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Development of a waste stream-specific roadmap for the circular economy Zambia

Activity 5.2:
Pilot Business Plan. A decentralized integrated waste-transfer station (DIWRS)

Date 26 April 2022

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Number of pages	30 (incl. appendices)
Number of appendices	4
Sponsor	
Project name	
Project number	

Contents

1 Background

This pilot business plan services as deliverable for activity 5.2 and focusses on defining the pilot concept, economic activities, position in the value chain, impact, rough budget calculations[1], identification of potential partners and assessment criteria to choose a location and partner, as well as performance indicators to measure success. The pilot business plan is not a feasibility study in itself, but a scoping study. Budget calculations are based on rough estimates to indicate the total costs. No implementation party will be chosen since this often needs to follow a strict and transparent procurement procedure. However, criteria will be defined to guide in making such a choice. The same holds for the pilot's location, which closely relates to the chosen implementation partner. The pilot business plan will provide a great starting point for a feasibility study.

The pilot business plan was developed in collaboration with a Technical Committee consisting of members from various government bodies and verified with stakeholders from practice. This report documents its findings and presents the chosen pilot concept: A Decentralized Integrated Waste-transfer and Recycling Station (DIWRS). The report first describes what a DIWRS is (section 1), and then proposes a phased approach for implementation to spread risks and focus on viability (section 2). In section 3 the business model and the first order financial analysis to assess the pilot’s financial viability are presented. Section 4 discusses the impact of the pilot and section 5 presents assessment criteria to choose a location and implementation partner as well as propose performance indicators to measure the pilot’s success. Lastly, section 6 gives the conclusions of the pilot business plan.

[1] Note that this was not part of the initial scope of this project, as per the Technical Assistance, but the consultants added it nonetheless since a rough estimate is essential to assess viability.

2 Description

Out of six pilot concepts, see Appendix H, the Technical Committee choose the Decentralized Integrated Waste-transfer and Recycling, in short DIWRS, as the pilot concept. A DIWRS combines four type of roles: (i) a buy back centre, (ii) a waste transfer station, (iii) a value addition facility, and (iv) a recycling facility. A DIWRS fulfils an essential role in the waste management system of Zambia where collection rates are low (<60% in urban areas, virtually non-existent in rural areas) and scaling of formal collection on the short term is challenging due to funding. A DIWRS provides informal waste collectors, public and private collectors, and individual households with a decentralized local alternative for waste disposal. In this way, a DIWRS provides a clear aggregation point for the whole value network. For households, a DIWRS is a point where they can bring their unseparated waste to or sell their separated waste to, thus providing them with an alternative to illegal dumping if collection services are not available (or cannot be afforded). For collection services (public, private, informal) the DIWRS provides them with a local solution to dispose their waste, that does not involve covering large transport distances. Lastly, for recyclers and processors a DIWRS provides them with a central point to buy materials at a fixed price that have already undergone some value addition steps, reinforcing the recycling sector and easing the recycling process for them.

In this way a DIWRS reduces the waste that ends up at legal and illegal dumpsites, since waste that has value is processed. Only waste that does not have value anymore, or of which value extraction is difficult, ends up at waste disposal sites. The decentralized character of a DIWRS also helps to reduce transport distances, since waste is managed within the community. Only after value addition steps, materials are transported over longer distances, but by this time there is more value to be extracted thus the prices for the materials are higher, which means the costs of transport is easier to bear.

2.1 How it works

In a DIWRS *separated materials* are repurchased from collectors of all levels (e.g., informal waste pickers, private collectors, small aggregators, public collectors) and from households. Additionally, collectors can discard their *unseparated waste* for a fee. This waste is then separated using both manual and mechanical separation techniques. Households can also discard their *unseparated waste* for a fee or for free, depending on income level or incentive structure necessary to prevent illegal dumping. However, if households separate, they can sell their materials, so there is an incentive to separate.

The DIWRS separates all unseparated waste and aggregates waste per waste type and characteristic (polymer type and colour in the case of plastics, colour in case of glass). This is done using a conveyor belt combined with manual labour to allow for efficient separation and better working conditions than fully manual separation. Depending on the level of advancement within the DIWRS, the DIWRS now has a few options:

1) Sell separated materials to the recycling industry or export. This means selling a low-value product at relatively low tariffs. In this case, the centre functions as a classical Waste Transfer Station.
2) Do value addition activities for each waste stream (e.g. for plastics: baling, washing, or shredding, for glass: crushing), and then sell to the recycling industry or export. This means trading a medium value product at an increased tariff.
3) Do low- or medium-tech recycling within the DIWRS. In the case of plastics, this could entail the production of household products or construction materials. Examples for the other waste streams could be composting of organics or making recycled paper bags out of paper. Depending on volumes, the products are sold within the community or via other outlets. This means trading a high-value product at a higher tariff.

The waste that cannot be separated or has no value should be brought to a waste disposal site, preferably an engineered landfill. It could also be possible to work with small-scale incinerators to process the non-recyclables.

In this way, a DIWRS fulfils a vital role in connecting collectors to recyclers and processors. The DIWRS also fulfils an important role in awareness creation within a community, and it reduces waste-to-landfill, waste transport distances and costs. Households without collection services now have an opportunity to get rid of their waste in an environmentally friendly manner, and if they separate, get something in return for it. The value addition steps ensure that not all value is exported out of Zambia or ends up at the recycler, but is distributed along the value chain. In this way, a DIWRS promotes scaling of the waste valorisation industry, since it will increase volumes for recyclers, and makes sure that waste pickers and aggregators get more value for their materials. A visualization of the actors participating in the value chain of a DIWRS can be seen in Appendix A.

2.2 The phases

To decrease the risk and costs, as well as address aforementioned challenges and giving the DIWRS the time to set up properly, a phased approach is proposed as visualized in Appendix B. Each phase comes with different investment needs, partnership opportunities, levels of necessary community involvement, operational costs, challenges and revenue streams. The end goal is a fully decentralized integrated waste transfer station, which handles all waste streams and does value addition steps and recycling for each waste stream. However, organizing this successfully will take time. It is important that each step has a viable business model in itself and that the concept is proven before expansion towards all waste streams. Therefore, the pilot business plan will focus on successful implementation of phase 1 and phase 2, which will be discussed in more detail in the following section. This will also guarantee that the pilot focusses on plastics, which has been the chosen waste stream to focus on by the NDE and critical stakeholders.

3 Pilot Plan: implement phase 1 and 2

3.1 Phase 1: Plastic Buy Back Centre with value addition (0-1 years)

What?

In phase 1, the focus is on setting up an economically viable plastic buy back centre (PBBC). The plastic buy-back centre buys back different polymer types either separated or unseparated from the informal and formal sector. The price paid for plastics depends on the polymer type, currently the market prices for plastic bought from collectors are approximately the following (depending on quality, cleanliness and timing):

- PET: 1-2 ZMW[2]/kg
- HDPE: 4-8 ZMW/kg
- PP: 4-10 ZMW/kg
- LDPE: 2-4 ZMW/kg

If this plastic is aggregated and sold to the recycling industry directly, prices only increase by approximately 1-2 ZMW per kg. Thus, the margins are small. However, various value addition steps can be done per polymer type, which can increase the value when selling to the processing industry with 3 ZMW per kg.

