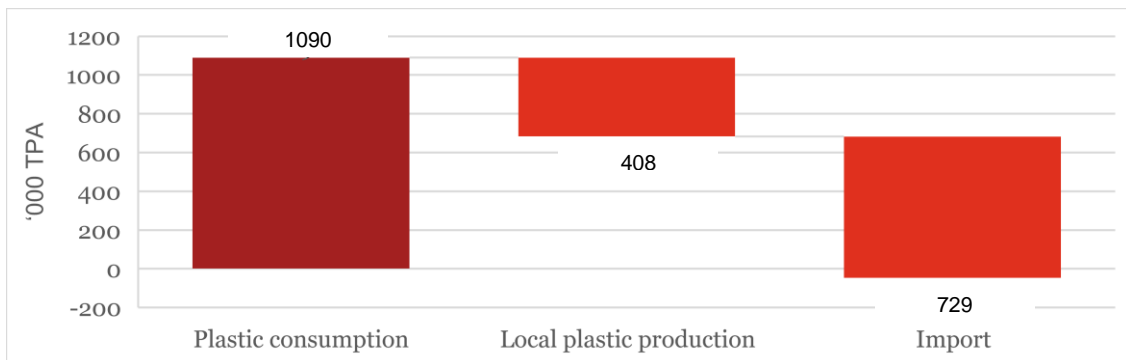


Figure 9: Demand supply in Nigeria

2.5. Demand assessment

Nigeria's plastic industry consumes approximately 1090 kTPA of plastics. Most of the plastic is used in packaging application followed by construction and automotive industry.

2.6. Conclusion

Nigeria is predominantly import dependent for meeting its plastic demand. plastic consumption was approximately 1090 kTPA in Nigeria in year 2017. Approximately, 63% of this demand is met through imports. On the other hand, plastic waste generation in Nigeria is approximately 1150 kTPA. Currently only 70 kTPA is being managed in through recycling or co-processing. If post-consumption waste is recycled effectively properly it could reduce the import dependence of Nigeria. The plastic waste management status and the global plastic waste management practices are discussed in the next chapter.

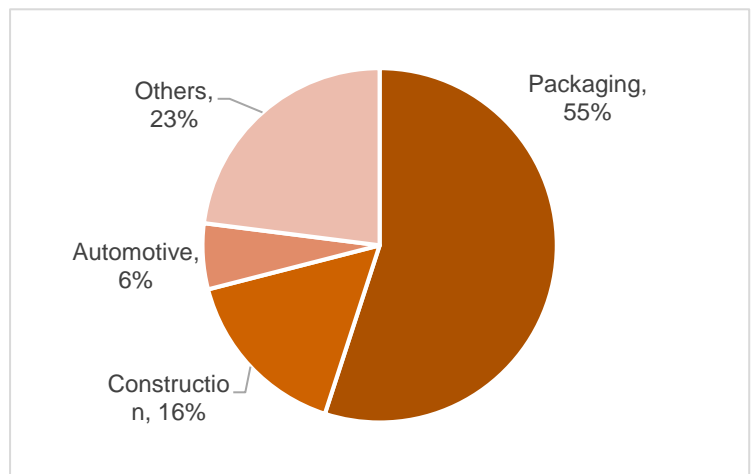


Figure 10: Plastic consumption by user industry

3. Plastic waste management

While plastic has many valuable uses, due to various properties such as durability, strength, chemical resistance etc. — it comes with severe environmental consequences. It has been proven that both the production and the consumption of plastics create risks for human health and compound the environmental challenges associated with climate change, loss of biodiversity, land degradation, deforestation and water pollution.

Nigeria is home to the 2 most polluting rivers which had an input of approximately 62,000 tons of plastic. 94% of the plastic waste generated is not being managed properly. Poor management of plastics is creating an adverse impact on the biodiversity. Thousands of seabirds and sea turtles, seals and other marine mammals are killed each year after ingesting plastic or getting entangled in it. Endangered wildlife like Hawaiian monk seals and Pacific loggerhead sea turtles are among nearly 700 species that eat and get caught in plastic litter.

The plastic waste that has such environmental consequences could be a resource to reduce dependence on scarce resources by enabling circularity. This requires a good understanding of the as-is plastic waste management in the country as discussed in following section.

3.1. As-is Plastic waste management

With a population of about 190 million people, it is estimated that the country generates around 1.15 million tons of plastic waste per annum. The average per capita waste generation also stands at 5.9 kg. However, out of this total plastic waste, only 6% is recycled. The rest of the plastic waste ends up in landfills or becomes marine debris. Nigeria is ranked 9th among the top ten countries in plastic marine debris pollution depositing 340,000 tons of plastic in to the oceans every year.

The figure below shows the plastic waste generated by each polymer type such as 37% accounts for PE waste followed by PP and PET. The waste generated by other polymers is represented in the figure below.

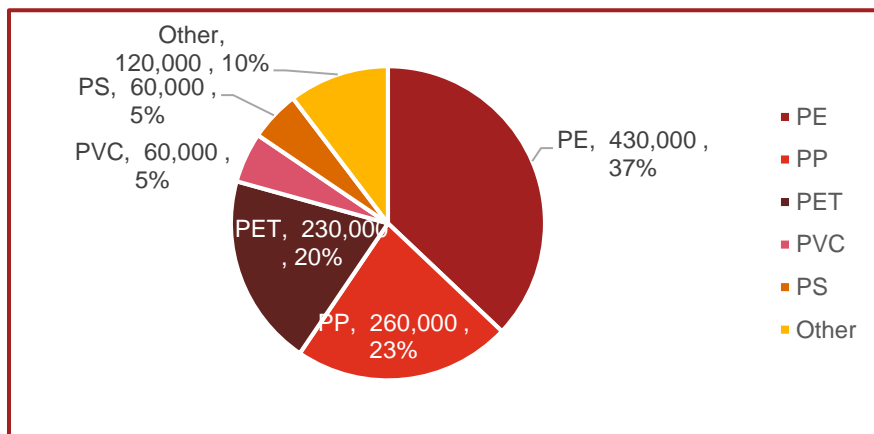


Figure 11: Plastic waste disposed by type

It is also estimated that majority of the plastic waste in Nigeria ends up in landfills or burned. The other 30% becomes marine litter polluting the rivers and ocean. Only 6% of the total waste in Nigeria is recycled.

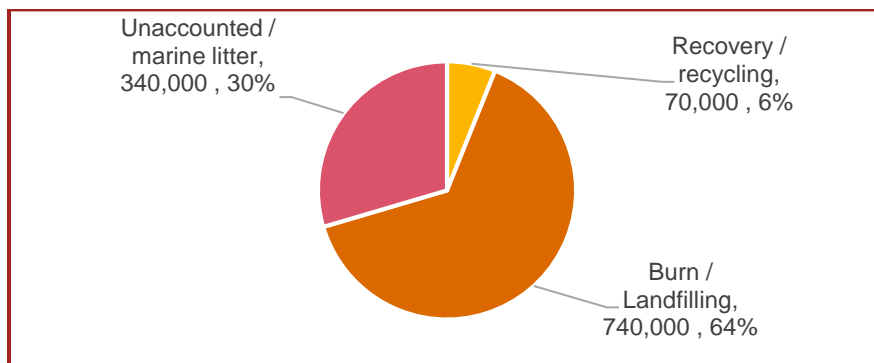


Figure 12: Plastic waste management in Nigeria

3.1.1. PET waste

230,000 tons of post-consumption PET waste is generated from households and businesses in Nigeria. The key PET waste products include PET bottles, PET containers and films. Waste from institutional waste generators ends up in landfills or collected by collection players. On the other hand, PET waste generated at household level ends up being burnt openly or leaks as marine litter in addition to landfill dumping and recycling.

Waste management authorities play a critical role in management of plastic waste. Various authorities such as LAWMA collect Municipal Waste from households through various PSPs (Private Sector Participations).

Lagos Waste Management Authority (LAWMA)

LAWMA is the agency responsible for the collection and disposal of municipal and industrial waste, as well as for the provision of commercial waste services to the State and Local Governments. The operations of the agency have been decentralized into 3 major operational districts namely Western District, Eastern District and Central District. They have recently initiated the **Blue Box Program** which is a single stream recyclable collection program that will encourage separation of recyclable materials from the general waste at the point of generation.



Figure 13: Blue box initiative launched by LAWMA

The key objectives of the program are to:

- Capture about fifty (50) percent of recyclables upstream with zero tolerance for scavenging by June 2021
- Attracting Major investors, create green jobs and further strengthen the sector
- Re-orientation of scavengers and Integration as Resource Managers at the Community Recycling centers where their expertise will be needed reducing the negative impact on their means of livelihood
- Encourage zero waste generation in the State and promote a healthier and cleaner environment
- Reduce carbon footprint
- Increase economic security by tapping domestic source of material

The government authorities dispose the MSW at various landfill sites. PET waste such as PET bottles are easily recognizable by the Baba Abibas (scavengers). In addition, PET polymer is easiest to recycle. Consequently, approximately 60,000 tons of PET waste is being managed efficiently in Nigeria through recycling into various applications such as PSF (Poly Staple Fiber).



Figure 14: Baba Abibas scavenging for waste

source: <https://qz.com/africa/1637931/lagos-entrepreneurs-champion-recycling-as-a-way-of-life/>

Private collection players play a key role in management of plastic waste. Some of the companies that are involved in PET collection include Chanja Datti, Recycle points, Wecyclers while recycling include Alkem Nigeria Ltd and Lexsz Plastics Limited. All the recyclers and collectors are registered under Recyclers Association of Nigeria (RAN) which is an umbrella body of indigenous enterprises registered in Nigeria with activities that promote Waste Recycling.

Wecyclers:

Wecyclers is a collector and sorter of plastic waste in Lagos, Nigeria. They have 2 hubs in Surulere and 1 hub in Ebute-Metta, 1 hub in Ojota and their headquarters at Lagos Island. Each hub covers a 2 or 3 mile radius of waste collection. 100,000 kgs of plastic waste is collected, sorted and compressed monthly by Wecyclers. Alkem Nigeria Limited and other recyclers buy from Wecyclers at between 180 and 192 USD per ton of PET. They are collecting 40% of the waste from private sector. Wecyclers is partnering with the Lagos state on the Blue Box Initiative to collect plastic directly from consumers in a customized blue bag to build the recycling culture in Lagos.

