Radarweg 60
1043 NT Amsterdam
The Netherlands

www.tno.nl

T +31 88 866 50 10

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

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

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Author(s)	Milou Derks Chandi Mutubuki Makuyana Andrew Chinyepe Ebenezer Alenga Amadi Naomi Montenegro Navarro Raymond Obare Ombega Paul van den Oosterkamp Dennis Kiplagat
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Contents

1 Background

This pilot business plan services as deliverable for activity 5.2 and focuses on defining the pilot concept, economic activities, position in the value chain, impact, rough budget calculations, identification of potential partners and performance indicators to choose a location and partner, as well as to measure success. The pilot business plan is not a feasibility study in itself, but should be seen as a pre-feasibility study. Budget calculations are based on rough estimates to give an indication about the total costs of a pilot. No implementation party will be chosen, since this often needs to follow a strict and transparent procurement procedure. However, criteria will be defined that help guide making such a choice. The same holds for the location of the pilot, which is closely related to the chosen implementation partner. The pilot business plan will thus 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 Station (DIWS). The report first describes what a DIWS is (section 1), proposes a phased approach for implementation to spread risks and focus on viability (section 2). In section 3 the business model and some first financial calculations 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.

2 Description

Out of six pilot concepts, (see Appendix G), the Technical Committee choose the Decentralized Integrated Waste-transfer Station with the option to include low- and medium-tech recycling, in short DIWS, as the pilot concept. A DIWS 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 DIWS fulfils an essential role in the waste management system of Malawi where collection rates are low (<30% in urban areas, virtually non-existent in rural areas) and scaling of formal collection on the short term is challenging due to funding. A DIWS provides informal waste collectors, public and private collectors, and individual households with a decentralized local alternative for waste disposal. In this way, a DIWS provides a clear aggregation point for the whole value network. For households a DIWS 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 DIWS provides them with a local solution to dispose of their waste, that does not involve covering large transport distances. Lastly, for recyclers and processors a DIWS 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 DIWS 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 DIWS 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 DIWS *separated materials* are bought back from collectors of all levels (e.g. informal waste pickers, private collectors, small aggregators, public collectors) and from households. Additionally, collectors can dispose their *unseparated waste* for a fee. This waste is then separated using both manual and mechanical separation techniques. Households can also dispose 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 DIWS then separates all unseparated waste and aggregates waste per waste type and characteristic, if necessary (e.g. polymer type and colour in the case of plastics, or glass per colour). Waste that cannot be processed or is hazardous is removed from the waste stream. This is done by using a conveyor belt in combination with manual labour. Using a conveyer belt allows for efficient separation and better working conditions than only manual separation. Depending on the level of advancement within the DIWS, the DIWS now has a few options:

1) Sell separated materials to the processing and 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 to the separated materials (e.g. for plastics this could be baling, cleaning and washing or shredding), and then sell to the processing and recycling industry or export. This means selling a medium value product at an increased tariff. An optional activity could be to install low- and medium-tech recycling technologies at the DIWS, to allow some recycling and value addition as well.

The waste that cannot be separated or that does not have any value anymore, can be disposed at 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 DIWS fulfils an important role connecting collectors to recyclers and processors. The DIWS also fulfils an important role of awareness creating within a community and it reduced waste-to-landfill as well as 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 make sure that not all value is exported out of Malawi or ends up at the recycler, but instead is being distributed along the value chain. A visualization of the actors needed to implement a DIWS can be seen in Appendix A. Note that an optional step can be to do low- and medium-tech recycling instead of value addition steps. This requires higher equipment investment, high numbers of raw materials and clear market outlets.

2.2 The phases

To decrease the risk and costs, as well as address aforementioned challenges and giving the DIWS 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 optional 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 include a first draft for phase 2, which will be discussed in more detail in the following section.

3 Pilot: implement phase 1 and 2

3.1 Phase 1: Plastic Buy Back Centre with value addition (0-2 years)

What?

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

- PET: 100 MWK[1]/kg,
- PP: 400-600 MWK/kg,
- LDPE: 200-400 MWK/kg,
- HDPE: 400-600 MWK/kg.

If this plastic is then aggregated and sold to the recycling industry directly, prices only increase by 100MWK per kg approximately. Thus, the margins are small. However, there are various value addition steps that can be done per polymer type, that can increase the value when selling to the recycling industry.

For **PET,** there is not really a domestic market within Malawi yet, thus baling the PET and exporting to South-Africa should be the first objective of the pilot. For the highest value per bale, it is important that the label (LDPE) and cap (HDPE) are 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 take place via salt-bath separation after the bottle is washed and shredded.

For **HDPE and PP,** there is a well-developed domestic market within Malawi. For **LDPE,** there is also a domestic market within Malawi, 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 impurities. The purity level can then receive a label or certificate supported by the Ministry of Trade or Malawi Bureau of Standards to guarantee purity levels to recyclers and thus increase prices. 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 collectors usually sell separated polymer types to a PBBC, there is always some impurity due to mixed

[1] MWK = Malawian Kwacha. 1MWK=0.0012USD

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.

