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Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Final report

Final version

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PROJECT DATA

Project name	Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura
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LIST OF ACRONYMS

LTA	Lake Tanganyika Authority
HWTa	Household Waste Transfer Area
HWRA	Household Waste Recovery Area
ABAKIR	Autorité du bassin du lac Kivu et de la rivière Ruzizi (Lake Kivu-Ruzizi Basin Authority)
HSW	Household and similar waste
MSW	Municipal Solid Waste
ENABEL	Belgian Development Agency
CE	Circular Economy
PPE	Personal Protective Equipment
SWM	Solid Waste Management
KUMC	Kigoma/Ujiji Municipal Council (Tanzania)
LATAWAMA	Lake Tanganyika Water Management
MEEATU	Burundi Ministry of Water, Environment, Regional Development and Urban Planning
MINITERE	Ministry of Land, Environment, Forestry, Water and Natural Resources (Rwanda)
LM	Linear metre
MLGH	Ministry of Local Government and Housing – Zambia
NGO	Non-Governmental Organization
PSW	Plastic Solid Waste
DRC	Democratic Republic of Congo
EPR	Extended Producer Responsibility
CSR	Corporate Social Responsibility
RVO	Netherlands Enterprise Agency
SETEMU	Municipal Technical Services (Bujumbura. Burundi)
TEOM	Tax on the Collection of Household Rubbish
ToRs	Terms of Reference
EU	European Union
WASH	Water, Sanitation and Hygiene
ZEMA	Zambia Environmental Management Agency



1. INTRODUCTION

The European Union Delegation to Burundi launched the study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura to contribute to protection of Lake Tanganyika's water quality and biodiversity. This study aims to implement a circular economy of municipal solid waste in the cities concerned.

The development of this work considered the European Commission's cross-cutting objectives: environment and climate change, a rights-based approach, and the rights of persons with disabilities, indigenous peoples and gender equality. This report analyses the institutional, organisational and legislative framework for solid waste management with a proposal for some optimisation recommendations. It also proposes technically feasible and adaptable, economically viable and sustainable strategies/solutions for development of a circular municipal solid waste economy.

Since the interim report, we have discussed an analysis of the institutional and economic situation, liquid sanitation infrastructure and service level for the city of Bujumbura (wastewater and drainage). At this stage of the study (final report), we have drafted a short- and medium-term investment plan. This regional study's results will serve as a basis for the identification and formulation of a new regional project to continue and strengthen the activities already being implemented under the LATAWAMA project.

As stipulated in this study's terms of reference, in this final report, the following tasks are presented:

- Analysis of the institutional and legislative framework for waste management in the five countries of operation.
- Proposal of recommendations to improve/optimize waste management and recovery, as a step for the transition to the circular economy.
- Analysis of the main challenges and opportunities of the transition to a circular economy, focused on technical, socio-economic, financial, geographical and regional and/or international collaboration/cooperation.
- Detailed presentation and analysis of several scenarios for development of solid waste management modes as a step for the transition to the circular economy at national and/or regional level.
- For sewage treatment in the city of Bujumbura, we presented a short- and medium-term investment plan to improve the service level according to the objectives set by Burundi for the city of Bujumbura. We also defined the main support lines in terms of capacity building for the liquid sanitation sector and especially the responsible sector actors in the city.

2. PART A – SOLID WASTE MANAGEMENT

a. REGULATORY AND INSTITUTIONAL FRAMEWORK IN BURUNDI

Over the past decades, many pieces of legislation have been enacted in Burundi. Although an environmental code exists, there is an overall lack of guidance and enforcement documents on liquid and solid waste (Fridolin NZAMBIMANA, et al, 2021)¹.