For **PET,** there is not a sufficient domestic market within Zambia yet, therefore exporting to South-Africa should be the first objective of the pilot. For the highest value per bale the label (LDPE) and cap (HDPE) should be removed. This can be done manually. When the domestic market for PET develops, other value addition steps such as washing and shredding can be considered. Then the separation of label and cap can be automated via salt-bath separation after the bottle is washed and shredded. Note that such a salt bath can only separate PET from HDPE/PP/LDPE. Separation of these streams would require another type of bath. However, due to high investment costs versus the low labour prices, this is only attractive in case of very large quantities of PET.

For **HDPE and PP,** there is a well-developed domestic market within Zambia. For **LDPE,** there is also a domestic market within Zambia, albeit smaller than for HDPE and PP. For all three plastic polymer types various recyclers compete to buy HDPE, PP and LDPE since the supply is low due to separation, collection and aggregation issues. HDPE, PP and LDPE are worth more if it is already washed and shredded, with a purity of above 90%. This means that the washed plastic shreds contain a maximum of 10% contamination of soil, other polymer types or other forms of impurifications. The washing can take place by relatively rudimentary methods using manual labour, or by more capital-intensive methods using fully automated washing systems. The plastics should then be dried by a low temperature oven (60-80 ◦C) or in the open air, this prevents the plastic shreds from being wet and heavy (which adds 30-40% to their net weight, increasing transport costs). The shreds are then bulked and sold to the processing industry. These are the first value addition steps to focus on in the pilot. This process is visualized in Appendix C.

The same machines for washing and shredding could be used for all polymer types. Separation can take place either before or after the shredding and washing process. Separation after can be done by a salt separation system that separates the shreds based on polymer type. Note that such a salt bath can only separate PET from HDPE/PP/LDPE and is quite costly. Separation of these remaining streams (HDPE/PP and LDPE) would require another type of bath. Therefore it will be omitted from this pilot business plan. The other option is to separate by polymer type before washing. Note that although

[2] ZMW = Zambian Kwacha. 1ZMW=0.059USD

collectors usually sell separated polymer types to a PBBC, there is always some impurity due to mixed materials. This then needs to be further separated manually using a conveyer belt; when volumes increase more advanced mechanisms can be used for separation. An important topic to raise concerning washing of plastics, is that it should be based on a closed water system, meaning that water is filtered and recycled to reduce pressure on water availability. The same would go for the separation baths, if these are deployed.

Who?

The PBBC will be operated by social enterprise, an NGO or foundation, in order to be eligible for external funding. The pilot could be an extension of existing organizations operating a PBBC, such as Manja Pamodzi, which is a community-based initiative supported by Zambian Breweries plc, National Breweries and Heinrich's Syndicated and has a partnership with the Lusaka City Council, and has 11 PBBCs in 11 communities in Lusaka (with approximately 350kg of plastic processed per PBBC per week). In Livingstone, there is Keli Clean-Up, a waste transfer station collecting, aggregating, and selling plastics, paper, glass, and metal, with very large amounts of plastics processed weekly (up to 9000kg). Currently, there is not much recycling industry in Livingstone, so materials are mainly sold to South-Africa or Lusaka, resulting in high transportation costs. There is also Plastics for Change in Chililabombwe, which is a network of plastic-collection centres in Zambia. In other cities there might be similar initiatives to build upon. A local entrepreneur will thus manage the day-to-day operation of the PBBC, preferably a woman, from within the community the PBBC is set in.

There needs to be a network of collectors that bring in mixed or separated plastics for a fee (higher for separated plastics) to allow for the raw material. To encourage this, among other things, a strategic partnership should be formed with the City Council and Ministry of Local Authorities. This partnership can then help with: (i) arranging land and permits, and (ii) City Council can request the separated collection of plastics by their own public collectors and contracted private collectors.

The community needs to be involved in the pilot to make sure there is willingness to separate plastics from other waste to allow for separated collection and awareness of the possibility of separating per polymer type and selling plastic waste to the PBBC.

A network of recyclers per polymer type needs to be set up in order to sell the washed, shredded, dried and certified plastic polymer types to the recycling industry. Possibly interested parties for the shredded materials include: M&F Manufacturing (manufacturing of finished goods from recycled materials) and Noor Plastic Industries (manufacture plastic products such as buckets, brooms, plastic kitchen utensils, duct pans and refuse bins).

Where?

To minimize transport distances and incentivize households to separate plastics, the PBBC should be set in a distinct urban zone. Since the pilot is a phased approach leading to a full DIWRS, there should be enough space to expand. Additionally, there should be electricity available and a shed or other simple building where value addition and low-tech recycling can take place.

3.2 Phase 2: Expand with Low- or Medium-Tech Recycling (1-3 years)

What?

In phase 2, the focus is on expanding the PBBC with Low- or Medium-Tech Recycling (LTR or MTR) steps. Depending on the level of funding and the success and scale of the first phase of the pilot, various recycling options exist per polymer type. Depending on polymer type, different products can be produced with different techniques.

For **all polymer types,** there are various LTR/MTR routes possible, depending on available budget and volumes as well as the market in 3 years. The lowest tech and low-cost form of recycling is making plastic bricks and pavers from plastics. A large advantage of this is that it can combine all different types of plastics, including multi-materials that are now very difficult to recycle. To make plastic bricks and pavers one simply needs to melt the plastic shreds, mix them with stone dust (ratio 1:3), put them in a mould, and let them cool down.

PET is usually recycled back into PET bottles, or downcycled into thick-walled products. Since there is currently not really a domestic market for recycled PET bottles, the pilot will not include recycling steps for PET.

For **HDPE and PP,** recycling into products that will not contain food (no food-grade products) are easiest due to the avoidance of regulatory restrictions. Products such as brims or plates or other household hardware can be produced with an extruder and an injection mould.

For **LDPE,** plastic bags could be made, which require a blow mould. It is also possible to produce thin film plastics for industrial or agricultural use, however, this requires a more expensive weaver. Yet, in comparison a mould consumes more energy than a weaver. Another advantage of a weaver is higher production volumes. Moreover, as LDPE is generally a bit more difficult to recycle it could also be processed into bricks (potentially in combination with currently non-recyclable multimaterial plastics).
For the non-recyclable materials, there are three options: bringing this to the dumpsite or landfill, to an incinerator, or accumulating the right volumes for sales to a cement kiln, of which there are six in Zambia.

Who?

Expanding the PBBC to include LTR/MTR, requires some extra responsibilities per actor and the necessity to add some actors:

- For the organization of the PBBC it means an expansion in terms of processes, labour, and thus personnel.
- Nothing changes for the relationship with collectors, the partnership with government bodies, and the community.
- For the recyclers something does change, since the PBBC will now do LTR/MTR less products will be sold to the recycling industry.
- A new actor group that is needed are market actors. Products made need to be sold to customers to make a profit. Depending on the quantity of the products produced this can be sales directly to the wholesale market, via local shops or to the community. Thus, depending on the product and targeted outlet, a network of actors needs to be established that are interested in selling the products.