Recycle Points

Recycle Points is a plastics collector and sorter set up to combat the waste management crisis in Nigeria. They started off as a household incentive program focused on earning points based on the weight of plastics collected. They later switched to the counting system based on their clients' preference. They have about 10,000 households and 22 corporate companies signed up. They collect PET, LDPE, HDPE. PET and pure water sachets are the main items collected. PET makes up between 75%-80% of the used plastics they collect. Recycle Points sells a ton of PET for between 180 and 220 USD depending on the season. They also supply 1500 tons of plastic flakes to Lexsz Plastics Limited.



Figure 15: Wecyclers storage site

Chanja Datti

Chanja Datti is a recycling company based in Abuja with a mission to convert waste into commercially viable products while empowering women and youth entrepreneurs in the process. The company has three waste collection hubs, located in Giri, Durumi (Abuja) and in Akure. They currently collect waste plastic (PET bottles, pure water sachet etc.) and other recyclables like aluminum cans, papers (old newspapers, old textbooks, cardboard, cartons etc.), tires, and glass bottles. Chanja Datti predominantly collects all types of plastic out of which 60 % is PET. Chanja Datti has three off takers namely Alkem, Lafarge and Environmental Expressions. They have carried out several projects such as Partnering with Jaiz bank to open green savings account for the informal waste pickers. Creating recycling hubs very close to market places. It is called a Cash-for-Trash scheme and offer basic insurance for the waste pickers

Alkem Nigeria Limited

Alkem Nigeria Limited is a recycled PSF manufacturer from hot washed pet flakes and is based in Lagos, Nigeria. They are currently recycling 20,000 tons of PET to PSF. The main suppliers include Wecyclers, Recycle Point, Chanja Datti.

Lexsz Plastics Limited

Lexsz Plastics Limited is a plastic recycling firm in Nigeria. Recently the company has invested US\$8 million in setting up a Polyethylene terephthalate plastic bottle recycling plant on a 10-acre land in Lagos.

Even though 60,000 TPA of PET is being recycled in Nigeria, recycling environment is constrained by various reasons. Currently, the country lacks bottle to bottle PET recycling. Bottle to bottle recycling requires necessary standards for food grade PET resin. FBRA and SON are collaborating to develop such standards. This could pave way for bottle to bottle PET recycling manufacturing in Nigeria.

Moreover, transportation costs increase the PET bail cost. Currently the PET bails cost approximately 160 USD per ton within Lagos. However, if this waste is transported to Lagos from neighboring states, the PET waste the PET bail costs approximately 200 USD per ton. It increases the cost of PET bales which decreases the price competitiveness of recycled PET vis-à-vis virgin PET resin.

3.1.2. PE and PP waste

Approximately 260,000 TPA of PP waste and 430,000 TPA of PE waste is generated post consumption in Nigeria. Plastic waste management systems are similar to that of PET. However, in total, approximately 10,000 TPA of PE and PP waste is being recycled. There are various reasons for the lower recycling rates for PP and PE.

- 1) PP and LDPE are not as easy to recycle compared to PET.

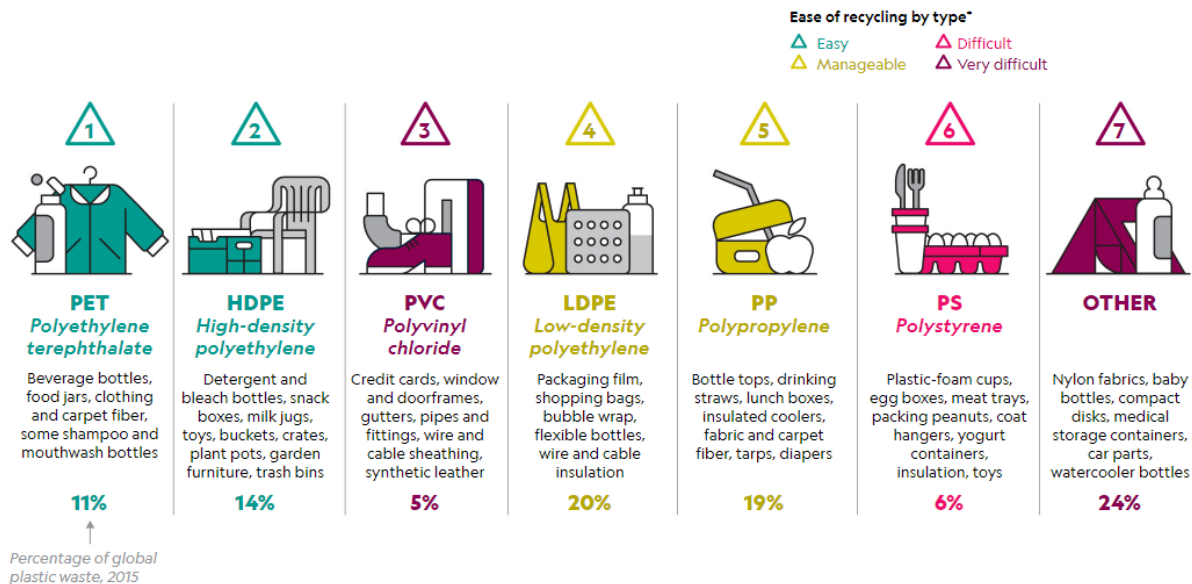


Figure 16: Ease of recycling by polymer type source: <https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-waste-pollution-trash-crisis/>

- 2) As compared to PET, it is not easy to differentiate PP and PE from other forms of plastic making recycling difficult. For sorting of PP and PE waste technical expertise is required which is still missing in the country.
- 3) In addition, PP and PE items are usually crushed to smaller flakes before transportation. This ensures efficient transportation. However, in absence of significant off takers, the private players are hesitant to invest in such infrastructure.

Accounting for PET, PE and PP waste only 6% of the total plastic waste generated is being recycled. The rates are significantly lower compared to global averages as discussed in the next section.

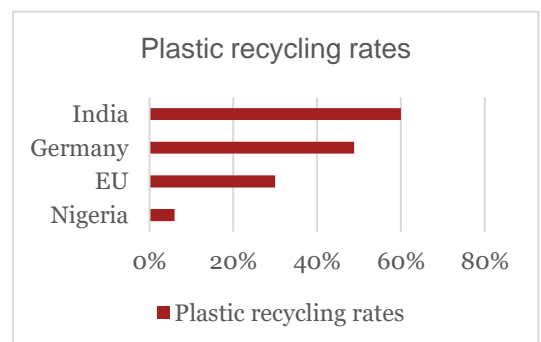
3.2. Plastic waste management globally

In comparison to the global recycling rates, the rate of recycling in Nigeria is towards the lower end. Recycling rates in the European Union average 30% and are thought to be considerably higher in some EU Member States such as Germany where the recycling rate stands at 48.8%. In India, leveraging the informal sector, high plastic recycling rate of 60% have been achieved⁸.

Common practices which result in enhanced the recycling rates include:

1. Landfill restrictions on recyclable waste
2. Ban and phase out of MLP
3. Substitution of difficult to recycle polymers such as PP with easily recyclable polymers wherever possible
4. Dual collection/Source segregation awareness and supporting infrastructure
5. Availability of economies of scale for polymers such as HDPE through organized collection and recycling

Few cases that illustrate best recycling practices are presented below:



⁸ <https://www.teriin.org/sites/default/files/files/factsheet.pdf>

Green Dot system in Germany

The “Green Dot” system, in Germany, is an industry-funded system of waste collection, which is operated by Duales System Deutschland GmbH (“DSD”, English for German Dual System). The system liberates retailers and firms from individual take-back and recovery obligations under the German Packaging Ordinance. Companies that participate in the system, pay for disposal of the plastic items they manufacture, beforehand and are eligible to have a “Green Dot” logo on their plastic packaging. Under this system, private households are given a yellow bag in which they can put every packaging. These are collected by DSD-operated waste collection vehicles, which will sort and recycle the wastes accordingly. Such systems enhance the collection rates of the country.

4-in-1 recycling programme

Taiwan’s 4-in-1 recycling programme is often cited as leading best practice. The system involves coordinated recycling efforts between consumers, recycling industries, local authorities, and recycling fund. Consumers are mandated to deposit their segregated waste at local collection points. Recycling industries buy the waste material in order to recover commodities and generate revenue. Local authorities organise municipal collection teams to collect waste from collection sites. The recycling fund is the most important aspect of the system. Manufacturers and importers of new regulated recyclable waste are required to pay a fee to the Environmental Protection Administration Taiwan (EPAT) that contribute to the recycling fund. This is distributed to trust funds and special income funds that are used to subsidize private collectors and recycling enterprises.

Better Future Factory



Better Future Factory has developed; the Perpetual Plastic Project which is world’s first mobile interactive recycling machine, where people can convert their own plastic waste into a 3d printed object. Better Future Factory has 3 startups.

Refil: This company enables people with a 3d printer to use a sustainable alternative. The portfolio offers different plastics from different waste sources like ABS from car dashboards, HIPS from refrigerators, PLA from packaging and PET from plastic bottles. Currently Better Future Factory is a sustainability partner of several companies. For example, a Dutch coffee roaster, where an internal waste stream of coffee packaging (cutting waste) is transformed into coffee service products like trays.

The recycling rates in Nigeria is estimated to be 6%-7%. Nigeria can aim higher recycling rates like other developing economies such as in Bangladesh, where the plastic recycling rate stands at 51%. The recycling rate for plastic in India has also reached up to 60%. In Bangladesh, Dhaka city has a PET recycling rate of about 90% and about 31% of PP recycling.⁹ India has an overall PET recycling rate of over 70%.