¹ Household and related waste management challenges and opportunities Case of Bujumbura – Burundi, Fridolin NZAMBIMANA, Wael El ZEREY, Asma El ZEREY-BELASKRI, (2021)



In the hygiene and sanitation sector in Burundi, the responsibility is fragmented among multiple actors. Among the governmental actors, several Ministries are concerned:

- The Ministry of Public Health and the Fight against AIDS (MSPLS), through the Administration for the Promotion of Health, Hygiene and Sanitation,
- Ministry of Environment, Agriculture and Livestock,
- Ministry of Infrastructure, Equipment and Social Housing
- Ministry of Hydraulics, Energy and Mines,
- Ministry of the Interior, Community Development and Public Safety.

Because of this plurality, responsibilities among Ministries overlap and some responsibilities are not fulfilled. Another recurring institutional problem is the changes in the responsibilities among Ministries.

At the territorial level, the municipality is an important player because it participates in the management of hygiene and sanitation in several ways. It has the prerogative to take the necessary environmental prevention measures and it owns the infrastructure built and can realize or delegate the management to service providers.

Despite these relatively general elements, no specific provisions validate the municipalities' competence to collect, transport and treat solid waste. Nevertheless, the Bujumbura City Council's urban development and environment department is in charge of cleaning public spaces and beautifying the city.

During our field mission, we also learned that the Mayor set up a multidisciplinary technical commission on 20 April 2022 and created a health brigade.²

Private companies actually perform waste collection. In 2013, the Bujumbura City Council allowed companies and associations to undertake household waste collection under an agreement with the City Council.

MSW sector governance is not properly identified. From an institutional and legal viewpoint, the institutional framework must be clarified to understand the distribution of roles and tasks among the municipality that is legally responsible for the public service of MSW management, the OBUHA, which is some kind of technical enforcement agency, and the private operators that conduct a mission similar to a delegation of public service.

b. RECENT REFORMS – FROM THE SETEMUS TO THE CREATION OF THE BURUNDIAN OFFICE OF URBAN PLANNING, HOUSING AND SANITATION (OBUHA)

The municipal technical services (SETEMU), established in 1983 by the Decree of 12 July 1983, were responsible for the study, execution and operation for all technical services for the city of Bujumbura, including the maintenance of roads and related landfill works, and wastewater and waste disposal under Bujumbura City Council funding. In 1989, a new decree amending that of 1983 stipulated that SETEMUs would be paid according to the services rendered. However, with the capital extension, the SETEMUs were no longer able to collect the rubbish in all areas of the city³.

Decree No.100/79 of 24 May 2019 establishes the OBUHA - Burundian Office of Urban Planning, Housing and Sanitation by merger of the following institutions:

- General Urban Planning Administration -DGUH,
- National Building and Public Works Laboratory "LNBTP,"
- General Building Administration "DGB,"
- Municipal technical services board "SETEMU,"
- Supervision of social constructions and land development "ECOSAT,"
- The Public Real Estate Company "SIP."

² Project team meeting with the Head of the Health Brigade on 08 July 2022.

³ <https://www.iwacu-burundi.org/englishnews/longform/bujumbura-city-towards-a-war-of-waste/>



This new body is placed under the supervision of the Ministry that has Urban Planning and Habitat in its attributions. In this decree, OBUHA's role regarding sanitation is to:

- Collect and dispose of waste,
- Collect and dispose of wastewater,
- Ensure protection of Lake Tanganyika and watercourses crossing Bujumbura City Council and other cities.

During our field mission, we learned that following the creation of the OBUHA, SETEMU employees were transferred to other departments. As a result, the former services' competences were diluted in different Ministries and therefore not capitalized upon within OBUHA.

C. REGULATORY AND INSTITUTIONAL FRAMEWORK IN TANZANIA

The Government of the Republic of Tanzania has enacted several environmental management laws. The Environmental Management Act No. 20 of 2004 establishes a legal and institutional framework for the country's sustainable management of the environment and waste.