Where?

The location of the LTR/MTR is the same as that of the PBBC. This is why it is important to have land of sufficient size to allow for expansion.

4 Business Model and Financial Plan

4.1 Business Model

This section discusses the proposed business model for the first two phases of the DIWRS: a plastic buy back centre with value addition steps (phase 1) ánd low- or medium-tech recycling (phase 2). The business model is based on the insights from previous project activities, field work, various financial calculations and the feedback of the Technical Committee members.

In phase 1 the pilot works with several business models simultaneously, to get sufficient supply of plastics, and to sell the processed plastics to the right customers. The pilot needs to experiment with several types of business models, to understand what works in the context of Zambia. For the plastics input, the pilot follows a standard buy-back business model, where customers bring plastics to the PBBC, where the plastics are weight and the collectors receive a fixed price for the plastics, which can be Kwacha, airtime or other products of value to the collectors. Other types of business models used in phase 1 involve offering free waste collection to those who separate their waste. In order to implement such a business model, willingness and close collaboration with the local authorities is essential. For the output of the plastics, i.e. the sales of washed and sorted plastic shreds, the pilot follows a standard product-based business model. The product is sold for a fixed price per tonne, depending on the plastic polymer type.

In phase 2, the plastic input business model does not change, but the plastic output business model does. Instead of selling shreds to recyclers, the pilot will use (part of) the shreds to manufacture its own basic plastic products, which are then sold to customers within Zambia.

4.2 Financial Plan for Phase 1: Plastic Buy Back Centre with value addition

The financial forecast should be perceived as a rough first order forecast, since a full feasibility study and cash-flow analysis is not part of the scope of this project. However, it is important to already make some rough calculations, to gain insights in the viability of the pilot and the volumes necessary. First the financial calculations are presented in 3.2.1, then in the following subsection (3.2.3) the assumptions on which the financial calculations are based, will be discussed.

4.2.1 *Financial analysis*

The financial analysis shows that the economic viability of the pilot is largely dependent on the scale. If the pilot focusses on one community, then collection of 1,5 tonne of plastics per week, equivalent to the plastics of 1200 households, will be realistic. However, as shown in Appendix H, first order rough budget calculations illustrate that without subsidy or other financial incentives the annual revenue streams of this option barely cover the operational costs (OPEX). The annual revenue will not be enough to support the initial investment costs (CAPEX). Thus, the revenues cannot justify the costs of the equipment, e.g. washers, shredders, sorters. The equipment used to do value addition steps can process 1 tonne of plastic per day. To justify the costs of the equipment to do value addition steps, roughly 2% of all plastics generated in Lusaka[3] needs to be collected within one community: 6 tonnes per week. In a country where there is limited overall collection and low separated collection, this seems highly unlikely.

Thus, scaling is essential. When considering increasing the assumed plastic stream, one needs to assess the viability of acquiring a larger amount of plastic waste within just one community. To address the issue of scale and the challenges that come with collection, two directions are possible, largely

[3] Note that Lusaka is taken as an example to illustrate the pilot size. The location of the pilot has not been chosen.

dependent on the chosen location and implementation partner. The first direction is to work with organizations that process large amounts of plastics weekly. There are cities within Zambia where organizations exist that collect large amounts of plastic per week. For example, Keli Clean-up in Livingstone processes 9 tonnes of plastic per week. They have only one facility, which is a waste transfer station that also processes metal and paper, just outside of Livingstone. These are sufficient volumes for financially feasible value addition steps, as is shown Appendices D. The second direction is to work with multiple PBBCs throughout a city and with one central place where all the PBBCs can take their plastics to, to do value addition activities in phase 1 and low- or medium-tech recycling in phase 2. Each PBBC can then aim for collection of 1 tonne per week, and transport the plastics to the larger site where value addition steps are done, i.e. sorting, washing, shredding and baling. This system can then be expanded with low- and medium-tech recycling taking place at the larger site only. Also here, this setup is financially feasible, as is shown Appendices E. An example of an organization who has multiple PBBCs on strategic locations throughout a city is Manja Pamodzi, which is operating 11 PBBCs throughout Lusaka. Their model could be expanded with value addition steps and low- or medium-tech recycling.

In conclusion, the financial calculations presented in Appendix D and E show that the revenue streams for both options are higher than the OPEX, thus the pilot is financially viable. With the profit made, part of the CAPEX investments can be paid off. Or the prices for purchase of plastics can be increased to increase the wage of the waste pickers that bring in plastics, therefore contributing to better livelihoods for waste pickers. Instead of paying waste pickers per kg, the DIWRS can also hire waste pickers to formalize their jobs and improve their livelihoods. To cover the CAPEX costs, donor funding is advised. Opportunities for donor funding can be found in 3.4.

Additionally, there are some other options to increase the revenue streams, therefore creating more value which can be distributed among the upstream value chain and can assist to increase collection rates:

- If combined with EPR Regulations, the pilot will plugin and register as a producer responsibility organization (PRO) for plastics. This would diversify the revenue streams, since plastic manufacturers can support the PBBC’s financially to comply with EPR.
- A strategic partnership with the targeted City Council who will simultaneously invest in collection and separated collection.
- In the situation with multiple PBBC, one of the six PBBC can be placed in close proximity to the main dumpsite of the chosen city, this provides informal waste pickers with a clear outlet for their raw material. This will reduce pressure on collection mechanisms.

4.2.2 *Adopted Assumptions*

Financial calculations are based on assumptions to determine the scope of pilot, cost of investment and the projection of revenues. These calculations illustrate the basis for estimating pilot expenditure. The biggest determent for financial viability of the pilot is the scale in terms of volumes of plastic waste received. The initial assumption as agreed upon with key stakeholders are:

- The project assumes that the pilot will be established in a distinct urban zone.
- The pilot will make two assumptions about the generation of plastic waste.
    - First, the situation is analysed where 2% of the plastic waste generated in Lusaka is processed by one PBBC that does value addition. Since Lusaka produces 107,220 tons of waste each year, of which 14% are plastics, plastic accounts for about 15,010 tons according to Lusaka City Council and the waste characterisation study done in activity 2 of this project. The assumed 2% of this results in 300 tonnes of plastic, thus 6 tonnes a week approximately.
    - Second, the situation is analysed where there will be six PBBCs, each collecting roughly 1 tonne of plastics per week. Each PBBC will be established within a community. The intention will be to leverage the available asset (land) within the

community and reduce the costs that would have been incurred in collection. In this case, there will be one larger site on a strategic location where value addition activities will be done, this will from now on be called the Value Addition Site (VAS). In phase two this is expanded with Low- and Medium-Tech Recycling (LTR/MTR).

- The pilot assumes that shreds raise the price with 3K/kg compared to the prices for the unwashed and unshredded raw material.
- The pilot assumes that 75% of the plastics will be bought back against market prices, as mentioned in section 2. The other 25% will come from separated public collection.
- The pilot anticipates that the local authority will support the pilot's setup and engagement with waste pickers and aggregators.
- The market for recycled plastic products will grow, and firms will begin to use recycled material in their packaging.
- The country's policies will provide an enabling environment to support the pilot's sustainability and stimulate extension, as expected under the phased approach.
- The pilot assumes that the market prices for plastic will be stable.