In the immediate short term Nigeria can target enhancing the PET recycling rates to 45% from the existing 26 percent which can further be enhanced to 70% recycling rate over long term (benchmarking with Indian scenario) by embarking on the following interventions:

- **Improve solid waste management practices** – particularly through enhancing the collection, transportation and segregation system. This ensure unconstrained supply for PET recycling plants and also reduce contamination. The collection system can be enhanced through (a) effective source segregation (b) effective EPR implementation which can formalize the collection supply chain and (b) by creating an uptake market for the plastic products manufactured through recycled resin. For instance, India has strong collection system for PET waste owing to the presence of the textile industry which has the uptake for the PSF manufactured through PET waste. In Bangladesh, the country has an export incentive in place for export of PET flakes which prioritized PET collection and developed a strong PET waste collection eco-system. With the standards being formulated in Nigeria for the use of the recycled resin in manufacturing of food grade plastic is expected to create the uptake market. Creating an uptake market needs to be complemented by having source segregation implemented by adopting the 4-dot model of Germany and the effective EPR implementation can help in formalizing and improving the collection efficiency.
- **Having decentralized circularity solutions** – Nigeria has weak logistic network which increases the transportation cost for procuring the raw material. For instance, the transportation of the PET waste from Kano to Lagos increased by 15% due to the inadequate transportation system. Having decentralized circularity solutions in the economic centers of the country can offset the transportation cost making the production of recycled resin competitive.
- The country can introduce **economic incentive for PET recycling** by developing standards around recycled food grade plastic which will give a legal framework for recycled food grade PET production. Considering Nigeria does not have a textile industry to consume recycled PSF, recycled food grade PET resin production should be a priority.
- **The transportation and logistics infrastructure** in Nigeria should be developed to explore recycled PSF export opportunities in regional textile hubs like Egypt. Reaching the PET recycling target may be easier for the private sector if the transportation and logistics challenges to export is resolved considering recycled PSF production is less capital intensive compared to recycled food grade PET resin manufacturing as detailed in the chapters to follow.
- The competitive production of recycled requires **collaborative platforms** that could ensure reliable offtake of recycled resins. Currently, such platforms are absent in Nigeria.

Nigeria is recycling about ~2-4% of PP waste generated. The country can target to reach 10% PP recycling rate by focusing on the source segregation and improving the collection efficiency. The source segregation can be achieved by introducing the labelling standards which can differentiate the product types of various plastics.

⁹ PwC study on Plastic Market Assessment of Bangladesh and Waste concern study on Plastic Waste Recycling and its opportunities in Bangladesh.

3.3. Regulatory assessment

As discussed in the previous section, Nigeria’s plastic recycling rate is low as compared to the global rates. One of the key reasons for a low recycling rate in Nigeria is the lack of enabling regulatory recycling environment. EPR is an important instrument which can facilitate the recycling environment. EPR is an increasingly popular approach to make the polluter’s pay. It makes producers responsible for the treatment and/or disposal of post-consumer products (financially by paying for or physically by collecting, treating and disposing of the products).

Case of successful EPR implementation in Italy

The European Directive on packaging and packaging waste was drawn up with a view to sustainable development and the definition of the environmental and social responsibilities of business enterprise, public authorities and private citizens. It was later acknowledged by Italian law in 1997 and amended in 2006. With the aim of achieving the recovery and recycling targets set by the European directive, Italian law set up CONAI, the national packaging consortium, with obligation of adhesion on the part of all packaging Producers and Users.

Due to the regulation, packaging recovery rose from around 3.5 million ton in 1998 to almost 10 million ton in 2016, reaching and exceeding the targets set by law. Plastic recovery also increased from 10.7% in 1998 to 41.1% in 2016.

EPR measures incentivize the reduction of waste at its source. Today many governments have EPR policies in place and the trend is towards an extension of EPR to new product groups and waste streams, such as electrical appliances and electronics. EPR for packaging waste and waste electrical and electronic equipment has proved to be successful in many countries such as Austria, Belgium, Germany, France, and other EU countries and thus improving the recycling rates of these countries.

Success of business models in plastic circularity require an enabling eco system. Regulations form a key part in establishing a conducive eco system for plastic circularity as they enhance collection efficiency of plastic waste. In this regard, regulatory assessment of the key policies related to EPR, standards, solid waste management were reviewed.

3.4. EPR Programme in Nigeria

EPR policy and its implementation is the key enabler for an efficient plastic waste collection. The EPR Programme in Nigeria with respect to plastic is driven by various policies as discussed below:

S. No.	Regulation	Provisions affecting EPR
1.	National Environmental (Sanitation and Wastes Control) Regulations, 2009, S. I. No. 28	<ul style="list-style-type: none"> Manufacturers and importers of food and beverage products are required to establish an effective Product Stewardship Programme (PSP) They need to undertake buy back of containers for recycling
2.	National Environmental (Food Beverages & Tobacco Sector) Regulations, 2009, S. I. No. 33	<ul style="list-style-type: none"> Need to establish a buyback programme for bottles and other packaging of products
3.	National Environmental (Chemical, Pharmaceutical, Soap and Detergent Manufacturing Industries) Regulations, 2009, S. I. No. 36	<ul style="list-style-type: none"> Need to establish a buyback programme for packaging of products
4.	National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector) Regulations, 2011, S. I. No. 17	<ul style="list-style-type: none"> All manufacturers and importers need to subscribe to an Extended Product Stewardship Programme including a buyback programme

3.4.1. EPR Assessment

A detailed review of some of the key regulations discussed above was undertaken. The EPR programme in Nigeria includes key features such as:

1. Responsibilities of various stakeholders including producers, collectors, recyclers, PROs, consumers and government is clearly defined.
2. Various economic instruments such as deposit refund schemes, advance disposal fee, tradable recycling credit system are provided.
3. A manufacturer does not have the core competency of undertaking plastic waste management. Considering this, provision of PRO is defined in the regulations.

3.4.2. EPR gap assessment

The EPR programme in Nigeria was compared with EPR programme in Germany and India as they have better plastic waste management rates. A brief about the EPR programme in Germany and India is provided below:

EPR (Plastic) in Germany	EPR (Plastic) in India
<ul style="list-style-type: none">• In 2019, the German Packaging Act (VerpackG) came into force. The new law regulates the responsibilities in terms of who bears the cost for the disposal and recycling of packaging waste, with the aim of significantly increasing the recycling rate for this kind of waste. The Act applies to all those who introduce packaging (product packaging, shipment packaging and service packaging) onto the market in Germany. The Act requires that anyone who fills packaging with goods and sends them within or to Germany must register this packaging through a "license fee" in a so-called dual system.	<ul style="list-style-type: none">• In India, the concept of EPR for plastic waste was recognised by plastic waste management rules 2016. The regulation imposes primary burden on the producer for collection of waste plastic products. Producer, Importers and Brand Owners need to work out modalities for waste collection system for collecting back the plastic waste within a period of six months in consultation with local authority/State Urban Development Department and implement with two years thereafter.

Some of the key gaps that were identified included:

1. Lack of collection targets – Nigeria's EPR lacks specific year wise collection targets for stakeholders
2. Lack of Waste Management mechanisms – The EPR lacks specific waste management options and corresponding targets. Some of these may include co-processing for MLP, recycling of recyclable content in plastic products etc.
3. Lack of 3rd party performance monitoring – Provision of 3rd party monitoring could increase recycling rates by ensuring implementation of the policy

3.5. Resulting landscape due to existing EPR

The provisions provide in the EPR are not being implemented effectively. The 'as-is' Management of plastic waste is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal – consequently only close to 6%-7% of the plastic waste is managed properly. The key issues include:

- **Delayed collection of household solid waste** – in some cases by couple of weeks. Lack of adequate infrastructure facilities such as bins and transportation facilities is constraining the collection of waste by the regulatory authorities. This is creating the contamination of the waste as well as constraining the development of formal collection system
- **Lack of segregation at source:** Plastic waste is mostly collected from landfill by informal collectors and not directly from source. As a result, the plastic waste is contaminated with dirt, sludge, leaches, chemicals, etc. Also, the lack of segregation at source leads to mixing of the PP and PE waste This adds to the processing cost in the form of expensive capital machineries and electricity consumption.
- **EHS issues:** The existing collection practices are constrained by social non-compliance and EHS, occupational health and safety concerns at the collection centers.
- There are various challenges that exist in the existing practices of the collection system: (a) fragmented supply chain (b) lack of market intelligence on generated plastic waste (c) lack of recycling and cleaning

technology – resulting in the production of low quality recycled polymer that can't be used for the mainstream brands

- **Limited involvement of PRO** - Only one PRO, Food and Beverage Recycling Alliance, is active in management of plastic waste
- **Reduced cost of collection of PET waste** – An effective EPR would help in reducing the cost of collection of PET waste thereby increasing the potential of the business cases as explained in next section.

3.6. Licensing framework for recyclers

An entity to operate as recycler needs to register either with (a) state waste management authority or (b) at federal level with NESREA. For registering with NESREA¹⁰, the process is fairly straight forward and includes (a) submission of online application form (b) inspection of the facilities and (c) granting of certificate. For registering with state waste management authorities, the recyclers submit a printed application form which is followed by inspection visit and grant of license on Stakeholders indicated that lack of man-power usually delays the inspection visit which causes hinderances in the registration process.

However, the biggest concern indicated by the stakeholders is the high processing fee associated with the registration at NESREA which is impacting the business viability. The processing fee for recyclers is pegged at USD 700 (Naira 250,000) and for collectors it is 276 USD. The annual fee for the recyclers is USD 1400 (Naira 500,000) for collectors the annual fee is 552 USD (200,000 Naira).

¹⁰ <https://www.nesrea.gov.ng/extended-producer-responsibility/>

4. Business cases

EPR is key enabler to increase the collection and recycling of plastic and has proved to be successful in achieving the bigger goal of circularity. Apart from EPR, global brand commitments also play an important role in driving the linear economy to a circular one. In January 2018, the Ellen MacArthur Foundation announced that at least 11 leading brands, retailers and packaging companies have committed to working towards 100% recyclable, reusable or compostable packaging by 2025. These include widely known names like The Coca-Cola Company, PepsiCo, Unilever, Evian, M&S, L'Oréal, and such. The list includes 11 such brand names who together represent more than 6 million tons of plastic packaging each year. This comes at a time when consumers are more aware about the products that they use, and how these impacts the larger environment and social dimensions of their society. Consumer awareness, combined with brand commitments is opening a previously, largely, untapped area of business economics *mainly circularity of materials*, in this case plastic.