Optional: if enough plastic volumes are available, one could choose to include low- and medium-tech recycling of plastic waste as well. Options are to make construction material such as bricks, pavers or fence poles by melting unseparated plastic waste in barrels, mixing it with stone-dust (ratio 1:3) and putting it in a mould. Another option could be to buy an extruder and start producing hard shelled plastic products such as plates, spoons, cups or other household kitchen ware.

Who?

The PBBC centre will be operated by a social business, in order to be eligible for external funding and stimulate local entrepreneurship. The pilot could build on existing organizations operating a PBBC or a WTS. More information of potential organizations can be found in section 5.1. However, the challenges of such existing organizations need to be considered to make improvements and prevent repetition of existing shortfalls. The day-to-day operation of the PBBC can thus be managed by a local entrepreneur, 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 Government. 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 to separate per polymer type and sell 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: OG Plastics Ltd (recycle PVC, HDPE and PET plastics into pipes and fittings, household furniture and bottles), Shore Rubber Ltd (recycle LDPE and HDPE in bread bags, snack packages and carrier bags), Golden Plastic Company (produces plastic bags and sheets), RK Plastics (produces water buckers, water dispensers, cups and plates), Poly Park Plastic (produce packaging materials), and Parklink, Auro, BNC, Flow Tech, GM Plastics and Anchor Industries who are all involved in recycling of thick walled plastics.

Where?

To minimize transport distances and incentivize households to separate plastics, the PBBC should be set in a urban zone, preferably a community. Note that since the pilot is a phased approach leading to a full DIWS, there should be enough space to expand. Additionally, there should be electricity available as well as a shed or another simple building where value addition and potentially recycling can take place.

3.2 Phase 2: Include other waste streams (2-5 years)

What?

In phase 2, the focus is on expanding the PBBC with other waste streams. This means that the PBBC, now becomes a Decentralized Integrated Waste Transfer Station (DIWS). Not only the plastic waste

stream is processed, also household glass, paper, metal and organic waste are processed. Collection services can now bring unseparated waste to the DIWS for a fee and the DIWS will separate, aggregate and sell to the recycling industry or export.

Who?

Expanding the PBBC to a DIWS, 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.
- For the relationship with collectors, they are now allowed to bring unseparated waste against a fee and sell multiple types of separated household waste.
- For the partnership with government bodies and the community nothing changes.
- Many new actor groups are needed within the processing industry, as illustrated in Appendix A. In Phase 1 the actor network only includes plastic processors, this needs to be expanded with paper, glass, organics and metal processors within or outside of Malawi.

Where?

The location of the DIWS is the same as of the PBBC. This is why it is important to have land of sufficient size to allow for expansion to do DIWS during the selection of the location for the PBBC.

4 Business Model and Financial Plan

4.1 Business Model

This section discusses the proposed business model for the first two phases of the DIWS: a plastic buy back centre with value addition steps and optional low- or medium-tech recycling (phase 1) and expansion to other waste streams (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 Malawi. For the plastics input, the pilot follows a standard buy-back business model, where customers bring plastics to the PBBC, the plastics are weight and the collectors receive a fixed price for the plastics, which can be MWK, 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. If recycling is done, then 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 Malawi. In this case, marketing becomes an important part of the business model. Market studies should be carried out to see which products fit best with customer needs in Malawi and how to persuade customers to buy the recycled products made by the DIWS.

In phase 2, the pilot will continue with the existing business models for input: buying back separated materials and offering free collection in collaboration with the local authorities if waste is separated. An expansion will be made to allow unseparated waste, which can be dumped at the DIWS for a fee. The output business model will depend on the waste stream and the processing steps. After separation, waste can either undergo value addition steps and then be sold to recyclers, or waste can be recycled on site. In the case of waste recycling on site, marketing is an important part of the business model and market studies should be carried out.

4.2 Financial Plan for Phase 1: Plastic Buy Back Centre with value addition (0-2 years)

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 pilot. 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 subsections the process including necessary equipment (3.2.2) and the assumptions (3.2.3) on which the financial calculations are based on, 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 tonne of plastics per week, equivalent to the plastics of 1300 households, will be realistic. However, as shown in Appendix E, 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 Lilongwe[2] need to be collected within one community: 5 tonnes per week. In a country where there is limited overall collection and virtually no 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, the pilot should work with five PBBCs and one place where value addition will be done (the Value Addition Centre). Each PBBC will be set in a community and collect approximately 1 tonne of plastics per week. The VAC will be in a strategic location, in close proximity to the recyclers and the PBBCs. Financial calculations presented in Appendix D show that the revenue streams 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. To cover the CAPEX costs, donor funding is advised. Opportunities for donor funding can be found in 3.4. This system can then be expanded with low- and medium-tech recycling taking place at the larger site only. Some rough budget calculations for this optional addition, can be found in Appendix F.