4.3 Financial Plan for Phase 2: Expand with Low- or Medium-Tech Recycling

Appendix F shows the CAPEX and OPEX costs for inclusion of low- or medium-tech recycling, under the assumption that 6 tonnes of plastic per week is collected, resulting in 312 tonnes of plastic per year. The revenues depend greatly on the product made, and what product is best suited for the market in Zambia should be determined during a feasibility study. Therefore the revenue streams are not included in the financial analysis for phase 2. Note that the same land as in phase 1 will be used, so no need to acquire this extra.

4.4 Funding Opportunities

An assessment of funding opportunities was carried out, to identify opportunities that fit the defined pilot. These opportunities are highlighted below:

Infraco - Infraco supports infrastructure projects with finance and expertise, allowing them to go from an early concept to a bankable investment possibility to a sustainable functioning business. The approach is to collaborate with projects from their early stages, either directly if they already have an experienced lead developer, or through their teams to give on-the-ground project development knowledge. Infraco also provides equity to support the building of ground-breaking projects or innovative infrastructure enterprises that need to scale up or demonstrate economic viability in order to attract more investment. Based on the financing structure, the businesses would take advantage of equity financing. This would change the business model from an envisioned public entity to a private entity.

The **Africa Enterprise Challenge Fund (AECF)** is an African development funder that encourages innovative commercial enterprises in order to eliminate rural poverty, build resilient communities, and create jobs through private sector growth. The AECF has invested over $392 million to date and provides catalytic funding and technical support to entrepreneurs in 26 Sub-Saharan African countries by investing in enterprises that struggle to meet normal risk-return rules for commercial investors.

European Investment Bank (EIB) is looking out for ideas that will prevent plastic waste from entering rivers, lakes and oceans or from being dumped in the environment. To qualify, initiatives must demonstrate efficient and effective methods of minimizing plastic waste or microplastics discharge. The European Investment Bank, in collaboration with the French and German development banks Agence Française de Développement (AFD) and KfW, started the initiative in October 2018 with the goal of investing €2 billion in projects that reduce plastic waste by the end of 2023.

The **Alliance to End Plastic Waste:** Since 2019, the Alliance to End Plastic Waste has brought together over 90-member firms, project partners, allies, and supporters dedicated to the elimination of plastic waste in the environment. The partnership brings a varied network of resources and experience together. Technical leaders, engineers, scientists, and practitioners collaborate to develop and grow new solutions all around the world. The goal is to achieve transformative change and eliminate plastic waste in the environment by collaboration with policymakers, non-governmental organizations, and local communities. The alliance has committed more than $1.0 billion, with a target of investing $1.5 billion over the next five years to develop, deploy, and scale solutions to reduce and manage plastic waste, as well as to promote post-use solutions.

Repurpose is a global coalition of people and businesses devoted to decreasing waste, revitalizing lives, and restoring nature's balance. Through a plastic credit system, Repurpose assists businesses in becoming plastic-free. Plastic credit finance enables businesses to create new waste management infrastructure and supply chains where none previously existed. This includes the entire system, e.g. collection networks, sorting facilities, and recycling.

5 Impact

This section assesses the impact of the pilot business plan on four areas; institutional, environmental, economic, and social impact.

Areas of Impact	Description
Institutional	Plastic production and (some forms of) plastic disposal emit greenhouse gases, which contribute to climate change. According to current trends, greenhouse gas emissions from the global plastics sector are expected to account for 15% of the global yearly carbon budget by 2050. The proposed pilot will reduce such emissions since it stimulates replacement of virgin polymers with existing materials. Therefore contributing to the targets of Zambia for emission reduction. Additionally, the pilot provides a system that can be used in support of an EPR mechanism. For EPR to be implemented, producers need to have an efficient way of collecting and recycling the plastics, which does not necessarily have to be done by themselves individually. By already setting up such pilots, EPR mechanisms will be easier to implement later on.
Environmental	Plastic waste is seldom recycled. A large portion of it is burned, or ends up in open dumpsites where it can take up to 1,000 years to degrade. Plastic litter may also leach toxic chemicals into the soil, which can eventually contaminate groundwater or other nearby water sources. Microplastics can also interact with soil fauna, influencing their health. Animals are severely harmed by plastic litter because they swallow it, producing clogs in their respiratory systems and stomachs. Additionally, the soil functions are damaged by plastic littering. Implementation of the pilot will contribute to the reduction of plastic disposal to illegal and open dumpsites by enhancing the collection and recycling and will thus lower these negative environmental impacts. In terms of GHG impacts, the DIWRS will process a plastic flow of 6 tonnes per week in the first two phases, this results in a plastic waste flow of 6*52*1=312 tonnes per year, resulting in a projected CO_2 reduction of 6*26,000[4]= 156,000 kg CO_2 = 156 tCO_2 per year. For detailed information of the calculations the reader is referred to the closure report of this project.
Economic	Plastic waste has the ability to clog drains, sewers, and rivers, hence increasing the danger, frequency, and severity of flooding. As a result, infrastructure is harmed, productivity is lost as a result of job interruptions, and human health is threatened. Reducing this blockage from plastic litter is expected to greatly reduce these negative effects. This will thus also increase the productivity of the labour force and contribute to GDP growth.
Social impact	The pilot is envisioned to support the formalization of waste pickers and creation of jobs for the youth. The formalization to some extent will create dignified jobs by providing a safe working environment. Providing an opportunity for an alternative source of livelihood is anticipated to increase the ability to spend for

[4] Zheng, J., & Suh, S. (2019). Strategies to reduce the global carbon footprint of plastics. *Nature Climate Change*, *9*(5), 374-378.

	the waste picker hence create a ripple effect in the number of families that can support their children to go to school.

6 Assessment and Performance indicators

6.1 Assessment criteria for implementation partner and location

Instead of setting up a plastic buy back centre from scratch then adding low- or medium-tech recycling and expanding to other waste streams, one could also work with existing organizations operating similar facilities. Advantages of this are that the pilot can rely on an existing network of collectors and recyclers to buy waste from and sell materials to. Additionally, labour forces are already there and the organization already has a more or less sustainable business model in place. Building on an existing organization does mean that the organization chosen needs to be able to support the various phases of the pilot concept. Therefore assessment criteria are formulated on both organization and location, to guide the decision on an implementation organization:

- Location needs to have sufficient land available to expand activities to include other waste streams and value addition steps as well as low tech recycling.
- Location needs to have access to electricity and water to do value addition activities which often need electricity and water (e.g. shredding, baling, washing).
- Location needs to be in an urban area where there is sufficient waste available and that is accessible for collection services (proper roads). Preferably there is already some collection in the area.
- Location needs to be in a community that is willing to experiment with separation at source.
- Organization needs to have solid network of collectors and focus at least partly on plastic household waste.
- Organization needs to have ties to processing and recycling industry to sell separated materials.
- Organization needs to be willing to prioritize plastic waste stream during the first years of the pilot.
- Preferably the organization does already collaborate with the local authorities such as the city council to stimulate separation and collection.
- Preferably the organization already does some value addition steps to the plastic waste stream.