At least 25% recycled HDPE for bottles of personal care brands like Dove, Surf, Sunsilk and TRESemme by 2025⁴



By 2025 Evian will become a full circular brand, making all of its plastic bottles from 100% recycled plastic, seeking zero plastic bottle waste.



Coca Cola Company aims to for all its bottles to be made from 50% recycled content on average by 2030.

Figure 17: Examples of brands committing to use recycled plastic



Figure 18: Concept of Circular Economy

EPR and global brand commitments are two key reasons that are driving business cases in the circular economy. The concept of circular economy offers an alternative to the current linear “take, make, use, dispose” economy model, and aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimizing the generation of waste.

The concept offers a circular process of inputs and outputs to ensure materials and resources remain in the production and consumption process. It encompasses three principles:

- Prioritizing renewable inputs
- Maximizing product use
- Recover by-product and waste

Transitioning to a circular economy does not only amount to adjustments aimed at reducing the negative impacts of the linear economy. Rather, it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits. Economic circularity provides opportunities to be ahead of

systemic risks from waste and pollution, climate change, resource scarcity, and impending environmental regulations.

The linear model of production leads to more unmanaged waste and pollution that causes **environmental degradation**. It is estimated that by 2025 the ocean could contain one ton of plastic for every three tons of finfish.¹¹ In a business-as-usual scenario there would be more plastic than fish by 2050.¹² There is evidence that some of this plastic enters the ocean’s food chain, and thus also enters human food chain. Studies suggest, an average person consumes about 50,000 pieces of plastic per year and inhales an equal amount.¹³ Ingestion of plastics can adversely impact the health of any organism. Large volumes of plastic can greatly reduce stomach capacity, leading to poor appetite and false sense of satiation. Plastic can perforate the gut, cause ulcer or gastric rupture.¹⁴

Climate change is another side-effect of the linear production model. The existing business model presents several risks to the availability of raw materials and energy. As the impacts of climate changes becomes severe with the progression of time, businesses will face more natural disasters like floods, wildfires and storms which will cause a disruption in their business. These climate risks may reduce the market value of many companies

¹¹ Ocean Conservancy and McKinsey Center for Business and Environment (2015), Stemming the Tide.

¹² Ellen MacArthur Foundation (2017), The New Plastics Economy: Rethinking the future of plastics & catalysing action.

¹³ Cox, Covernton, Davies, Dower, Juanes and Dudas (2019), Human Consumption of Microplastics

¹⁴ <https://ourworldindata.org/plastic-pollution>

by 2-3%. Adopting circular business practice can be the contribution of the companies towards reducing climate change and also increasing for their own resilience.

Resource scarcity means the fluctuations in raw material prices, availability and flow of raw materials, which can lead to even higher prices. Maintaining linear production models would pose a higher risk to the companies which rely on steady flow of input materials- and on stable prices for those materials. For instance, the production of virgin polymer resin is significantly dependent on the extraction of fossil fuels, which is a depleting resource. Scarcity in the supply of fossil fuel would entail a fluctuation in the availability and price of virgin polymer resins.

Resource scarcity and environmental degradation has prompted authorities to impose strict environmental standards on manufacturers and consumers to reduce resource consumption. Embracing circularity principles will enable the companies to avoid being caught off-guard by impending regulations.

If implemented effectively, business circularity helps in substituting virgin plastic resin by recycled plastic resin as it enhances the price competitiveness of recycled resin viz-a-viz virgin resin. Regulations such as EPR improve collection efficiency which leads to price competitiveness of the recycled resin produced. For Nigeria, availability of recycled resin could reduce import dependence as it imports approximately 63% of plastic resin for meeting its demand. This resin then can be converted into newer products.

Nigeria has a high potential to establish circularity of materials due to the following reasons:

1. Availability of large amount of plastic waste
2. Existing policy framework that supports PRO obligations
3. Existing private players engaged in collection and recycling

Considering various advantages and supporting environment, various business cases for investment in circularity of plastics have been prepared. Companies that are interested in investing in such business cases have also been identified. Business cases have been prepared for a) immediate opportunities and b) long term opportunities. Various short-term business opportunities have been identified for different polymers that are easily recycled using existing technology. Cases of long-term opportunities that are based on chemical recycling technologies are also discussed.

4.1. Potential opportunities:

The low hanging potential opportunities include those for which the stakeholders have expressed interest in investing during the interactions undertaken as part of the study.

Polymer	Potential opportunity	low hanging opportunities
PET	Bottle to Bottle recycling	Coca Cola is piloting a project with Sonnex. Expected plant size: 70 TPD
		Indorama (PET) Ventures is keen to explore investment. Expected plant size: 50 TPD
		EPR if effectively implemented can lead to significant scalability potential
	PSF	PET to PSF is being manufactured by Alkem, Lexsz in Nigeria. Lack of local textile industry will constraint the replication. Need to look at integration to regional value chains
PP	Household products	Sona group looking for investments for 40 TPD plant

4.1.1. Bottle grade PET resin from PET waste



PET bottles are light, practical, non-breakable, and easily recyclable using conventional mechanical recycling. Generally, Poly Staple Fiber (PSF) is produced from discarded PET bottles. However, using techniques such as Solid State Polycondensation (SSP) food-grade recycled PET resin could be produced which is used in manufacture of PET bottles.

4.1.1.1. As-is situation

Private players in Nigeria are involved in recycling of PET to PSF. However, Nigeria lacks food grade recycled resin facilities. As food grade resin comes in direct contact with edible content, it is necessary to have appropriate

standards that ensure suitability for human consumption. Currently there are no standards for manufacturing food grade recycled resin. The standards for the use of recycled resin for manufacturing food grade plastic are being formulated. This is constraining the growth of the industry.

In addition, contamination of the PET waste due to the lack of source segregation and informal collection system is also hindering the scalability. With most of the industries located around Lagos region, inadequate road transportation network increases the cost of raw material at factory gate. Transportation cost from hinterland states such as Kano and Abuja contribute about 15% to the overall costs. The high transportation cost impacts the margins of the collectors.

4.1.1.2. Potential Investment

Low hanging opportunities:

Currently there is no PET to PET bottle grade resin manufacturing in Nigeria. Lack of standards for the use of PET recycled resin in food grade packaging has constrained the establishment of the plant. Interactions with FBRA indicated that the standards are likely to be formulated in the next couple of months. The change in regulations along with the formulation of EPR has translated to companies such as Sonnex and Indorama expressing interest in establishing PET recycling plant for producing food grade packaging products. The envisaged investments by Sonnex and Indorama translates to an immediate investment potential of approximately 40,000 TPA of PET recycling. This presents an investment opportunity of **120 to 140 Million USD** and reduce **69,000 tons** of CO₂ emission. Following is basis for estimating the potential:

- Due to ease of recycling of PET, all the collected PET could be used for the investment opportunity.
- Currently around 60,000 tons of PET waste is being collected. Out of this 20,000 tons is already being recycled. Therefore, approximately 40,000 tons shall be available for further recycling.
- An average plant that produces approximately 6800 TPA of food grade resin requires an investment of approximately 20 to 25 Million USD. Plant and machinery cost around 20 Million USD whereas land and civil works cost approximately 2 Million USD each.

Scalability potential:

Currently, 230,000 tons of PET waste generated annually, with only 60,000 tons being collected currently. With the enhancement in the effectiveness of EPR, voluntary recycling commitments by various brands and advancement in market analytics, it is likely that in future almost all the waste PET could be collected.

In India the PET recycling rate is more than 70%.¹⁵ In Bangladesh, Dhaka city has a PET recycling rate of more than 90%.¹⁶ India had the uptake market for recycled PET due to presence of a strong textile industry which can offtake the PSF produced from PET waste. The uptake market contributed to the historically high PET collection rates and the Indian EPR policy enacted in 2016 aims at formalizing of the collection system in India. On the other Bangladesh government has incentivized export of PET flakes which has encouraged the collection and recycling of PET in the country. If Nigeria adopts the standards for use of recycled resin in the manufacturing of food grade plastic along with effectively implemented EPR policy, it will increase the strength and efficiency of the collection system.

Nigeria can to achieve recycling rate of 70% (benchmarking with the recycling rate of PET in India) with economic incentive tied to recycling and enhanced collection system. The recycling rate of 70% translates to a theoretical potential of investment scalability to **480 to 560 Million USD and a potential GHG savings of 280,000 tons per annum**.

4.1.1.3. Business Case

The uptake of the recycled resin in the manufacturing of the food grade packaging is dependent on: (a) formulation of standards for the use of recycled resin in food grade packaging (b) being cost competitive in comparison with virgin resin. The cost of virgin PET resin in Nigeria ranges between USD 1150- USD 1200 per ton.

The key cost components for the manufacturing of the recycled resin for food grade packaging includes: (a) PET Bailing costs (raw material) (b) financing costs and (c) Electricity charges. In the below sections for each of these cost components two scenarios have been presented (1) Best case Scenario and (2) Business As Usual Scenario. The best case scenario corresponds to the situation which is likely accessible to large players and the

¹⁵ Council of Scientific and Industrial Research (CSIR) study conducted by National Chemical Laboratory (NCL) in 2017.