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 Lilongwe City Council who will simultaneously invest in collection and separated collection.
- One of the five PBBC can be placed in close proximity to the main legal open dumpsite in Lilongwe, this provides informal waste pickers with a clear outlet for their raw material. This will reduce pressure on collection mechanisms.

4.2.2 *Process description*

The guarantee of sufficient plastic waste collection is a critical enabling condition for the establishment of a plastic buy back centre. A steady supply of raw materials is important for the company's sustainability. Intermediaries will play a key role in collection, this includes the informal waste pickers. In addition the pilot will collaborate with the community to engage in collection schemes that are backed up by a public awareness campaigns, which is important to ensure a constant supply of plastic. The DIWS will require storage space in order to retain all collected waste items, processed materials, and finished commodities. Waste sorting operations can be done manually with support of a conveyer belt in the first part of the pilot and gradually transition to an automatic system, utilizing proper identifying techniques. The better the precision and efficiency of the identification, sorting, and separation methods, the higher the quality of the recovered product. The manual conveyer belt technique is best suited for sorting plastics and will necessitate the utilization of full-time staff. The secondary raw material generated by hand sorting is of excellent quality and serves as a solid basis for small and medium-sized businesses to make high-quality goods. After sorting, the plastics are washed using a low-tech washing machine, which recycled its own water by using a filter. It is critical to ensure that the plastic is dried after washing. Initially, an open space will be used to allow for natural drying, along with a simple drier to reduce the moisture content while minimizing electricity costs. Typically, cutting is done to minimize the initial size of large plastic objects. It is possible to do so with a plastic cutting machine, which is specifically designed to cut plastic into smaller pieces. Shredding is ideal for small parts. A basic shredder will be used. Optional, the plastic flakes will be utilized as raw material to produce final goods

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

utilizing comparable manufacturing machinery such as injection moulding. Note that plastic is separated per polymer type (LDPE, HDPE, PP and PET, other types of plastic will not be processed by the PBBC), but can be processed by the same machinery, although not simultaneously, i.e. a shredder can first shred a batch of HDPE, then be cleaned and then shred a batch of LDPE.

4.2.3 *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:

- There will be 5 PBBCs (which in phase two will include other waste streams to become a DIWS). 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.
- There will be one larger site on a strategic location where value addition activities and potentially recycling will be done, this will from now on be called the Value Addition Site (VAS).
- Each PBBC will collect 1 tonne of plastic per week, resulting in an average of 5 tonnes of plastic per week. Note that an average household in Lilongwe produces 0.75kg of plastic waste per week.[3] The assumption of 1 tonne per week thus means the plastic waste of an equivalent of 1300 households is used for each PBBC.
- The pilot assumes that shreds raise the price with 250MKW/kg compared to the prices for the unwashed and unshredded raw material.
- The pilot assumes that there will be goodwill from the local authority in supporting the establishment of the pilot and collaboration with waste pickers and aggregators.
- It is anticipated that the market for plastic recycled products will increase, and companies will begin to increase recycled content in their packaging.
- It is assumed that there will be consistency of policy in mainstreaming circularity in the waste sector. The policies in the country will create an enabling environment to support the sustainability of the pilot and encourage expansion as anticipated in the phased approach.
- The pilot assumes 75% of the plastics is bought back from informal waste pickers, the other 25% is delivered by community members or the local authorities

4.3 Financial Plan for Phase 2: Include other waste streams (2-5 years)

In phase 2, other waste streams are included. Each PBBC can expand with buy-back of other waste types such as metal, glass, paper and organics, as well as accept unseparated waste which is then separated. After sufficient volumes are reached to justify transport, each separated waste stream can be transported to the larger site where value addition activities and potentially recycling is done.

The financial plan for phase 2 will not delve deep into the setup of the inclusion of other waste streams, since this involves the last phases of the pilot and the revenues and OPEX depend greatly on accurate pricing. Nonetheless, an overview of the needs will be provided. Other waste streams are expected to be incorporated as part of the buyback centre in phase two of the pilot, with the opportunity for value addition. The waste streams to be included in this pilot are household metal, glass, paper, and organic waste. As with plastics, each waste stream will need a specific set of equipment to enable the setup of a functional buyback centre with the option of low- and medium-tech recycling. A brief review of the capital investment need reveals that the expenditures for this model would be significantly higher. The prerequisites for setting up phase two of the pilot are outlined below, per waste stream.