Several potential organizations have been identified that could provide a good starting point to look for an implementation organization. Note that this is not an exhaustive list. Some we were able to contact to get basic information on their business, but many have not responded and should be contacted during a feasibility study to assess their willingness and potential. The potential implementation organizations identified are:

1) Manja Pamodzi – Lusaka
   Runs eleven plastic waste buy back centres in different parts of Lusaka. Their model is based on a local entrepreneur managing the facility and informal collectors bringing plastic waste, which is then sold to aggregators. Most facilities do not have access to electricity or water and no value addition activities are conducted.
2) Separation at Source – Lusaka
3) Plastics for Change – Chililabombwe
4) Keli Clean-Up – Livingstone
   Runs a waste transfer station just outside of Livingstone. Informal and formal collectors can bring separated plastic, paper, glass and metal waste to their facility where it is further separated into specific types, baled and exported. The facility does have access to electricity and some value addition activities are conducted such as baling.

6.2 Performance indicators to track pilot success

To evaluate whether the pilot is performing as expected it is important to determine some Key Performance Indicators (KPI's). For the several processes in the pilot different KPI's are relevant.

Starting with collection, it is important to keep track of the collection rate, meaning the percentage of collection compared to the estimated total waste (or in specific plastic waste) in the targeted community. This helps to get an understanding of the efficiency of collection and which potential volumes are still available. The total cost of acquiring all the plastics is also an important KPI, this again helps to get an understanding whether resources, are put in place effectively. Additionally, assessing the number of collection zones, number of collectors and their volumes helps to get an understanding whether collection is organised properly. These indicators help to see where there is still potential to enhance collection. A gender balance KPI is important to assess the number of women that benefit from the pilot in all levels of the value chain. Additionally the income and quality of life for waste pickers need to be included to monitor if the pilot actually stimulates better livelihoods for the upstream value chain.
Regarding processing of the plastics it is important to monitor the recycling rate, i.e. the rate of recycling shows the amount that is recycled compared to the total amount of waste that is available. Assessing the costs and benefits of recycling indicate the profitability of the process which is important to assess to sustain operation. Further, it is relevant to define KPI's that assess what happens to the waste that cannot be recycled. The last dimension is the economic viability. For this the most important indicator is if the yearly revenues can cover the OPEX costs, and what margin is still left after OPEX, i.e. the nett profit made.

7 Conclusion

This report has presented the pilot business plan: A Decentralized Integrated Waste-transfer and Recycling Station for five household waste streams. The pilot business plan proposed a phased approach to spread investment risks and allowing for time to set up collection and processing networks for each waste stream before continuing to the next.

The financial analysis for phase 1 shows that an economically viable pilot is possible, if sufficient volumes can be achieved. Therefore the pilot business plan advises to work with an existing organization that already processes large volumes of plastics (more than 6 tonnes) or to set up six PBBCs, that can later be expanded to include other waste streams, and one central location where value addition and recycling can take place. Each of these PBBCs can then be set in a distinct community or close to a large open dumpsite. In this way the PBBCs are close to the generation point, therefore minimizing transport distances and costs. The financial analysis also shows that value addition does result in more value to be distributed among the upstream part of the value chain. A profit of 40.000 USD is expected every year. This could be reinvested in increasing the money paid to informal waste pickers to increase their livelihoods, or to hire informal waste collectors who will then receive training and equipment from the DIWRS.

The financial analysis for phase 2 shows that the additional investment costs (CAPEX) are similar to the CAPEX of phase 1. However, the revenue made will most likely be higher since a product is made from the recycled plastics. Thus, instead of selling processed raw materials to the recycling industry, a product is sold to consumers via the wholesale market, shops or the community.

After all four phases of the pilot have been executed successfully, the pilot concept can be replicated throughout Zambia. The potential to replicate throughout Zambia depends on potential buyers, i.e. at this moment there is not enough recycling done in Zambia to largely scale a DIWRS and much will need to be exported which raises the costs. However, stimulation of recycling for each of the waste streams can help in the viability. For example, if local plastic recycling can be stimulated then this can increase the demand for plastics. The potential increase in quality of life for the upstream value chain is closely related with the scale the pilot can be replicated on and the amount of value each DIWRS can generate after scale-up. Policy reform, such as EPR or a minimum content requirement in the case of plastics for recycled plastics in plastic products, can help to replicate the pilot throughout Zambia, since it will increase the demand and profit margin when sold to recyclers.

The first step in the role out of such a pilot, is conducting a thorough feasibility study in which the location, implementation organization and supporting actors will be mobilized. The feasibility study should also focus on assessing what numbers of plastic waste are realistic to receive from a community weekly, since the scale is essential for the economic viability of the pilot. Building on existing organizations is a good way forward. These organization already have a network of (in)formal collectors and recyclers. They also already have a facility, investment costs will then mainly focus on increasing the infrastructure and adding value addition and recycling equipment.