¹⁶ On-going Plastic Market Assessment Study conducted by PwC in Bangladesh.

business as usual scenario, corresponds to the situation accessible for smaller local recyclers in absence of incentives

PET Bailing cost:

The PET bailing costs ranges from USD 160 to USD 220 per ton, with the below scenarios depicting the variances:

- Optimal scenario: The PET bailing cost can be reduced by having a decentralized recycling and packaging plant in Lagos. The historic cost of PET bailing in Lagos are in the range of USD 160-180/ton. Thus, a decentralized collection system waste would help companies to decrease the cost of Raw Material. The volume of the PET waste collected can also be enhanced by targeting bulk consumers such as commercial institutions (malls), residential welfare associations (RWA's) and also collaborating with community based collectors such as Wecyclers. Enhanced volumes of collection will also ensure an unconstrained supply of the raw material. (Realistic scenario)
- Scenario B: The cost of the PET waste is dependent on the region of procurement. Procuring from the hinterland such as Kanu and Abuja increases the PET bail costs due to the transportation costs. Having a centralized plant procuring the PET waste from hinterland will enhance the average cost of raw material (PET Bails) procurement to USD 220.

Depending on the technology, the conversion rate from PET bottles to PET bails (rPET) by weight could be estimated at 80%. In the Nigerian market, the transportation of bails and losses due to contamination and moisture could push the resulting rPET price by further 10-15%. As a result, the baseline baling cost could be estimated at US\$265 (optimal scenario, likely accessible to large players investing in community collection schemes and through enabling SWM framework) to US\$324 (business as usual scenario, typical for smaller local recyclers in absence of incentives or capacity to develop collection).

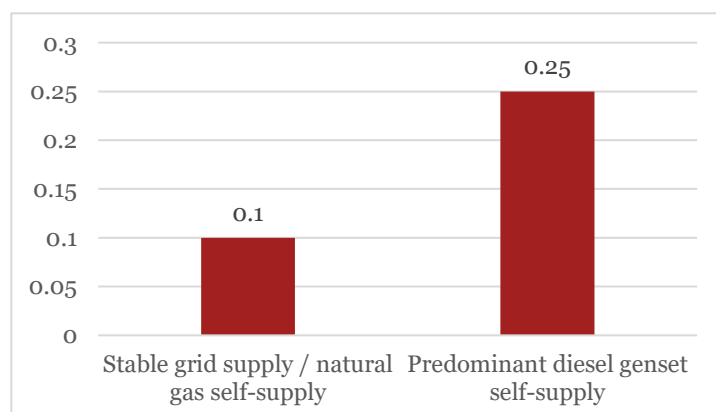
Financing cost:

The financing charges varies from 10% to 20%, with the below scenarios depicting the variances:

- Optimal Scenario: Established players having robust balance such as Indorama, Sonnex can leverage robust balance sheets to obtain reduced interest rates at 10% through balance sheet funding.
- Business as usual (BAU) scenario: The financing costs for the greenfield plants will be much higher in the range of 15% - 20% as the greenfield projects typically use project financing which is non-recourse lending.

Energy costs:

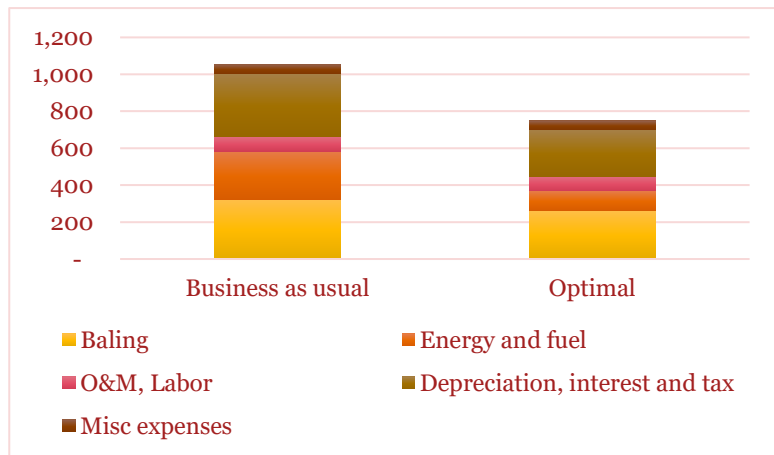
As recycling is an energy-intensive process, managing the cost of energy and fuel becomes critical for project viability. In 2019, the loaded cost of electricity from the grid for medium to large firms in Nigeria varied between US\$0.055-0.08/kWh. However, the sporadic and lengthy power outages are common, forcing companies to operate diesel gensets 8 to 16 hours a day, pushing the loaded cost to US\$0.25-0.3/kWh. This is especially relevant for small and medium-sized companies that dominate waste collection and recycling business. The environment is significantly different for large-scale petrochemical



companies that typically operate high-capacity power plants that run on natural gas, allowing to achieve the loaded cost of electricity of around US\$0.1/kWh. As a result, energy and fuel cost for such project sponsors could be less than half of the business as usual. Implementation of renewable energy solutions could be considered by all types of players in order to maintain such cost of energy. The business as usual scenario for B2B recycling would thus assume a cost of energy of US\$260 per t rPET, while the optimal scenario (currently accessible to larger players) would involve the cost of US\$104 per t rPET.

O&M and labor costs would also vary, and will be custom for every project, depending on the scope, terms of equipment procurement and organizational structure – the average costs work out to be in the range of US\$80 per t rPET.

The cost of the recycled resin production for both the scenarios has been compared to the cost of virgin resin to determine the competitiveness of the use of recycled resin. The cost of production in case of business as usual scenario is on-par with the cost of virgin resin which will inhibit the uptake of the projects. However, the optimal scenario which leverages the lower financing costs, better access to the PET Bails and access to cheaper energy makes the project of recycled PET resin for B2B production viable for large players.



4.1.1.4. Enabling environment for scalability

For ensuring scalability following conditions need to be ensured:

- Reduced cost of collection of PET bottles
 - Ensuring quality of discarded PET bottles
 - Reduced cost of finance
- effective EPR
- fiscal policies

Effective EPR implementation can be a key enabling environment for reducing the cost of raw material. Under EPR, brands are responsible for the collect back of the plastic waste through interventions such as deposit refund scheme etc. The collected PET bottles can be provided to the preform manufacturing facilities. The brands can work with the registered recyclers with Recyclers association of Nigeria (RAN) to create a formal system of waste collection. Effectively implemented EPR can ensure source segregation – thereby reducing contamination as well as reducing the raw material cost. To scale the collection, collaboration at local waste collections system level (LAWMA etc) along with focus on emerging technologies in waste collection and recycling infrastructure is crucial. In addition, fiscal policies such as interest rate rebate, tax holidays are also key to ensure the scalability

4.1.2. Polyester staple fiber from PET flakes



PET bottles are primarily recycled into polyester fibers. Polyester staple fiber is the largest end-use segment for recycled PET. Fiber is widely used in textile, home furnishings, and automotive sector. However, investments in PSF is mutually exclusive with investments in bottle to bottle plant considering both rely on the same raw material – PET waste.

4.1.2.1. As-is situation

Alkem Nigeria Ltd and Lexsz Plastics Limited is manufacturing recycled PSF from PET waste. Initially Alkem collaborated with FBRA to source the PET waste. However, now it sources the PET waste through various collection facilities such as Wecyclers, Recycle Point, Chanja Datti.

4.1.2.2. Potential Investment

Low hanging opportunities:

There is an immediate investment potential of approximately 20,000 TPA of recycled PSF manufacturing from PET flakes. This translates to an investment opportunity of 15 to 20 Million USD and reduce approximately **27,000 tons** of CO2 emission. Following is basis for estimating the potential:

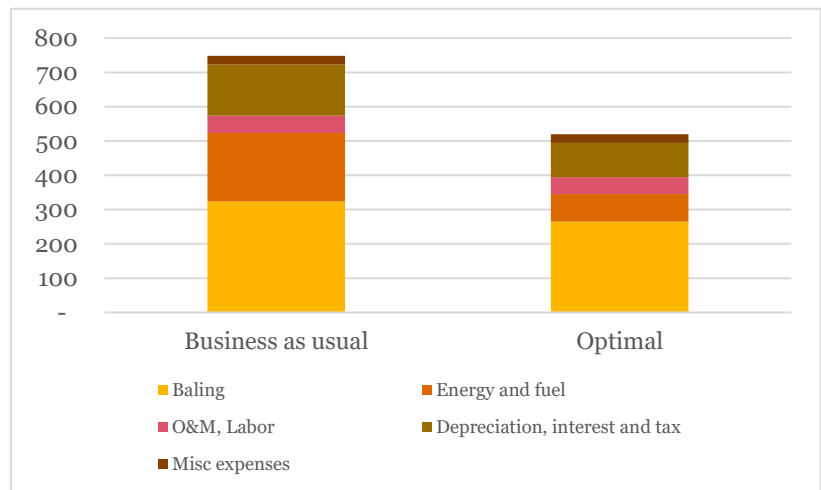
- Currently around 60,000 tons of PET waste is being collected. Out of this 20,000 tons is already being recycled. Therefore, approximately 40,000 tons shall be available for further recycling. Stakeholder consultations suggest an immediate demand of 20,000 TPA for recycled PSF exists.
- An average plant that produces approximately 20000 TPA of PSF production unit requires an investment of approximately 15 to 20 Million USD.

The financial success of the immediate investment opportunity depends on the underlying costs and the cost of its perfect substitute – virgin PSF fiber. The key operating cost components comprise of:

1. PET flake cost – Currently priced at 300 USD/ton to 360 USD/ton.
2. Electricity cost in Nigeria can range from 0.1 USD/kwh to 0.25 USD/kwh. The lower cost of energy corresponds to the use of captive gas based power plants. The extensive use of diesel generator to offset the sporadic and lengthy power outages will increase the energy cost to 0.25 USD/kWh.
3. Due to high upfront investment costs, the financing cost contribute significantly to the cost of recycling. In Nigeria, the interest costs range from 16% to 20%. Large players having robust balance sheets can avail much cheaper financing which can be as low as 10% as reported by the stakeholders.

As explained in the earlier section, the viability of the project has been analyzed for two scenarios which include: (a) Business as usual (BAU) – which considers the unorganized and expensive PET waste collection models, higher financing charges and use of diesel generators increasing the cost of energy charges (b) optimal scenario which is accessible to large corporations.

For both the scenarios, the cost of production of PSF using the recycled PET flakes is competitive including when accounted for additional cleaning and procesing into chips, signaling strong potential for scaling up of this option, given availability of the source material.