[3] Based on waste characterization study in Activity 2

Recycling of **metal** requires much energy and high investment costs, therefore the pilot will refrain from focussing on metal recycling. Nevertheless, value addition steps can be done to increase the value when selling to the recycling industry. Various types of metal can be aggregated and processed. In terms of income generation, aluminium is one of the most profitable materials, but in terms of accessibility, copper is one of the most valued and accessible materials. Iron and steel are the most recycled materials on the planet, and they're also among the easiest to reprocess since they can be magnetically separated from waste. Regarding capital expenditure requirements, the buyback centre will have the advantage to leverage existing equipment like the weighing scale, loader as well as land. Nonetheless, there will be a need to invest in a metal baler, it crushes, cuts, and bales scrap metal from a number of sources. Bailing reduces the amount of space required and makes transportation more convenient. Between $25,000 and $35,000[4] would be spent on a scrap metal hydraulic baling machine. The pilot will also need to invest in a metal shredder which will cost between $10,000 – $20,000[5].

Organic waste investment is similarly capital intensive; the quantity of investment is determined by the quantities necessary to ensure economic viability. The most fitting product to be made from organic waste for Malawi seems to be organic fertilizer, which can be done by the DIWS itself. Composting is a necessary step in the production of any approved, high-quality organic fertilizer. The composting procedure begins with the collecting of raw materials and advances to visual assessment to alter the waste's composition and mix. To increase the quality of compost, a high carbon-to-nitrogen ratio should be strived for during alteration of the organic mix. This may be performed by blending household organic waste with agricultural waste such as grain straws and husks, corn stalk or saw dust, and other wood products. Hence the need for a shredder which would cost between $7,000 - $24,000[6]. Throughout the composting process, the waste will be crushed and shredded to shorten compost time and promote material consistency. Using existing equipment, there is no need to acquire an additional loader; nevertheless, a compost turner is necessary to guarantee adequate oxygen supply to promote composting. At this stage, the compost might be sold on the market. Pre-screening of compost is required throughout the fertilizer manufacturing process. Organic nutrients are added at this point to increase the quality of the compost. Further processing transforms the compost into granules, which are then further dried to add strength and compactness to the fertilizer. A dryer would cost between 7,500 and 9,000 dollars. The organic fertilizer is then ready to be packed and sold.

It should be noted that regulations for a **glass** deposit system are preferred over glass recycling techniques. However, for the glass that cannot be collected via deposit systems, the DIWS can do some value addition activities. Glass recycling requires a lot of energy and advanced equipment. Therefore value addition steps and then selling to recycling industry or exporting seems the best solution for this waste stream. To increase the value of glass waste, colour sorting is done before the glass is crushed.
Paper recycling is a relatively easy process which can be done by the DIWS if volumes are high enough. Wastepaper of comparable quality is mixed because it contains comparable amounts of fibre that can be recovered from the pulp. After sorting, the paper is shredded to break it down into minute fragments. After the material has been finely shredded, a considerable amount of water is added, along with additional chemicals like hydrogen peroxide, sodium hydroxide, and sodium silicate, to break down and separate the paper fibres. Pulp is the resulting slurry solution. After bigger pollutants are removed, pulp is put to a flotation tank where chemicals and air bubbles remove dyes and inks to improve the purity and whiteness of the result. The pulp is then pushed through rollers that press out excess water or a vibrating machine to produce a product that is 50%

[4] https://jiangsuhuahong.en.made-in-china.com/product/SwbxCrVXkpho/China-Scrap-Metal-Hydraulic-Baling-Recycling-Machine-Compactor-Press-Baler-for-Iron-Aluminum-Copper-Steel-Waste-Car.html

[5] https://hnjljx.en.made-in-china.com/product/SXmElMUJsurK/China-Rubber-Metal-Plastic-Glass-Paper-Wood-Shredder-Double-Shaft-Shredder.html

[6] https://www.alibaba.com/product-detail/Waste-Shredder-Shredders-Food-Kitchen-Organic_1600436094824.html?spm=a2700.galleryofferlist.normal_offer.d_title.4f484e1bAxzoP7&s=p

water and 50% fibre. The pulp can be utilized alone or in combination with other virgin materials to produce new paper.

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[7]:** 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.

[7] For more information, see: endplasticwaste.org

5 Impact

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

Impact Area	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 Malawi 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.
Economic	Plastic waste has the ability to clog drains, sewers, and rivers, hence leading to blackouts since power supply form hydro is hindered or 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. The impact of plastic contamination on marine life will have serious consequences for fisheries stocks and productivity. This is especially alarming in Malawi, where many people rely on Lake Malawi's fisheries and other floodplain wetlands for a living. Degradation of soil and water quality also endangers food production and has a significant impact on small-scale farmers who rely on animal and agricultural output as their major source of income. In terms of GHG impact, the DIWS will process a plastic flow of 5 tonnes per week in the first phase, resulting in a plastic waste flow of 5*26,000[8] = 130,000 kg CO_2 = 130 tCO_2 reduction per year. For more detailed information of the calculations the reader is referred to the closure reports.