According to the Environmental Management Act (EMA), solid waste is defined as non-liquid material from domestic, street, commercial, industrial and agricultural activities. These include rubbish, non-liquid material from construction and from demolition activities, garden waste, dead animals and abandoned car parts. Solid waste management is defined as an essential service provided to protect the environment and public health, promote hygiene, dispose of materials, avoid waste, reduce waste quantities, reduce emissions and residues and prevent spread of disease.

The Act establishes the National Environmental Advisory Committee (NEAC) to advise the Minister responsible for the Environment on environmental matters. The National Environment Management Council (NEMC) is responsible for implementation.

Part IX of the Act deals with waste management. Although it does not specifically mention waste management strategies, it covers solid waste management throughout its life cycle.

More recently, this law has been revised to consider other waste types that may pose risks to the environment. This is the case with waste electrical and electronic equipment (WEEE), which often contains substances or components that are dangerous for the environment (batteries and accumulators, greenhouse gases, mercury-containing components, capacitors that may contain PCBs, etc.). However, there is also a high potential for recycling the materials of which they are composed (ferrous and non-ferrous metals, rare metals, glass, plastics, etc.). In May 2021, due to the importance of WEEE, a law⁴ was enacted to regulate management of this type of waste.

Similarly, special waste (chemical, gas, medical waste, etc.) is likely to harm health, life or the environment. Another law⁵ was enacted to organize the regulatory framework for the management of these waste types.

Overall, the legal framework for environment and waste management in Tanzania is quite comprehensive. However, the institutional framework presents some shortcomings in terms of institutions competent in waste management and which specialize in reflection and establishment of in-depth strategic guidelines for implementation on the ground, as well as various stakeholders' control (town hall, private, associations operating in collection and recovery, ...). This institutional gap explains the huge imbalance among the different cities' sanitation.

⁴ Environmental management act, government notice No.388

⁵ Environmental management act, government notice No.389



d. REGULATORY AND INSTITUTIONAL FRAMEWORK IN ZAMBIA

In Zambia, several laws regulate waste management:

- The Law on Regulation and Management of Solid Waste [No. 20 of 2018 353] specifies the mode of management, responsibilities, involvement of private individuals, taxation and incentives (fines, incentives, etc.) of waste management,
- The 2011 Environmental Code,
- Public Health Act, Chap. 295 of the Laws of Zambia (mandates local authorities to maintain cleanliness).

However, field missions tell us that implementation documents are not always followed.

Management of municipal solid waste in Zambia is the responsibility of each district's local authorities, while the Zambia Environmental Management Agency (ZEMA) provides regulatory oversight. Local authorities deal mainly with non-hazardous solid waste, while specialized private companies deal with hazardous waste.

Under the Environmental Management Act No. 12 of 2011, the ZEMA issues licences for hazardous and non-hazardous waste to local authorities and private companies.

The legal framework for solid waste management (SWM) appears to be relatively well established. However, due to a lack of understanding among stakeholders, a lack of adequate budget allocation and inadequate resources for waste life cycle management, it is not properly implemented. We note the regulatory framework's lack of specific laws on recycling, distinct laws/regulations to encourage renewable energy, and laws/policies to support the informal sector.

Zambia's regulatory and institutional gaps in waste management require special government attention to align with international standards and norms for protecting wetlands and the environment from the adverse effects of poor solid and liquid waste management.

e. REGULATORY AND INSTITUTIONAL FRAMEWORK IN THE DRC

In the Democratic Republic of Congo, the preliminary guidelines of the legal aspects of environmental sanitation are found in Law No.11/09 of 9 July 2011 on the fundamental principles relating to protection of the environment. The DRC has been engaged in the decentralization process since 2006. With a view to improving performance in all vital sectors, it is determined to fully involve decentralized actors to provide solutions adapted to local needs and improve the quality of local services. This is evidenced by several laws published (Law No.08/012 of 31 July 2008 on fundamental principles relating to the free administration of the provinces; Organic Law No.08/016 of 7 October 2008 on the ETDs' composition, organization and functioning and their relations with the State and the provinces; etc.). Hence the need to define a National Sanitation Policy (PONA) that sets out the fundamental options to be undertaken by the State and other actors to allow the populations to benefit from this sector's services. This was achieved in December 2013 under the guidance of the Ministry of the Environment and Sustainable Development, with the support of the German Cooperation through its project to support the water sector reform (RESE) implemented by GIZ.