However, the potential of scalability of PET to rPSF production in Nigeria is capped by lack of domestic textile sector in Nigeria. Lack of brands sourcing from Nigeria also constraints the requirement of recycled content in PSF production. Nigeria can explore integration to the regional value chains such as Egypt to export PSF and improve its economic complexity. The cost of PSF production in Nigeria as calculated in both the scenarios is lucrative in comparison to the import of PSF by Egypt (Egypt on an average imports PSF at USD 1200 per ton) – exporting to Egypt can be cost competitive. The PSF production can also lead to incubation of spinning industry in Nigeria to produce PSF yarn and cater to the growing demand of African regional value chains of Egypt – Egypt annually imports 300,000 tons of Polyester yarn. The incubation of PSF can also explore the scalability to meet the growing demand of the textile sector in other African regions such as Morocco, South Africa and Ethiopia.

However, challenges in trade and logistics will limit the export potential. Time delays, bottlenecks for international shipments, poor tracking and tracing capabilities and poor logistics quality and competence are all industry risks that weigh on growth prospect. Adding to this are burdensome customs procedures, which are still a major stumbling block in the effective functioning of the Nigerian logistics system and add to business costs and risk for transport and logistics services providers. Contamination of the PET waste due to the lack of source segregation, transportation costs for raw materials and informal collection system will also hinder the scalability

4.1.2.3. Enabling environment for scalability

For ensuring scalability following conditions need to be ensured:

- | | | |
|---|---|-----------------|
| 1. Ensuring quality of discarded PET bottles | } | effective EPR |
| 2. Enhanced collection of PET bottles | | |
| 3. Conducive policies and investment in trade and logistics | } | fiscal policies |

Effective EPR implementation can be a key enabling environment for greater collection of PET raw materials and higher quality of manufactured PSF. In addition, policies and investments to support the efficiencies in trade and logistics will be crucial to realize the scalable potential.

4.1.3. Household plastics from PP waste



Recovered PP waste can be used to manufacture items such as soap case, hangers, buckets, containers, tubs, bins and other household plastic items. The processes include crushing, washing and extrusion and injection molding to produce household articles.

4.1.3.1. As-is situation

A total of 10000 tons of PP and PE waste is being recycled in Nigeria. The cost of collection and transportation of PP waste is twice as high compared to PET waste (cost of PP waste is around 200 to 240 USD per ton) due to:

- the lack of segregation at source leads to mixing of the PP and PE waste which is difficult to separate at the stage of resin production. The lack of source segregation is leading to underutilized management of PP waste
- The size of household PP waste varies which (Different products such as plates, basins, buckets, furniture etc.) which is difficult to compact and leads to increased transportation costs.
- Crushing operations require reliable and uninterrupted electricity supply which is constrained in Nigeria. The cost of electricity augments the cost of producing the recycled resin.

4.1.3.2. Potential Investment

Low hanging opportunities:

Currently 10000 TPA of PP and PE is being managed in Nigeria. The immediate potential opportunity comprises of 40 TPD plant which is being envisaged by Sona group for producing household plastics from recycled resins. This translates to an investment potential of USD 10-15 Million and an opportunity to reduce 8000 tCO₂e per annum.

Scalability potential:

The theoretical scalability potential includes managing 36,000 Tons of household PP waste disposed per year in Nigeria. 36,000 TPA plant provides an investment opportunity of **35 to 45 million USD and 24,000 tons** of CO₂ emission reduction. Following is basis for estimating the potential:

- PP is difficult to recycle as compared to other polymers. Easily recyclable items comprise of household items which account for 10% of PP waste generated in Nigeria. This amounts to approximately 36,000 TPA.

4.1.3.3. Business Case

The financial success of the above investments depends on the underlying costs and the cost of its perfect substitute – virgin PP based household items. The key operating cost components comprise of:

1. PP waste cost – Currently priced at 200 USD/ton to 240 USD/ton.
2. Electricity cost in Nigeria can range from 0.1 USD/kwh to 0.25 USD/kwh. The lower cost of energy corresponds to the use of captive gas based power plants. The extensive use of diesel generator to offset the sporadic and lengthy power outages will increase the energy cost to 0.25 USD/kWh
3. Due to high upfront investment costs, the financing cost contribute significantly to the cost of recycling. In Nigeria, the interest costs range from 16% to 20%.

PP Waste Cost:

PP waste cost – Currently priced at 200 USD/ton to 240 USD/ton, with the scenarios depicting the variances below:

- Optimal Scenario: The cost of waste PP procurement can be reduced by enhancing the efficiency of the solid waste management system in Nigeria with focus on at source segregation of waste. Without “at source segregation”, the recyclers incur labor cost for sorting of the waste. The cost of PP waste also comprises of transportation cost incurred by recyclers. The transportation of PP waste is a challenge because of the varying size of waste PP articles. Introduction of a collection system with decentralized crushing centers near the source of waste generation would reduce the cost of transportation of PP waste, thereby, reducing the cost of PP waste. The costs of PP waste can be reduced through (a)

Providing subsidies and other financial incentives for the collectors to install Automated sorting machines and crushing systems and (b) Utilizing Decentralized waste management to reduce the collection costs: State agencies such as LAWMA could appoint large waste recyclers as authorized plastic waste recyclers for various regions. The authorized recyclers shall be responsible for end to end plastic waste management in their region. Through these initiatives – cost can be reduced to \$ 200 per ton of PP waste and assuming a conversion rate of 85% and potential losses of 5% during transportation – the cost at the factory gate works out to be USD 248 per ton.

- Business as usual (BAU) scenario: Currently the cost of collection and transportation of PP waste is high due to: (a) the lack of segregation at source leads to mixing of the PP and PE waste which is difficult to separate at the stage of resin production. The lack of source segregation is leading to underutilized management of PP waste (b) The size of household PP waste varies which (Different products such as plates, basins, buckets, furniture etc.) which is difficult to compact and leads to increased transportation costs and (c) Crushing operations require reliable and uninterrupted electricity supply which is constrained in Nigeria. The cost of electricity augments the cost of producing the recycled resin. Due to this, the cost of PP waste is around 240 USD per ton and assuming a conversion rate of 85% and potential losses of 5% during transportation – the cost at the factory gate works out to be USD 297 per ton.

Electricity Cost:

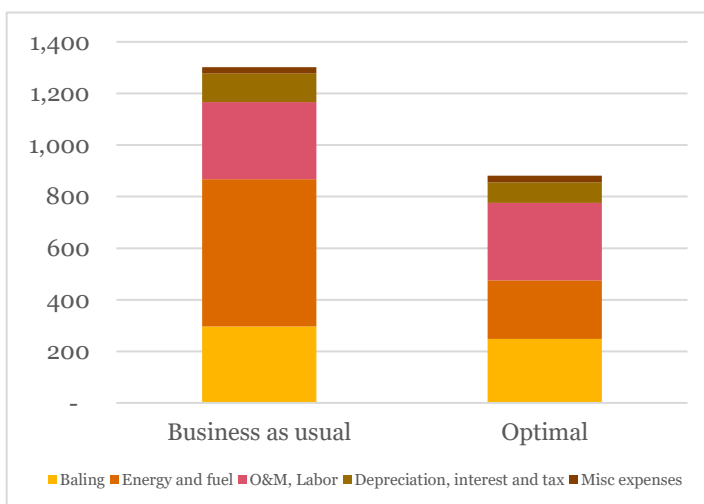
Electricity cost in Nigeria can range from 0.1 USD/kwh to 0.25 USD/kwh. The lower cost of energy corresponds to the use of captive gas based power plants which represents the optimal scenario. The extensive use of diesel generator to offset the sporadic and lengthy power outages will increase the energy cost to 0.25 USD/kWh which represents the BAU scenario

Financing cost:

Due to high upfront investment costs, the financing cost contribute significantly to the cost of recycling. In Nigeria, the interest costs range from 12% to 20%, with the scenarios depicting the variances below:

- Optimal scenario: Established companies like Sona Group, with their strong balance sheets may receive balance sheet financing at very competitive rates like 10%-14%.
- Business as usual scenario: The other small and medium companies may get traditional project financing at normal rates of 16% to 20%.

The levelized cost of the recycled PP household article production for both the scenarios has been compared to the cost of virgin PP household item import price (\$/ton) to determine the competitiveness of the use of recycled PP household articles (\$/ton). Compared to virgin resin price which ranges between USD 1200 to USD 1400 per ton, only the projects which can be taken up under the gambit of the optimal scenario are economically viable. The scalability of the program will depend on the convergence of the BAU scenario and the optimal scenario for which the starting point will be an enabling and robust solid waste management framework which should be coupled with access to energy and cheaper finance.



4.1.3.4. Enabling environment for scalability

For ensuring scalability following conditions need to be ensured:

1. Subsidies and other financial incentives for collectors
2. Utilizing decentralized waste management to reduce the collection cost
3. Authorization of plastic waste recyclers

Government could devise Providing subsidies and other financial incentives for the collectors to install Automated sorting machines and crushing systems. Utilizing Decentralized waste management to reduce the collection costs: State agencies such as LAWMA could appoint large waste recyclers as authorized plastic waste

recyclers for various regions. The authorized recyclers shall be responsible for end to end plastic waste management in their region.

4.2. Long term Opportunities

The immediate opportunities could be leveraged using mechanical recycling techniques. However, chemical recycling could offer long term opportunities. Circularity Opportunities such as use of Multi-Layer Packaging (MLP) to Sachet production, PP to oil which are piloted in other geographies are discussed in this chapter. Unilever can be partnered for MLP to Sachet while BASF is keen to explore the potential of PP to oil. However, the scalability of these projects will be limited.

Oil from PP waste

BASF has aimed to reduce the environmental impact caused by plastics waste entering drains and the Atlantic Ocean, leveraging on strong collaboration of public, private and civil society partners. To achieve this commitment the company has developed a Waste-2-Chemicals project which focusses on recycling plastic waste to produce Syngas or Oils.