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

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 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, adding low- and medium tech recycling and expanding to other waste streams, the pilot could also build on 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- or medium-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).
- Organization needs to have solid network of collectors and focus at least partly on plastic household waste.
- Organization needs to have ties to 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 extensive 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) Area 24 Waste Transfer Station – Lilongwe
2) Area 25 Waste Transfer Station - Lilongwe
3) Our World International (OWI) Waste Transfer Station - Lilongwe
   OWI separates plastics, glass, organics, metal and paper. They have access to electricity and have recently bought an extruder to start with on-site plastic recycling. They also produce compost from organic waste which is then sold to farmers.
4) Kuntaya Waste Transfer Station – Blantyre

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 net profit made.

7 Conclusion

This report has presented the pilot business plan: A Decentralized Integrated Waste-transfer Station with the option to do recycling 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 five PBBCs, that can later be expanded to include other waste streams, and one central location where value addition and optional 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 DIWS.

After the pilot has been executed successfully, the pilot concept can be replicated throughout Malawi. The potential to replicate throughout Malawi depends on potential buyers, i.e. at this moment there is not enough recycling done in Malawi to largely scale a DIWS and much will need to be exported which raises the costs. However, if local recycled plastic production 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 DIWS can generate after scale-up. Policy reform, such as EPR or a minimum content requirement of recycled plastics in plastic products, can help to replicate the pilot throughout Malawi, since it will increase the demand and profit margin of plastics 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 realistic volumes, setting up collection networks and forming a partnership with the local authorities to guarantee sufficient collection. In appendix H a brief implementation plan with timing for the pilot is included.

A Appendix A

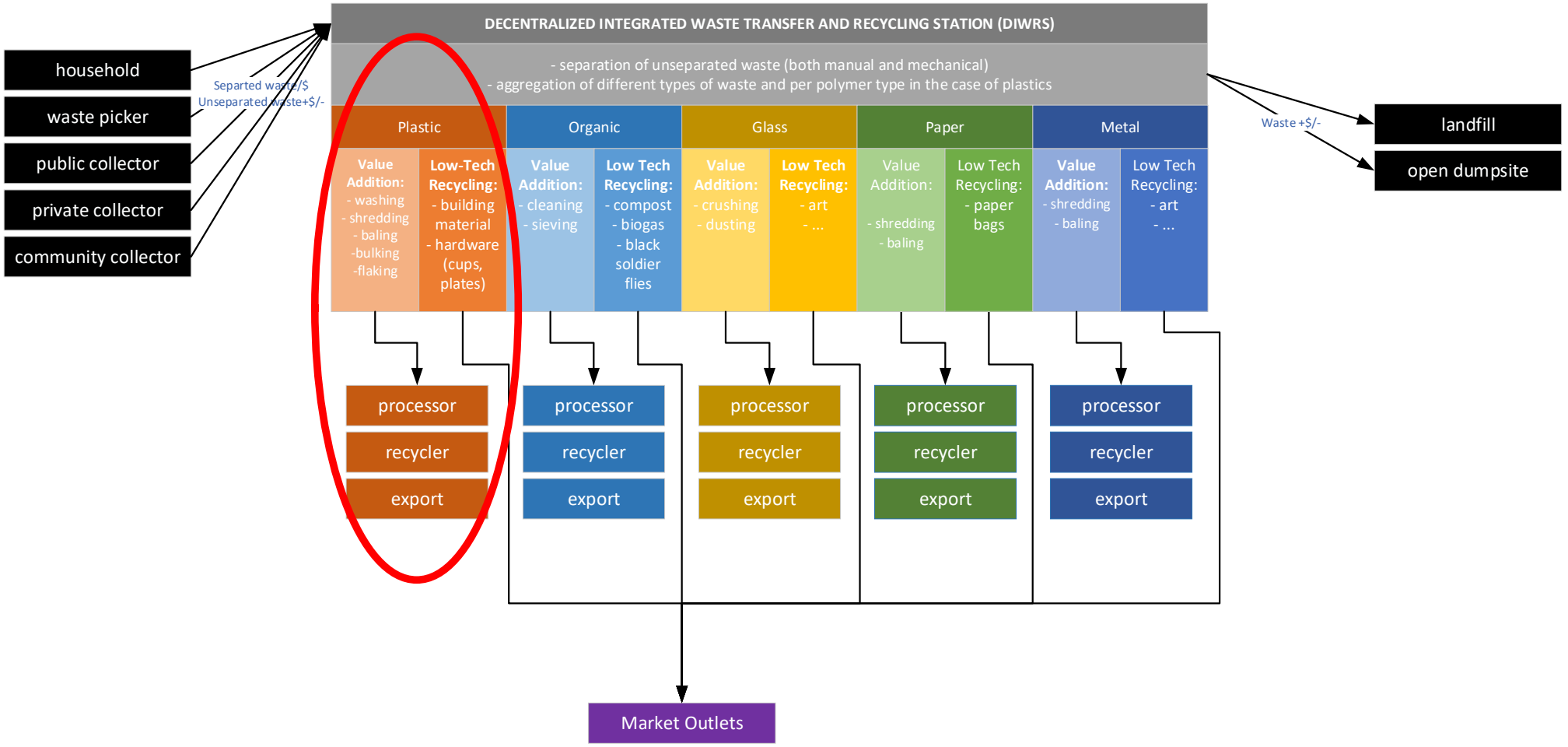

Figure 1: graphic visualization of actor network and functions of a full decentralized integrated waste transfer station (DIWS), red circle represents phase 1