The National Sanitation Policy provides the policy framework for sound and sustainable sanitation sector management. It defines the sector's general orientations, which are translated into a national sanitation plan and action plans at the decentralized level.

A first version of a national strategy for sanitation in rural and peri-urban areas was also implemented with the aim of improving sector governance, strengthening institutions, defining the sector's strategic axes and creating a realistic action plan. At present, this strategy is incomplete because it does not explicitly define the institutional reforms to be undertaken or the financial resources to be mobilized. The current inadequate



institutional framework and lack of financial resources allocated to the sector are the main causes of the poor sanitation service.

A pre-existing report⁶ on solid waste management in Uvira offers us some information on the institutional framework.

We learn that there is no legal framework regarding the issue of collection, treatment and a possible obligation to sort waste. Nevertheless, some regulatory texts on environmental protection exist, namely:

- Law No. 11/009 of 9 July 2011 on basic principles relating to protection of the environment,
- Provincial Decree No.19/040/GP/SK of 28/08/2019,
- Ordinance-Law No. 18/003 of 13 March 2018 establishing the nomenclature of duties, taxes and charges of the central government,
- Ordinance-Law No. 18/004 of 13 March 2018 fixing the nomenclature of taxes, duties, levies and fees of the Province and the decentralized territorial entity as well as their distribution modes.

Among the municipalities of the city of Uvira, waste management faces several institutional, structural, financial and physical difficulties. There is generally no strong local sanitation policy in place. To date, the collection is totally held by the associations and the private sector because this public service is not organized at the central as well as decentralized level. Tricycles are rented for waste collection for associations interested in this service. Unfortunately, this system has proved to be ineffective and, given the increase in the city size, a different waste management system must be conceived.

All the structures involved have a role to play in waste management, but the law does not clearly describe it. as part of implementation of the solid sanitation policy, the central government as well as provincial institutions should take back control of this sector abandoned to NGOs and the private sector without any monitoring or follow-up being performed. The institutions present in the city do not exercise their control roles due to lack of resources and tools of specific regulation in this area.

f. REGULATORY AND INSTITUTIONAL FRAMEWORK IN RWANDA

The Organic Law determining the modes of protection, conservation and promotion of the environment in Rwanda (2005)⁷ constitutes the basis of waste management in the country. The Act underlines the general principles that guide the entire environmental sector, such as the principle of protection, the polluter pays principle, and definition of a legal basis and responsibilities for various competent authorities.

Other laws were subsequently enacted:

- The Environment Act 2018⁸, which sets out the rules in the waste management sector, as well as the penalties and measures to be taken,
- The national sanitation policy, which aims to improve solid waste management efficiency at national level, while highlighting principles such as full cost recovery and waste operators' financial stability.

RURA (Public Utilities Regulatory Authority)⁹, REMA (Environmental Management Authorities) and all municipalities in Rwanda determine regulations and guidelines for collection, transportation and recycling. These include:

- The solid waste collection and transport guidelines (2014), drafted by RURA, categorise waste collection companies, define requirements and types of licences, regulate the manner and frequency

⁶ Mission on development of the waste management master plan and support for development of the circular economy, city of Uvira, Democratic Republic of Congo, Diagnostic report-Phase 1 Data collection, ALMADIUS SRL (2021)

⁷ See Organic Law No. 04/2005 of 08/04/2005 determining the modes for protection, conservation and promotion of the environment in Rwanda.