The pilot project has been launched in Nigeria. The project will deploy 3 micro recycling hubs for plastic waste by 2021. These hubs will be able to recycle about 5-10 tons of plastic waste per day [each hub]. This will pave the way for the establishment of 50-60 micro hubs then set up by local governments, NGOs, social entrepreneurs, able to recycle up to 100,000 metric tons out of the 750,000 metric tons per annum of plastics waste generated in Lagos per annum. The initiative can also contribute to create 12,500 to 15,000 jobs by 2025.

The commercial feasibility of the project will depend upon the advancement of technologies in order to produce consistent high-quality pyrolysis oil. Recognition of this process in the industrial policies (or related) ones will also increase the uptake of this technology. To scale the collection, collaboration at local waste collections system level and focus on emerging technologies in waste collection and recycling infrastructure is crucial.

MLP to MLP

Due to lack of viable recycling technology and no off-takers of MLP waste, it ends up in landfill. These wastes are predominant in Nigeria as well. In a long run, brands can collaborate to collect these sachet waste and produce new ones from the recovered waste. At present, Unilever has developed a new technology to reduce (MLP) multi layered packaging sachet waste. In case of MLP sachets, ~60% of the layers consist of Polyethylene (PE). In 2017, Unilever introduced a new technology - CreaSolv® process in association with the Fraunhofer Institute. It recovers plastic from the sachet, to create new sachets for Unilever products. This technology uses material recycling process to recover the plastic from the sachet and produces new sachets from the recovered plastic. CreaSolve requires one-sixth of energy to recover PE as required to produce of one kilo of virgin polymer. A pilot plant of 3 tons sachet waste per day was set up in Indonesia to test the long-term commercial viability of the technology.

The commercial feasibility of the project depends on access to **high volumes of waste and the presence of reliable collection** systems in place. To scale-up the collection, collaboration at local waste collections system level and focus on emerging technologies in waste collection and recycling infrastructure is crucial.

5. Recommendations

Enabling circularity of plastic sector offers multiple benefits to government, private players, customers and citizens. It increases the resource utilization, reduces the costs of production, and decreases the burden of end of life waste management while increasing the employment. However, despite the interest by several private players, the extent of circularity in plastics sector is not up to the potential. To boost plastic recycling sector various interventions at policy level and private sector level are required.

5.1. Policy level interventions

These interventions require support from government bodies and think tanks for formulation and implementation. Key policy interventions are discussed here.

5.1.1. Strengthening the EPR system

As discussed in a preceding chapter, EPR is a key enabler for encouraging circularity of plastics. Following changes in the EPR policy are recommended:

- Recycling targets for various sectors should clearly defined. Year-wise targets for different type of plastics could be defined depending on the recyclability of polymer and service life of the product.
- Standards (including labelling) for plastic recycling could be defined. This shall ensure ease of segregation resulting in better end-life management of various plastic polymers. (A draft for preparation of such standards and labels are under consideration.)
- The EPR framework focuses on utilizing PRO's for efficient plastic waste collection. PRO's are normally sector wide organizations which control the collection and recycling waste. Currently Food & Beverage Recycling Alliance (FBRA) is the only registered PRO in Nigeria. FBRA focuses on managing the collection of only PET waste. Absence of PRO's for other plastic waste streams (PP, PE, PVC) as well as lack of wider database of PRO's is impeding the envisaged scalability of the managed plastic waste collection system in Nigeria. Enabling multiple PRO's will also alleviate social non-compliance and EHS, occupational health and safety concerns at the collection centers.
- The deposit scheme in the EPR framework can be utilized to incentivize the door to door collection. Currently, **Delayed collection of household solid waste** – in some cases by couple of weeks; creating the contamination of the waste as well as constraining the development of formal collection system. Lack of adequate infrastructure facilities such as bins and transportation facilities is constraining the collection of waste by the regulatory authorities. The enhanced door to door collection system enabled by the EPR can address the problem of source segregation as well as the on-time collection of the waste.
- Enhance end management – define strategies for different plastic waste
 - Co-processing of MLPs
 - Phased ban of MLP
 - Recycling of recyclable content in plastic products

In addition, the implementation of EPR could be enhanced by:

- Registration of manufacturers before goods are first put into circulation should be made mandatory in a phased manner.
- Online real time platforms shall be used to track data on the quantities, types of packaging as well as the mass flow verifications.
- 3rd Party verification for the registered quantities would enhance compliance with the regulations.

5.1.2. Enhancing the financial efficiency

Cost of capital is a significant contributor to the cost of production of recycled resin. Nigeria has one of the highest lending rates when compared against some of the African and Asian economies.

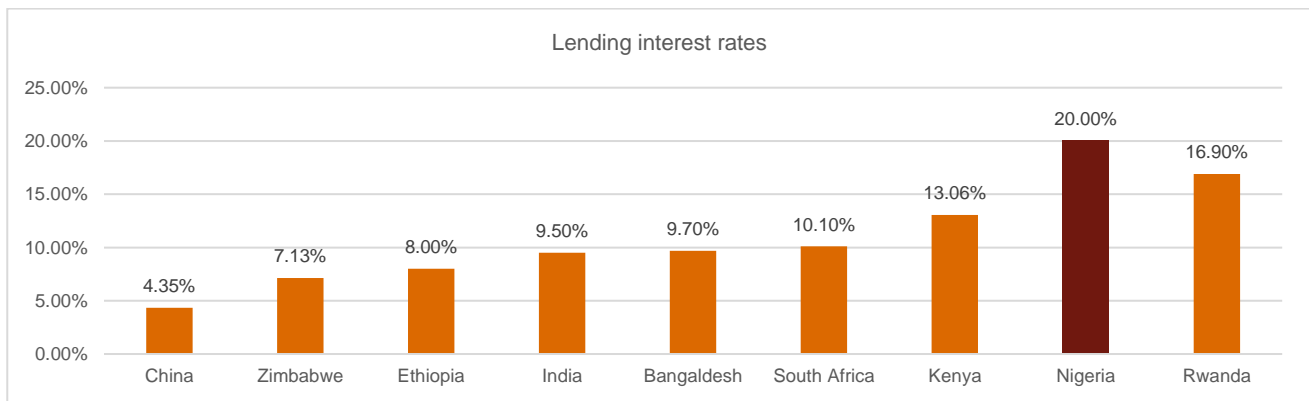


Figure 19: Comparison of lending rates

Considering this, access to finance could be a key enabler in enhancing circularity of plastics. Various financial mechanisms that can be adopted to facilitate establishment of recycling sector include:

- Refinancing schemes through various green financing mechanisms. Green financing could include various measures such as lower interest rates on machinery for recycling, higher moratorium periods, relaxed collateral requirements and working capital loans.
- Tax exemptions on capital investments in recycling infrastructure
- Accelerated depreciation
- Tax exemption provisions on capital gains from the transfer of shares of public limited companies listed with a stock exchange
- Reduction on import duty of recycling machinery

5.1.3. Decentralized waste management

Utilizing decentralized waste management to reduce the collection costs, GHG emissions and lead times. In a decentralized waste management system, key regions that have enough waste generation and demand need to be identified. Such regions need to be developed such that the waste of the region could be recycled to products locally. State agencies such as LAWMA could appoint large waste recyclers as authorized plastic waste recyclers for various regions. The authorized recyclers shall be responsible for end to end plastic waste management in their region.

5.1.4. Inclusion of Guidelines for labelling

One of the challenges faced by plastic recycling industry is segregation of plastic as per the properties of recyclable material. The manufactured plastic products should be labelled as per standard guidelines for ease of identification of plastic. Guidelines for identification shall be based on:

- **Identification of basic raw materials:** The standard symbols as per Society of Plastics Industry, USA could be used to identify basic raw material
- **Source of waste or scrap:** Letter codes could be used to designate source
- **Density and Melt Flow Rate:** Classification codes which specify the specific gravity and melt flow rate of recycled polymer shall be developed and used for designating
- **Material detail:** Numeric codes to identify addition of colorants or additives
- **Filler material and ash content:** Letter codes shall be used to identify filler material such as Boron, Carbon etc. Ash content and filler material content could be expressed in percentage form
- **Physical form:** Designation to differentiate granules, scales and flakes



5.1.5. Incubation of testing facilities

The use of recycled polymers in the plastic manufacturing requires testing and accreditation based on internationally acceptable standards such as UL 746D. The testing and accreditation is performed on parameters such as tensile strength, Flammability, Impact Strength, Heat Deflection Temperature, Dielectric Strength, color etc.

Currently, Nigeria does not have accredited testing laboratories for testing of the parameters required by international standards. The absence of testing facilities in Nigeria will result in additional cost for the manufactures to send the samples overseas for the testing and accreditation and thereby eroding the profit margins.

For the scalability of the circularity program, it is recommended that testing and accreditation facilities be incubated.

5.2. Private sector interventions

These interventions require efforts from private sector – individually or collectively.

5.2.1. Collaborative platforms for uptake of recycled plastic

Many of the business models in recycling require significant economies of scale. This requires availability of necessary supply and demand dynamics. Collaborative platforms composed of brands, industrial plastic buyers, plastic recyclers and associations could establish contracts to ensure sufficient raw material and off take is guaranteed.

- a. Brands and packaging manufacturers to have access to off-takers contracts
- b. Packaging manufacturers to assure availability of recycled plastic while brands guarantee off-take

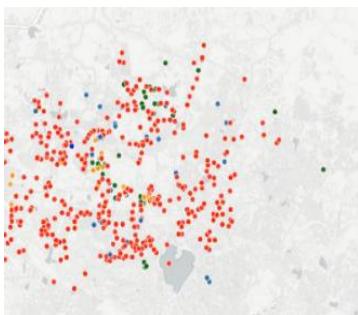
In addition, a key hindrance restricting the uptake of recycled plastic product is the quality of recycled product among the application industries. The uptake of recycled plastic products could be increased by

- a. Establishing quality standards backed by reputed brands
- b. Awareness raising campaigns
- c. Setting targets on usage of recycled PSF
- d. Technology transfer for manufacture of high grade recycled material.

Collaborative platforms composed of brands, industrial plastic buyers, plastic recyclers and associations could establish common quality standards for recycled polymers.