B Appendix B

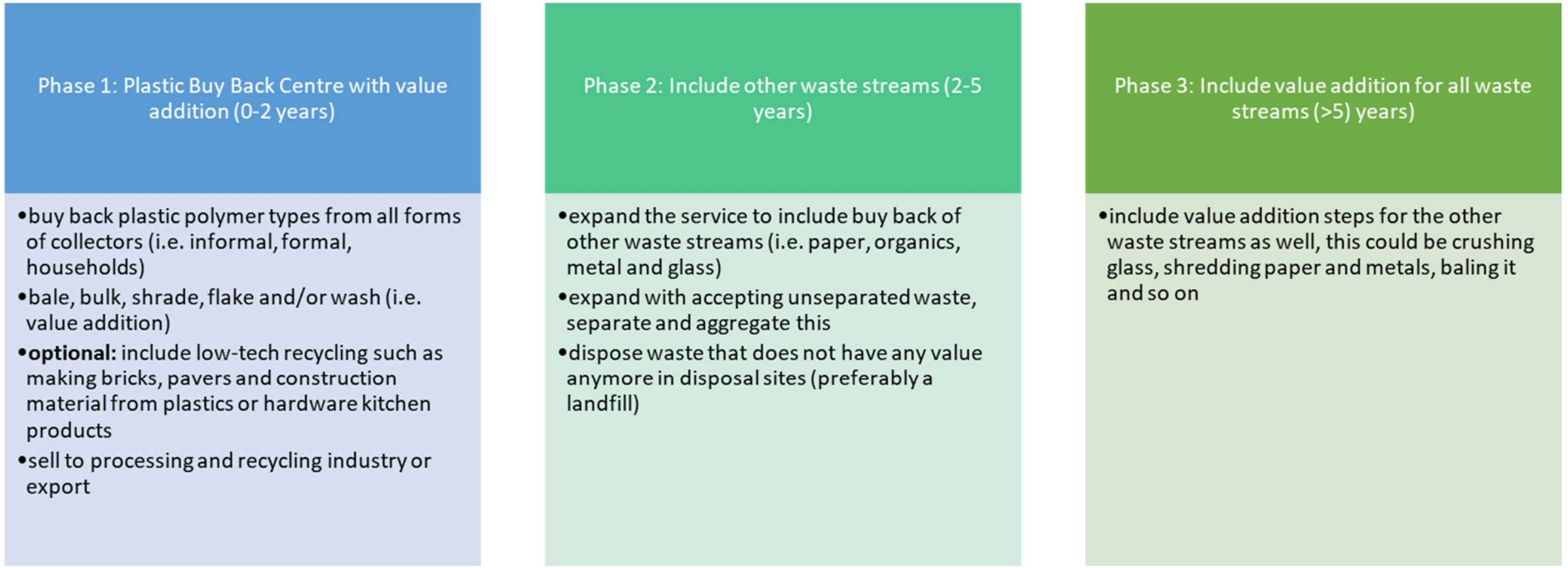

Figure 2: phased approach of Decentralized Integrated Waste Transfer Station (DIWS)