A Appendix A

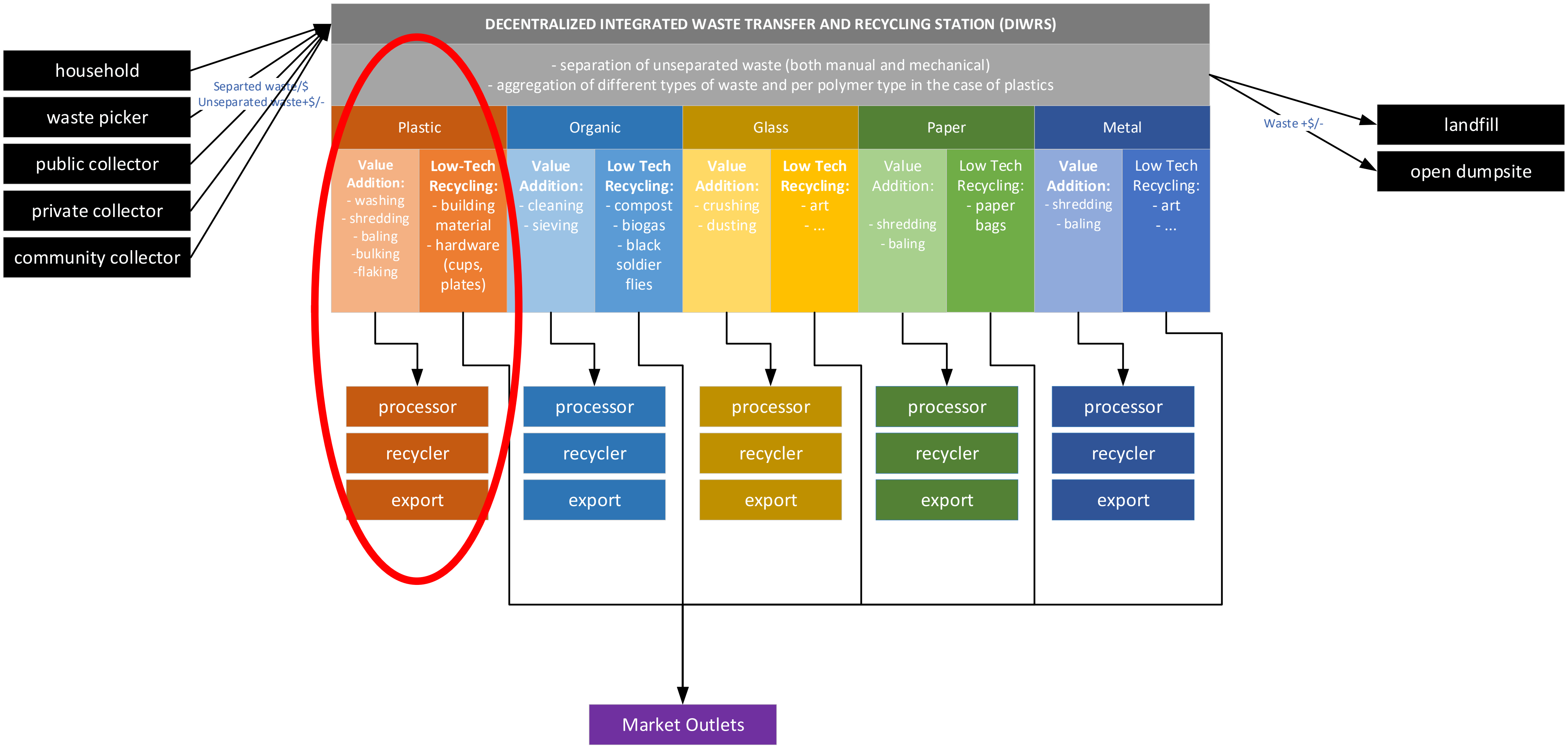

Figure 1: graphic visualization of actor network and functions of a full decentralized integrated waste transfer and recycling station (DIWRS), in red the first two phases are circled.

B Appendix B

Phase 1: Plastic Buy Back Centre with value addition (0-1 years)

- buy back plastic polymer types from all forms of collectors (i.e. informal, formal, households)
- bale, bulk, shrade, flake and/or wash (i.e. value addition)
- sell to recycling indsutry or export

Phase 2: Expand with Low-Tech Recycling (1-3 years)

- when volumes of certain plastic polymer types are large enough, expand with Low and Medium-Tech Recycling
- could be construction material (e.g. poles, pipes) or building material (e.g. pavers, bricks) or household hardware (e.g. cups, plates)
- depending on choice of products, an extruder and moulds are necessary

Phase 3: Include other waste streams (3-5 years)

- expand the service to include buy back of other waste streams (i.e. paper, organics, metal and glass)
- expand with accepting unseparated waste, separate and aggregate this
- dispose waste that does not have any value anymore in disposal sites (preferably a landfill)

Phase 4: Include value addition and Low-Tech Recycling for all (3-10 years)

- include value addition steps for the other waste streams as well, this could be crushing glass, shredding paper and metals, baling it and so on
- include low or medium tech recycling for other waste streams, this could be composting for organics, making paper bags from old paper and so on

Figure 2: phased approach of Decentralized Integrated Waste Transfer Station (DIWS)

C Appendix C

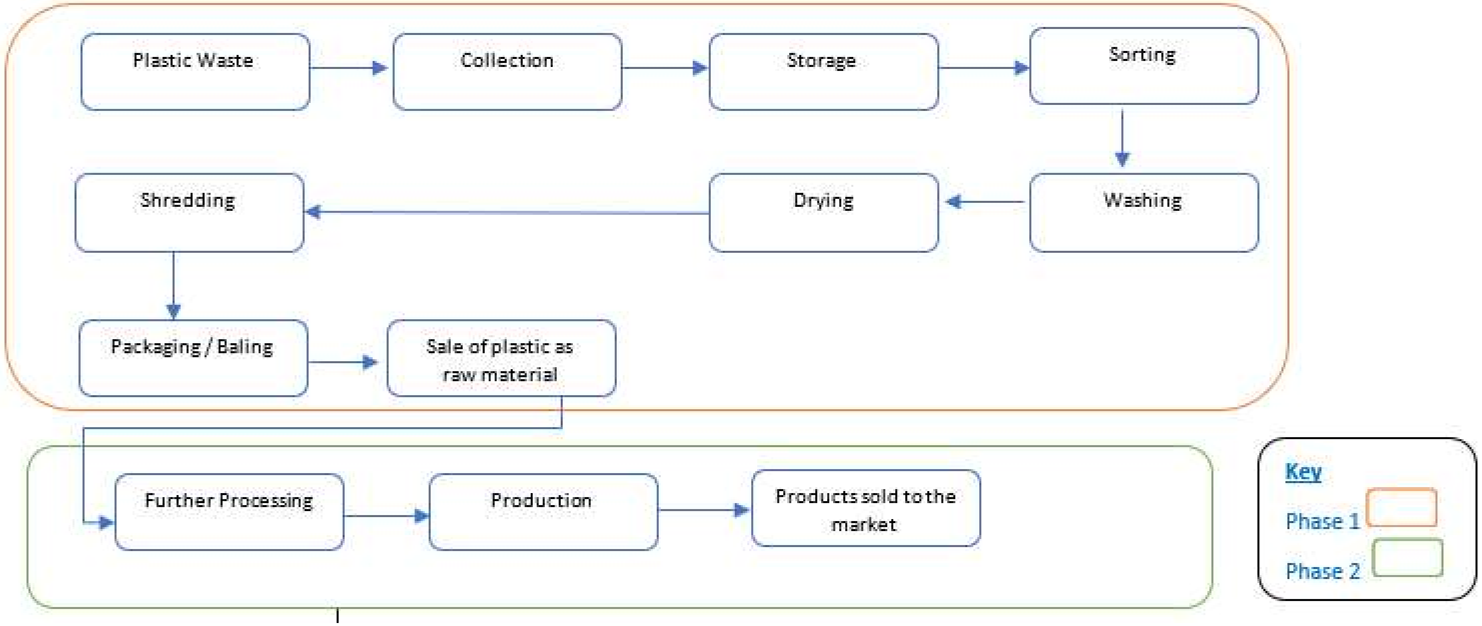

Figure 3: Production Process Flow Chart for phase 1 and 2

D Phase 1 - one PBBC that does value addition on site (6 tonnes per week)

TABLE 1: CAPITAL EXPENDITURES (CAPEX) AND OPERATIONAL EXPENDITURES (OPEX) FOR ONE PLASTIC BUYBACK CENTRE PROCESSING 6 TONNES PER WEEK

Item	Total (USD)
Washing line[5]	20,000-30,000
Plastic Scrap Flakes Colour Sorter	20,000-35,000
Waste Plastic Baler[6] (2)	12,000-16,000
Sorting Conveyor belt[7] (2)	12,000- 16,000
Storage Facility/Office (400 ft)	15,000-20,000
Loader[10] (2)	10,000-15,000
Plastic Shredder[11] (2)	12,000-15,000
Ventilation System (2)	500- 1,000
Weighing scale[12] (2)	500-1,000
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	4,000- 5,000
Other	5,000-7,000
Total CAPEX	**131,000-191,000**