5.2.2. Development of market and ecosystem for plastic waste management

Nigeria lacks real time data on plastic waste. Using a Smart Waste IoT platform, real time data on plastic waste generation could be generated. Data analytics can provide market intelligence for developing a plastic waste ecosystem.



The unorganized sector network could be integrated using mobile and cloud technology. It could develop a real time map of plastic scrap suppliers along with trade data. In

addition, it shall serve as a base for setting a circular economy on the concept of Industry 4.0 which is elaborated.

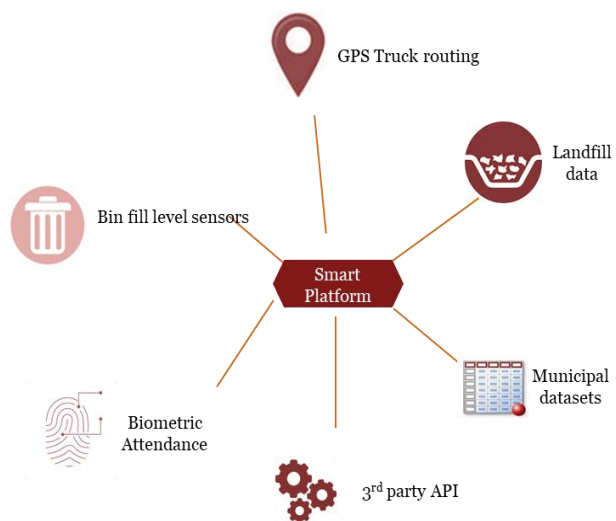


Figure 20: Smart IOT Platform

5.2.3. Automated segregation and sorting technologies

Currently the plastic waste is not segregated at source due to lack of regulations. The plastic waste is segregated manually as it moves along the value chain of baba abiba, plastic scrap dealers and the plastic recyclers. This results in increased costs of operations. Automatic segregation techniques could be used in large plastic recycling plants to lower the operational costs and improve quality.

Automatic waste segregation machines make use of a variety of sorting means to separate various types of plastics such as PET, HDPE, PP etc. and other material out from supplied waste to the maximum extent. At the same time, the separated waste materials can be further re-processed into useful resources if obtained in required volumes.

Advanced technology such as advanced metal separators are required for effective and efficient sorting of plastic waste.

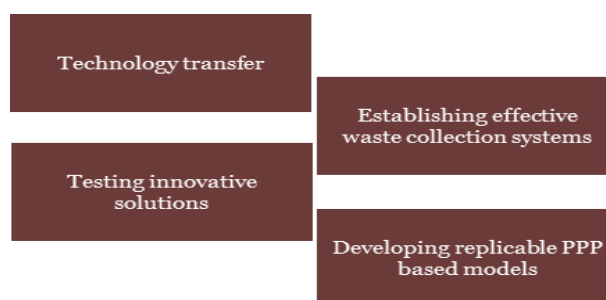
- Sesotecs **Rapid Pro sense metal separator K 2016** could reliably detect and separate magnetic and non-magnetic metal particles from plastics
- Sesotecs **Flake Purifier+ sorting system** has sensors for metal separation, sensors for color separation/sorting, and sensors for the separation and sorting by plastic types



Figure 21: Rapid Pro sense metal separator K 2016

5.2.4. Developing PPP framework

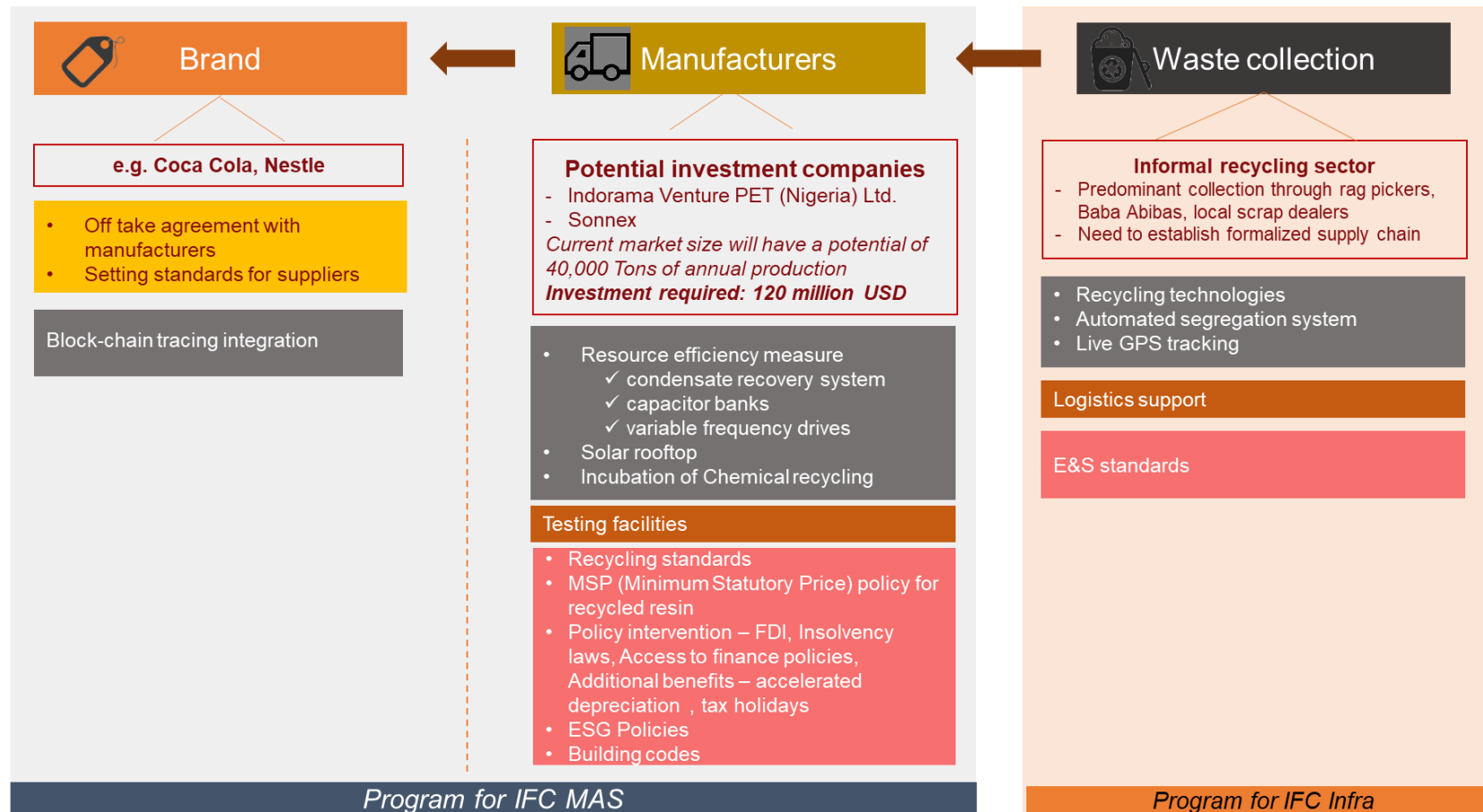
Innovative investment models are required in recovery and recycling facilities via Joint Ventures or other collaborative deal structures with private players such as waste collectors, recyclers, user industry etc. **Developing Public Private Partnership framework for recycling and waste collection could foster the innovation and technology transfer from private entities for increase in the efficiency of the recycling operations.**



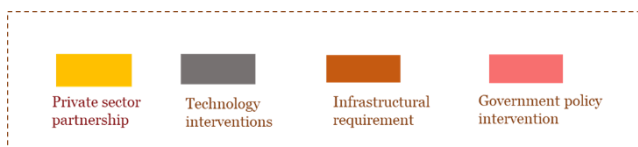
For the successful incubation and spur the growth of the circularity, IFC should initially create a program for PET bottle to bottle circularity which will constitute an ecosystem of partners including (a) the brands sourcing from Nigeria such as Coca Cola, Nestle (b) suppliers of the brands such as Sonnex, Indorama and (c) collection system.

The effective design of the program will require concentrated efforts from all the stakeholders and will also require collaborative cross-cutting platform to be created to ensure the implementation of the vision.

Partnership program of IFC with brands such as Coca Cola



Legend:



Annexures

1. Assumptions and calculations – PET to PET recycling

General information		
P&M investment	20,000,000	USD
Production	20	ton/day
Annual production	6800	TPA

Input requirements		
Raw material (PET baling)	1.43	ton/ton
Electricity	1920	kwh per hour
	16588800	kwh per annum
Water	20	m3 per hour
	172800	m3 per annum
Skilled workforce	15	person
Unskilled workforce	135	person

Market information		USD
Raw material (PET baling)	160 – 220	USD/ton
Electricity	0.1 – 0.25	USD/kwh
Water	0.97	USD/m3
Skilled worker wages	115	USD/month
Unskilled worker wages	50	USD/month

2. Assumptions– PET Waste to recycled PSF

General information		
P&M investment	15 Million – 20 Million	USD
Annual production	20,000	TPA
Input requirements		
Raw material (PET baling)	1.11	ton/ton
Electricity	4000	kwh per hour
	34560000	kwh per annum
Water	25	m3 per hour
	216000	m3 per annum
Skilled workforce	30	person
Unskilled workforce	250	person
Market information		USD
Raw material (PET Flakes)	300 - 360	USD/ton
Electricity	0.1 – 0.25	USD/kwh
Water	0.97	USD/m3
Skilled worker wages	113	USD/month
Unskilled worker wages	49.76	USD/month

3. Assumptions– PP waste to household plastic

General information

P&M investment	10-15 Million	USD
Production	40	ton/day

Input requirements

PP waste	1.33	ton/ton
Electricity	10050	kwh per hour
	86832000	kwh per annum
Water	15	m3 per hour
	129600	m3 per annum
Skilled workforce	500	person
Unskilled workforce	2300	person

Market information

USD

Raw material (PP Waste)	200-240	USD/ton
Electricity	0.1-0.25	USD/kwh
Water	0.97	USD/m3
Skilled worker wages	113	USD/month
Unskilled worker wages	49.76	USD/month