C Appendix C

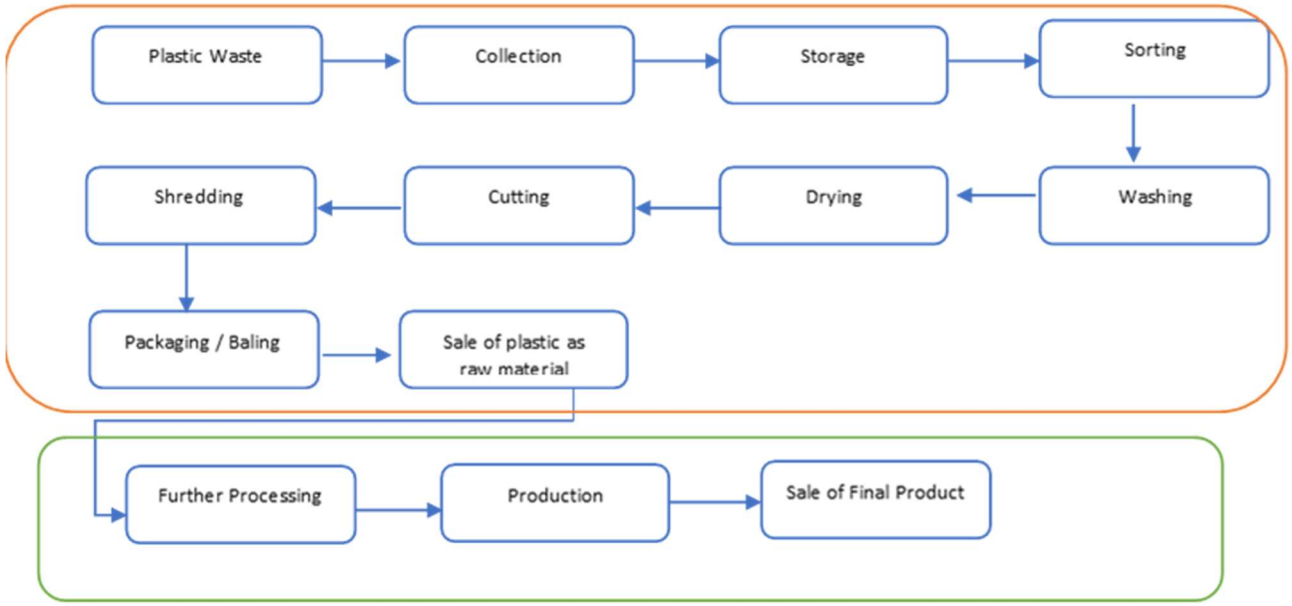

Figure 3: Production Process Flow Chart

D Appendix D

TABLE 1: CAPITAL EXPENDITURES (CAPEX) FOR FIVE PLASTIC BUY BACK CENTRES AND CAPEX FOR THE VALUE ADDITION CENTRE

Item	Total (USD)
Sorting Conveyor belt[9]	6,000-8,000
Storage Facility/Office (40 ft container)	7,000-9,000
Loader[11]	7,000-9,000
Weighing scale[13]	250-500
Office Equipment, Furniture	1,000-2,000
Other	5,000-7,000
CAPEX	**26,250-35,500**
times five for each of the PBBCs	
Total CAPEX	**131,250-177,500**

Item	Total (USD)
Washing line[10]	20,000-35,000
Plastic Scrap Flakes Colour Sorter	20,000-35,000
Waste Plastic Baler[12]	6,000-8,000
Storage Facility/Office (400 ft)	20,000-25,000
Loader[14]	7,000-9,000
Plastic Shredder[15]	6,000-9,000
Ventilation System	500-1,000
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	1,000-2,000
Forklift	7,000-10,000
Other	5,000-7,000
Total CAPEX	**112,500-171,000**

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

TABLE 2: OPERATIONAL EXPENDITURES (OPEX) FOR FIVE PLASTIC BUY BACK CENTRES AND OPEX FOR THE VALUE ADDITION CENTRE

Item	Annual Cost (USD)
Facility	
Land lease	1,000-2,000
Staff[16]	
Staff (2)	2,000-3,000
Operations	
Purchase of plastics	18,000-20,000
Large storage bags[18]	1,000-2,000
OPEX	**22,000-27,000**
times five for number of PBBCs	
Total OPEX	**110,000-135,000**

Item	Annual Cost (USD)
Facility	
Facility costs (water, electricity, etc.) machine	4,000-5,000
Land lease	3,000-4,000
Staff[17]	
Staff (5)	5,000-6,000
Administrator (1)	2,000-3,000
Operations	
Machine Maintenance	3,000-5,000
Large storage bags[19]	1,000-2,000
Total OPEX	**18,000-25,000**

REVENUE STREAMS PER ANNUM

Products	Market Price (in USD/tonne)	Unit (Tonnes)	Totals (USD)
Baled PET Bottles	300	35	10,500
HDPE Flakes	900[20]	100	90,000
PP Flakes	900[21]	75	67,500
LDPE Flakes	660[22]	50	33,000
	Total	**260**	**201,000**

[16] Staff cost estimates are based on the salary surveys in Malawi: https://www.paylab.com/mw/salaryinfo/
[17] Staff cost estimates are based on the salary surveys in Malawi: https://www.paylab.com/mw/salaryinfo/
[18] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1
[19] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1
[20] https://www.made-in-china.com/products-search/hot-china-products/Hdpe_Flakes.html
[21] https://www.recyclingtoday.com/article/plastic-scrap-prices-trend-upward/
[22] https://www.recycle.net/Plastic/ldpe/xv100400.html

E Appendix E

TABLE 1: CAPITAL EXPENDITURES (CAPEX) FOR THE PLASTIC BUY BACK CENTRE (1 tonne per week)

Item	Total (USD)
Washing line[23]	20,000-35,000
Plastic Scrap Flakes Colour Sorter	20,000-35,000
Waste Plastic Baler[24]	6,000-8,000
Sorting Conveyor belt[25]	6,000-8,000
Storage Facility/Office (40 ft container)	7,000-9,000
Loader[26]	7,000-9,000
Plastic Shredder[27]	6,000-9,000
Ventilation System	500-1,000
Weighing scale[28]	250-500
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	1,000-2,000
Forklift	7,000-10,000
Other	5,000-7,000
Total CAPEX	**105,000-165,000**