Item	Annual Cost (USD)
Facility	
Facility, leasing of land	3,000-5,000
Facility costs (water, electricity, etc.) machine	4,000-5,000
Minimum Staff[8]	
Operator[9] (2)	7,000-9,000
Administrator (1)	4,000-5,000
Casuals (5)	15,000-20,000
Operations	
Purchase of plastics[13]	65,000-75,000
Machine Maintenance	6,500-9,000
Large storage bags[14]	2,500-3,500
Total OPEX	**107,000-131,500**

[5] https://aceretech.en.made-in-china.com/product/edRfQWBMZlUS/China-Aceretech-Plastic-Waste-Recycling-Washing-Line-Machine.html

[6] https://www.alibaba.com/product-detail/Waste-Paper-Cardboard-Plastic-Horizontal-Scrap_60710675531.html?spm=a2700.galleryofferlist.normal_offer.d_image.76022440prLCxb

[7] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhIQD3&s=p

[8] Staff cost estimates are based on the salary surveys in Zambia: https://www.paylab.com/zm/salaryinfo

[9] https://www.paylab.com/zm/salaryinfo/car-industry/machine-operator?search=1&lang=en

[10] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb

[11] https://www.plasticcrushmachine.com/sale-16351285-ce-approved-tyrone-double-shaft-shredder-industrial-mini-plastic-shredder-machine-for-cardboard.html

[12] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p

[13] Assumption (30 tonnes per week) with a price of $56 per tonne

[14] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

TABLE 2: REVENUE STREAMS PER ANNUM (312 TONNES PER ANNUM)

PRODUCTS	MARKET PRICE (DISCOUNTED)	UNIT (TONNES)	TOTALS
Baled PET Bottles	200	42	8,400
HDPE Flakes	570	120	68,400
PP Flakes	570	90	51,300
LDPE Flakes	342	60	20,520
	TOTAL	**312**	**148,620**

E Phase 1 - six PBBCs (each collects 1 tonne per week) and one Value Addition Centre on a central location

TABLE 3: CAPITAL EXPENDITURES (CAPEX) FOR THE SIX PLASTIC BUY BACK CENTRES THAT EACH PROCESS 1 TONNE PER WEEK AND CAPEX FOR THE VALUE ADDITION CENTRE

Item	Total (USD)
Sorting Conveyor belt[15]	6,000-8,000
Storage Facility/Office (40 ft container)	7,000-9,000
Loader[17]	5,000-8,000
Weighing scale[19]	250-500
Office Equipment, Furniture	1,000-2,000
Other	1,000-2,000
CAPEX	**20,250-29,500**
times six for each of the PBBCs	
Total CAPEX	**121,500-177,000**

Item	Total (USD)
Washing line[16]	20,000-30,000
Plastic Scrap Flakes Colour Sorter	20,000-35,000
Waste Plastic Baler[18] (2)	12,000-16,000
Storage Facility/Office (400 ft)	15,000-20,000
Loader[20]	5,000-8,000
Plastic Shredder[21] (2)	12,000-15,000
Ventilation System	250-500
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	1,000-2,000
Other	5,000-7,000
Total CAPEX	**110,250-163,500**

[15] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhIQD3&s=p
[16] https://aceretech.en.made-in-china.com/product/edRfQWBMZlUS/China-Aceretech-Plastic-Waste-Recycling-Washing-Line-Machine.html
[17] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb
[18] https://www.alibaba.com/product-detail/Waste-Paper-Cardboard-Plastic-Horizontal-Scrap_60710675531.html?spm=a2700.galleryofferlist.normal_offer.d_image.76022440prLCxb
[19] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p
[20] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb
[21] https://www.plasticcrushmachine.com/sale-16351285-ce-approved-tyrone-double-shaft-shredder-industrial-mini-plastic-shredder-machine-for-cardboard.html

TABLE 4: OPERATIONAL EXPENDITURES (OPEX) FOR THE PLASTIC BUY BACK CENTRE AND OPEX FOR THE VALUE ADDITION CENTRE

Item	Annual Cost (USD)
Facility	
Land lease	*free*
Staff[22]	
Staff (2)	2,000-4,000
Operations	
Purchase of plastics	10,000-12,500
Large storage bags[25]	500-1,000
OPEX	**12,500-17,500**
times six for number of PBBCs	
Total OPEX	**75,000-105,000**

Item	Annual Cost (USD)
Facility	
Facility costs (water, electricity, etc.) machine	4,000-5,000
Land lease	3,000-4,000
Minimum Staff[23]	
Operator[24] (2)	7,000-9,000
Administrator (1)	4,000-5,000
Casuals (3)	9,000-12,000
Operations	
Machine Maintenance	4,000-6,000
Large storage bags[26]	1,000-2,000
Total OPEX	**32,000-43,000**

TABLE 5: REVENUE STREAMS PER ANNUM (6 TONNES PER WEEK, 312 TONNES PER YEAR)

Products	Market Price (Discounted in USD/tonne)	Unit (Tonnes)	Totals (USD)
Baled PET Bottles	200	42	8,400
HDPE Flakes	570	120	68,400
PP Flakes	570	90	51,300
LDPE Flakes	342	60	20,520
	TOTAL	**312**	**148,620**

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22 Staff cost estimates are based on the salary surveys in Zambia: https://www.paylab.com/mw/salaryinfo/

23 Staff cost estimates are based on the salary surveys in Zambia: https://www.paylab.com/zm/salaryinfo

24 https://www.paylab.com/zm/salaryinfo/car-industry/machine-operator?search=1&lang=en

25 https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

26 https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

F Phase 2 – Medium-tech recycling

TABLE 6: CAPITAL EXPENDITURES (CAPEX) AND OPERATIONAL EXPENDITURES (OPEX) FOR INCLUSION OF MEDIUM-TECH RECYCLING

Item	Total (USD)
Injection Moulding Machine[27]	4,000-8,000
Wood Plastic WPC Machine[28]	35,000-45,000
Plastic Bag Extruder[29]	15,000-20,000
HDPE Pelletizing Machine[30]	42,000-45,000
Storage Facility/Office (40 ft container)	7,000-9,000
Garbage Truck[33]	20,000-30,000
Operations Vehicle (1-ton)	20,000-30,000
Total CAPEX	**143,000-187,000**

Item	Annual Cost (USD)
Facility	
Facility costs (water, electricity, etc.) machine	5,000-6,500
Machine Operators	
Operator[31] (2)	7,000-9,000
Administrator[32] (1)	4,000-5,000
Casuals (5)	15,000-20,000
Operations	
Machine Maintenance	7,500-10,000
Large storage bags[34]	2,500-3,500
Total OPEX	**41,000-54,000**