⁸ See Law No.48/2018 of 13/08/2018 on the environment.

⁹ See Law N°09/2013 of 01/03/2013 on the creation of the Rwandan authority and regulation of certain public utility services (RURA) and determining its mission, powers, organization, and operation



of waste collection, specify the amount and timing of fees payable to RURA and determine household tariffs,

- The Rwanda Solid Waste Recycling Regulations (2015) also drafted by RURA, which provides standards for a recycling site and the process and permit requirements of a recycling facility, recycling operations and operation.

The administrative structure for waste management consists of policy-making institutions at national level, and a set of implementing agencies and regulatory bodies at national and local level.¹⁰ The local authority is Rusizi's City Council.

Several structures are involved in development of policies to be implemented by local administrative entities (including the city and local government bodies at the sector level):

- MININFRA (Ministry of Infrastructure),
- MoE (Ministry of the Environment),
- MoH (Ministry of Health),
- MINICOM (the Ministry of Commerce).

Guidance officers direct the way in which all implementation activities are performed:

- RURA (Public Utilities Regulatory Authority),
- REMA (Environmental Management Authorities).

The Water and Sanitation Authority (WASAC) implements waste management by getting involved in landfill management.

Finally, district and sector officials, with the City Council's support, are responsible for management of contracts with waste management companies and protection of the environment.

g. GENERAL RECOMMENDATIONS FOR THE IMPROVEMENTS NEEDED TO ESTABLISH A CIRCULAR ECONOMY

In the countries of the Lake Tanganyika region, the waste sector is positioned between a central authority and a local authority. It is thus often torn between quite different approaches and priorities.

This institutional positioning has clearly impacted the waste sector's governance system, put municipalities in rather uncomfortable situations and negatively impacted the performance of the programmes implemented, which are consequently slowed and sometimes blocked.

currently no dedicated structures or procedures exist for producing reliable, homogeneous, standardized and above all regular data in the various areas of waste management.

However, for their own planning needs, the main actors acting in this area occasionally produce some data outside a structured procedure; these, however, remain however approximate, not covering all the sector's fields.

To fill these gaps, the national level (and perhaps the regional level through the LTA) a dedicated information system on waste (typology, quantities, collection rates, recycling rates, equipment, final destinations, etc.) shared and put at the service of all the sector players. This system will provide information at the local, national and regional levels. It will be accessible to public and private actors, providing an opportunity for both to become involved in management of the system, but also to benefit from the exchange of data, information and experience on the various waste-related issues as part of an information flow mechanism. This will bring together regularly updated data and lessons learned from previous experiences in this area.

¹⁰ Assessing waste management services in Kigali, Anirudh Rajashekar and Gatoni Alexis Sebarenzi (2019)



On another level, waste management's professionalisation must involve continuous and targeted strengthening of the various stakeholders' capacities. Targeted training plans, by stakeholder category and according to specific needs, should be developed in support of the implementation of the strategy and permanent readjustments that would be made according to the observed developments.

For organization of the waste management sector, categorisation of trades involved in the field of is an essential step. After establishing an inventory of the various trades involved, they must be defined and distinguished in consultation with the profession. It will enable a definition of the skills required for each profession and fields of intervention and will delineate the responsibilities of each.

The vision for integrated waste management must be built around six (6) essential pillars:

1. The promotion of an integrated approach putting an end to sectoral practices that simultaneously considers all the links of the value chain and the different technical, financial and institutional aspects of management;
2. Integration of household waste management into the circular economy process. The objective is to reduce the consumption of natural resources by designing "regenerative" production and consumption models, allowing materials and products to remain in the economic circuit for as long as possible, to "close off" the material flows as much as possible and consequently to reduce the quantities of waste produced.
3. Effective implementation of the extended responsibility of producers, distributors and importers who place waste-generating products on the market. They must undertake management of this waste, namely financially. Their responsibility is extended not only to products placed on the market, but to all phases of their life cycle, including that of their management as waste or at the end of their life.
4. Capacity building and development of human, technical and financial resources of municipalities, key players in waste management and guarantors of process integration.
5. Protection of the environment, especially natural and environmental resources, by reducing the pressures generated by household waste throughout the chain, and in particular, during collection and landfilling.
6. Improvement in the quality of life, particularly in urban areas, nowadays very often degraded because of inadequate management of household waste, a source of obstacles to socio-economic development.