TABLE 2: OPERATIONAL EXPENDITURES (OPEX) FOR THE PLASTIC BUY BACK CENTRE

Item	Annual Cost (USD)
Facility	
Facility costs (water, electricity, etc.) machine	4,000-5,000
Land lease	2,000-4,000
Staff[29]	

[23] https://aceretech.en.made-in-china.com/product/edRfQWBMZIUS/China-Aceretech-Plastic-Waste-Recycling-Washing-Line-Machine.html
[24] https://www.alibaba.com/product-detail/Waste-Paper-Cardboard-Plastic-Horizontal-Scrap_60710675531.html?spm=a2700.galleryofferlist.normal_offer.d_image.76022440prLCxb
[25] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhIQD3&s=p
[26] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb
[27] https://www.plasticcrushmachine.com/sale-16351285-ce-approved-tyrone-double-shaft-shredder-industrial-mini-plastic-shredder-machine-for-cardboard.html
[28] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p
[29] Staff cost estimates are based on the salary surveys in Malawi: https://www.paylab.com/mw/salaryinfo/

Administrator (1)	2,000-3,000
Staff (5)	5,000-6,000
Operations	
Purchase of plastics	17,000-22,000
Machine Maintenance	3,000-5,000
Large storage bags[30]	1,000-2,000
Total OPEX	**34,000-47,000**

REVENUE STREAMS PER ANNUM

Products	**Market Price (USD/tonne)**	**Unit (Tonnes)**	**Totals (USD)**
Baled PET Bottles	300	7	2,100
HDPE Flakes	900	20	18,000
PP Flakes	900	15	13,500
LDPE Flakes	660	10	6,600
	Total	**52**	**40,200**

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

F Appendix F

TABLE 7: CAPITAL EXPENDITURES (CAPEX) for Recycling

Item	Total (USD)
Injection Moulding Machine[31]	4,000-8,000
Wood Plastic WPC Machine[32]	35,000-45,000
Plastic Bag Extruder[33]	15,000-20,000
HDPE Pelletizing Machine[34]	42,000-45,000
Storage Facility/Office (40ft container)[35]	2,600-4,400
Garbage Truck[36]	20,000-30,000
Operations Vehicle (1-ton)	18,000-25,000
Total CAPEX	**136,600-177,400**

TABLE 8: OPERATIONAL EXPENDITURES (OPEX) for Recycling

Item	Annual Cost (USD)
Facility	
Facility costs (water, electricity, etc.) machine	5,000-6,500
Minimum Staff[37]	
Waste Control Office	3,500-4,800
Machine Operators	
Operator Assistant[38] (3)	3,000-4,000
Administrator[39] (1)	2,000-3,000
Staff (8)	8,000-16,000

[31] https://www.alibaba.com/product-detail/Cheap-china-reliable-plastic-fruit-vegetable_1600183757435.html?spm=a2700.details.0.0.78082a0az1snUQ
[32] https://www.alibaba.com/product-detail/WPC-profile-machine-for-making-WPC_62014369383.html?spm=a2700.galleryofferlist.normal_offer.d_title.3b4cc1dbWmSU8x
[33] https://www.alibaba.com/product-detail/High-output-PE-HDPE-LDPE-plastic_60665583224.html?spm=a2700.galleryofferlist.normal_offer.d_title.7645557aWn3oge
[34] https://www.alibaba.com/product-detail/Machine-Hdpe-Ldpe-Pelletizing-Plastic-Pe_1600337757273.html?spm=a2700.galleryofferlist.topad_creative.d_title.35f64b7927ytS2
[35] https://www.alibaba.com/product-detail/Shenzhen-40ft-container-with-sea-freight_698203571.html?spm=a2700.details.0.0.5bc54446uxH53w
[36] https://www.alibaba.com/product-detail/New-or-used-dongfeng-4-2_1600345160218.html?spm=a2700.galleryofferlist.normal_offer.d_title.790b64feyRJUaH
[37] Staff cost estimates are based on the salary surveys in Malawi: https://www.paylab.com/zm/salaryinfo
[38] https://www.paylab.com/zm/salaryinfo/car-industry/machine-operator?search=1&lang=en
[39] https://www.paylab.com/zm/salaryinfo/general-labour?lang=en

Item	Annual Cost (USD)
Operations	
Machine Maintenance	7,500-10,000
Large storage bags[40]	2,500-3,500
Total OPEX	**31,500-47,800**

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

G Appendix G


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 Lilongwe
•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
•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

H Appendix H

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 NCST and MEPA
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 DIWS 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)	MEPA, with support from NCST. Potentially 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, MEPA and NCST
Implementation – From April 2023	**Who?**
- Implementation in phases, following the feasibility study	Implementation consortium, with support from MEPA and NCST