[27] https://www.alibaba.com/product-detail/Cheap-china-reliable-plastic-fruit-vegetable_1600183757435.html?spm=a2700.details.0.0.78082a0az1snUQ
[28] https://www.alibaba.com/product-detail/WPC-profile-machine-for-making-WPC_62014369383.html?spm=a2700.galleryofferlist.normal_offer.d_title.3b4cc1dbWmSU8x
[29] https://www.alibaba.com/product-detail/High-output-PE-HDPE-LDPE-plastic_60665583224.html?spm=a2700.galleryofferlist.normal_offer.d_title.7645557aWn3oge
[30] https://www.alibaba.com/product-detail/Machine-Hdpe-Ldpe-Pelletizing-Plastic-Pe_1600337757273.html?spm=a2700.galleryofferlist.topad_creative.d_title.35f64b7927ytS2
[31] https://www.paylab.com/zm/salaryinfo/car-industry/machine-operator?search=1&lang=en
[32] https://www.paylab.com/zm/salaryinfo/general-labour?lang=en
[33] https://www.alibaba.com/product-detail/New-or-used-dongfeng-4-2_1600345160218.html?spm=a2700.galleryofferlist.normal_offer.d_title.790b64feyRJUaH
[34] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

G Phase 1 – one PBBC that does value addition on site (1,5 tonne per week)

Tables 7 and 8 show the CAPEX and OPEX costs for the plastic buy back centre, under the assumption that 1,5 tonne of plastic per week is collected, resulting in 78 tonnes of plastic per year. Table 9 shows the revenues in this situation.

TABLE 7: CAPITAL EXPENDITURES (CAPEX) FOR THE PLASTIC BUYBACK CENTRE THAT PROCESSES 1,5 TONNE PER WEEK IN TOTAL

Item	Total (USD)
Washing line[35]	20,000-30,000
Plastic Scrap Flakes Colour Sorter	20,000-35,000
Waste Plastic Baler[36]	6,000-8,000
Sorting Conveyor belt[37]	6,000-8,000
Storage Facility/Office (40 ft container)[38]	7,000-9,000
Loader[39]	5,000-8,000
Plastic Shredder[40]	6,000-8,000
Ventilation System	500-1,000
Weighing scale[41]	500-1,000
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	1,000-2,000
Other	2,000-3,000
Total CAPEX	**94,000-143,000**

[35] https://aceretech.en.made-in-china.com/product/edRfQWBMZlUS/China-Aceretech-Plastic-Waste-Recycling-Washing-Line-Machine.html
[36] https://www.alibaba.com/product-detail/Waste-Paper-Cardboard-Plastic-Horizontal-Scrap_60710675531.html?spm=a2700.galleryofferlist.normal_offer.d_image.76022440prLCxb
[37] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhIQD3&s=p
[38] https://www.alibaba.com/product-detail/Shenzhen-40ft-container-with-sea-freight_698203571.html?spm=a2700.details.0.0.5bc54446uxH53w
[39] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb
[40] https://www.plasticcrushmachine.com/sale-16351285-ce-approved-tyrone-double-shaft-shredder-industrial-mini-plastic-shredder-machine-for-cardboard.html
[41] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p

TABLE 8: OPERATIONAL EXPENDITURES (OPEX) FOR THE PLASTIC BUYBACK CENTRE

Item	Annual Cost (USD)
Facility	
Facility, leasing of land	2,000-3,000[42]
Facility costs (water, electricity, etc.) machine	4,000-5,000
Minimum Staff[43]	
Waste Control Office	3,000-4,800
Machine Operators	
Operator (1)	3,500-4,500
Administrator (1)	4,000-5,000
Casuals (2)	6,000-8,000
Operations	
Purchase of plastics[44]	15,000-18,000
Machine Maintenance	3,000-4,000
Large storage bags[45]	1,000-2,000
Total OPEX	**41,500-54,300**

[42] https://centralestates.org/commercial_property
[43] Staff cost estimates are based on the salary surveys in Zambia: https://www.paylab.com/zm/salaryinfo
[44] Assumption (30 tonnes per week) with a price of $56 per tonne
[45] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

TABLE 9: REVENUE STREAMS PER ANNUM (1,5 TONNE PER WEEK= 78 TONNES PER ANNUM)[46]

PRODUCTS	MARKET PRICE (USD)	UNIT (TONNES)	TOTALS (USD)
Baled PET Bottles	200	10,5	2,100
HDPE Flakes	570	30	17,100
PP Flakes	570	22,5	12,825
LDPE Flakes	342	15	5,130
	TOTAL	**78**	**37,155**

[46] Prices are an estimation and are still being verified by recyclers

H Appendix H

Plastic Buy Back Center (PBBC)	•Buy back plastics from informal sector, public and private separated collection and (small) aggregators for fixed tariffs •Sell to recycling industry •**AND** do some value addition activities such as balling, washing or shredding
Decentralized Integrated Waste Station (DIWS)	•Link between collection services and recycling industry •Informal, public and private collectors can sell separated waste or dump mixed waste for a fee •DIWS separates, aggregates and sells to recycling industry •**AND** value addition activities such as balling, washing or shredding
Plastics Innovation Space	•Innovation space for plastic start-ups that provide land, plastics (so close to a BBC, WTS or dumpsite), on site washer, shredder and melter for collective use •Stimulate cross-learning •Access to capital
Subsidized inter-city transport	•Business case for waste collection and valorization is very difficult in smaller cities outside Lusaka •Subsidized inter-city transport could stimulate plastic collection and separation in other cities
Low-tech recycling	•Setting up a low tech plastic recycling facility in another city where there is no plastic recycling yet, such as Livingstone •Helps in creating opportunities for plastic valorization within the area and reduces waste-to-landfill
Combination	•A combination of either of the above mentioned pilots

I Appendix I

Scoping Study – April 2022	Who?
- Executed by TNO as part of the CTCN Technical Assistance. - Focused on defining a pilot business plan which is a pre-feasibility study	TNO with support from ZEMA and Ministry of Technology and Science
Tender Process – May-September 2022	**Who?**
- Choosing implementation partners and a location. Without this it is impossible to execute a meaningful feasibility study - Tender should focus on a consortium consisting of an implementation organization for the DIWRS that adheres to the criteria in section 5.1, and a committed city council that has the capacity and willingness to support a pilot in terms of land availability, permits and improving collection infrastructure. Based on insights scoping study. - Before a process can be tendered, the relevant ministries need to decide on what will be offered during the tender. There should be a clear plan, and the offered resources should be clear (e.g. will there be funding, or in-kind contributions from the ministries as support)	ZEMA and Ministry of Local Government and Rural Development, with support of Ministry of Technology and Science. Potentially also support from consultant
Feasibility Study – November 2022-March 2023	**Who?**
- Focus on defining targeted communities, realistic volumes, setting up a collection network and recycler network that are interested in buying the processed materials - Focus on which business models are best suited for the targeted community and location to guarantee volumes for input - Identify and start collaborating with other value chain actors that will be critical during implementation - Develop detailed plan for phased role out of pilot building on the existing scoping study	Consultant supported by implementation consortium, ZEMA, Ministry of Local Government and Rural Development, and Ministry of Technology and Science
Implementation – From April 2023	**Who?**
- Implementation in phases, following the feasibility study	Implementation consortium, with support from ZEMA, Ministry of Local Government and Rural Development, and Ministry of Technology and Science