Waste management as practiced in the five cities is based on the linear economy model which consists of: extracting, manufacturing, consuming and disposing. The observed increase in the quantities of waste and the poor control of its management have a negative impact on the quality of life through the unhealthiness generated, cause environmental pollution linked to landfilling and incineration, but also maintain the permanent need for new primary resources.

In a circular economy, as the strategy recommends, the products' and materials' values is maintained for as long as possible. Waste generation and use of resources are minimized and when a product reaches the end of its life, it is reused to regenerate additional value.

Promoting integrated solid waste management must end linear and sectoral waste management practices. A global approach will consider simultaneously the different links of the chain and the various technical, financial, institutional and communication aspects.

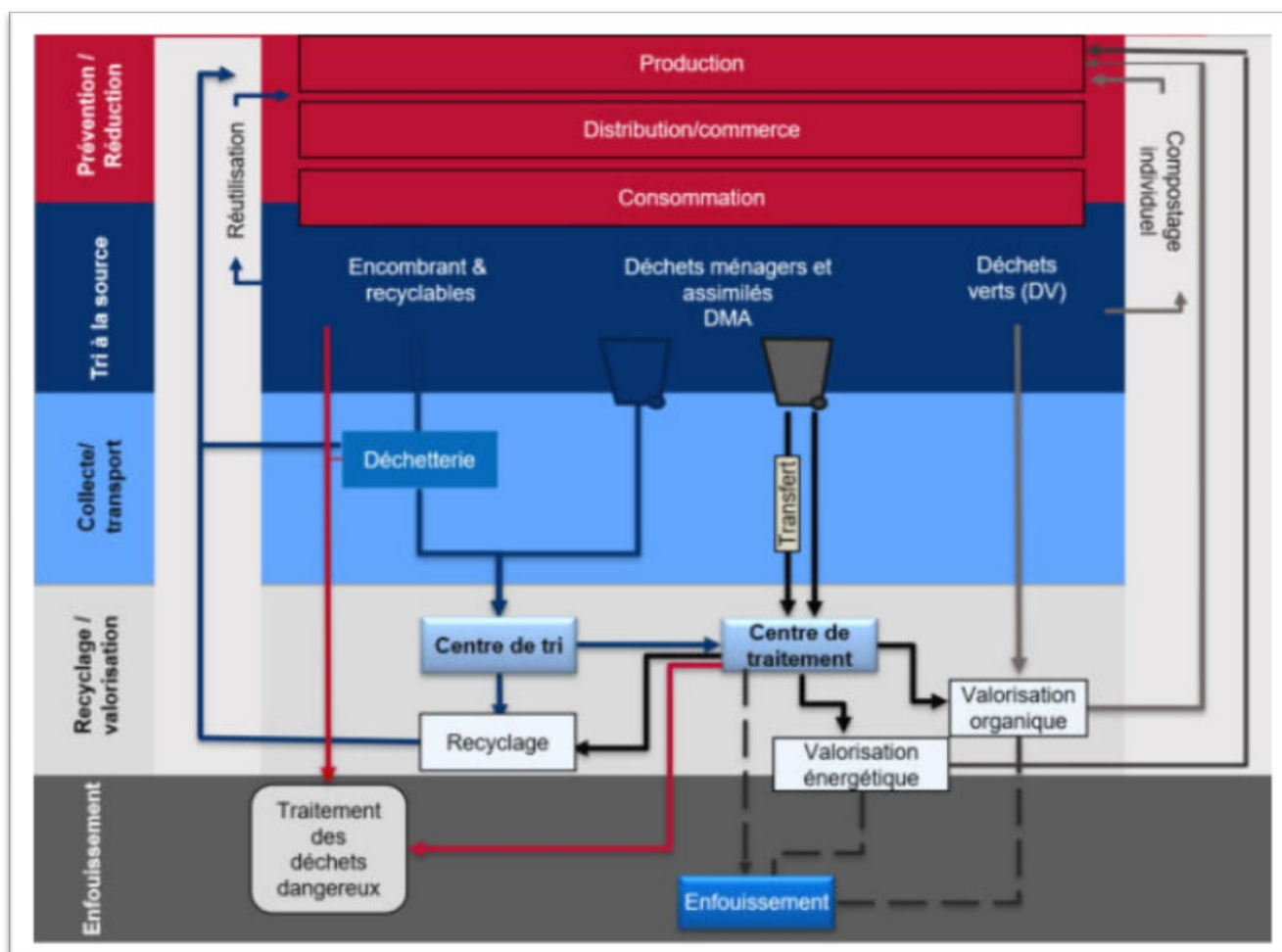
To pave the way for establishment of a circular economy in the cities concerned, especially since the regulatory frameworks in the countries currently allow it, we recommend working on the aspects constituting the integrated waste management strategy's technical axis. The following are the main elements:

- Design and implement, through activities and incentives, a vast waste reduction program working simultaneously on production, distribution and consumption patterns.



- Promote Extended Producer Responsibility (EPR) as a citizen measure and incentive for waste minimisation.
- Place the issue of sorting in a global logic of waste management and involve the municipalities substantially in this important link in the chain.
- Make urban cleanliness one of the national priorities, on which socio-economic development depends.
- Create the conditions for an effective and efficient partnership between municipalities and the private sector placing this pair at the forefront of waste management and cleanliness.
- Design and implement an effective strategy for collection and management of household waste in rural areas
- Upgrade municipal parks to better meet equipment maintenance and servicing needs.
- Adapt the material means to the municipalities' real needs and the urban context.
- Developing infrastructures for treatment, recovery and recycling of waste, adapted to the volumes and nature of HSW.
- Revisit the landfill development programme to upgrade operating landfills to treatment centres and close and/or rehabilitate uncontrolled landfills, improve the operation of active controlled landfills and prioritize areas that do not have controlled landfills.

The following diagram represents the HSW management cycle to be implemented in each city:





h. AMENDMENTS AND ADDITIONS TO THE LEGISLATIVE FRAMEWORK

To implement the actions listed below, modifications/additions must be made to the legislative framework (national and/or regional) in terms of environmental protection, waste management, economic development, trade development, etc., for the five cities:

- Reaffirm the municipality's legal competence and responsibility on the public service of waste;
- The municipality could delegate the collection and transport of waste to private operators. It appears that there is a provision to be paid when the service is provided. The City Council's role would then be confined to regulation of the service, but above all to control of the service performed by the operators and punishment of the infringements committed.
- Landfill management could also be delegated to a dedicated private operator.
- Service funds also need to be reviewed. If there is a provision to pay, a comprehensive waste management plan is needed to develop a financing plan. It is only based on a strategic plan for reconstituting the entire chain of collection and processing of MSW that it will be possible to draw up a draft financing plan.
- Encourage the private sector to invest in the service sector and waste recovery (subsidies, tax benefits, etc.).

i. EXCHANGE SPACES AND PLATFORMS

To ensure a better control of the situation in the five cities in terms of waste management and to ensure implementation of the proposed strategic guidelines, it will be relevant to set up exchange spaces/platforms among public actors, private actors, technical and financial partners and civil society organisations at national, regional, international level. In this context, we recall the recommendations noted in the previous report, namely:

- Create a coordination platform between the LTA and ABAKIR regional authorities: add a coordination and exchange mission for annual reports and results. The environmental managers in both authorities can take charge of this platform.
- Create a cell, under the direction of the LTA's environment, in charge of solid waste management and liquid sanitation. This cell should consist of a cell leader based in Bujumbura and 4 representatives based in other cities. The members of this team would benefit from continuous training in waste management and sanitation (processing technology, collection and transfer logistics, recovery, etc.). The mission of this cell would be:
 - Monitoring project implementation and operation in cities,
 - The technical support and training of the operators' municipal competences in each city,
 - Assistance to municipalities in defining equipment and financing needs in the provisional plans,
 - Support for municipalities in formulating requests for funding from donors,
 - Monitoring and interpretation of environmental indicators regarding management of liquid and solid discharges,
 - Preparation of assessment reports on solid and liquid waste management situation in each city, etc.
 - Support for municipalities in preparing calls for tenders and compliance with procurement procedures (to reassure donors)
- Development of networking among the municipalities concerned by the LATAWAMA project with other municipalities in the 5 countries and specialized private operators. This networking would allow exchanges on experiences and development of reflections on solutions to be undertaken to improve citizens' environmental quality of life. Annual workshops could be organised with the support of the EU, inviting other donors to identify possible funding avenues.

j. INTERGOVERNMENTAL BODIES' ROLES AND MISSIONS

To date there are two intergovernmental bodies around lakes Kivu and Tanganyika:



LAKE KIVU-RUZIZI BASIN AUTHORITY (ABAKIR):

The Lake Kivu and Ruzizi River basin is a transboundary watershed of the Congo River basin, common to the three countries: Burundi, DRC and Rwanda. The watershed of the Lake covers nearly 5,340 km². Its outlet, the Ruzizi River flows north of Lake Tanganyika between Uvira - DR Congo and Bujumbura. The area between the Ruzizi watershed at the exit of the lake is almost 325 km².

On 6 July 2011, in Kigali, Rwanda, the ministers in charge of water of the three member countries signed an agreement to set up an Authority in charge of the integrated management of the basin's water resources. Pending the signature and ratification of a convention by the three Member States, a transitional structure of ABAKIR has been created. On 4 November 2014 in Kinshasa, the ABAKIR convention and statute were signed.

The creation of ABAKIR is based on:

- Effective international cooperation;
- Sustainable and equitable management of water resources;
- Improved socio-economic integration of the countries of the sub-region.

This body's main objective is to implement a policy of cooperation for sustainable development and stabilization of the Great Lakes Region through the integrated management of water resources of the Lake Kivu basin and the Ruzizi River, in all its dimensions (energy, agriculture, fishing, lake transport, tourism, biodiversity, etc.).

The ABAKIR mission is as follows:

- Establish a state of the art on the basin's water resource and environment;
- Monitor the state of the resource, its uses and consequences considering risks such as floods, droughts, lake level fluctuations, gas releases at the lake surface, erosions, volcanic and seismic activities, pollution, etc., to propose consistent measures.
- Develop and maintain a network regarding the water resource quality and quantity.
- Develop management and development plans for management and protection of the resource based on information collected from different sources or existing structures and those exchanged between Member States.
- Establish common rules relating to the regulation of the resource, ensureir application and assess the impact of non-application to establish remedial measures.
- Examine possible complaints from users and assist States in resolving conflicts in this area.

The current challenges for ABAKIR are:

- Clearing of forests for agriculture and the cutting of firewood that causes erosions and mudslides in watercourses.
- Strong sedimentation that alters biodiversity through habitat destruction.
- The absence of a common liquid and solid sanitation policy
- Improvement of the state of the lake water polluted by rains, which results in all the pollution produced by the inhabitants, industries, hotels along the lake, mines, livestock breeding along the rivers, pesticides and chemical fertilizers, which alters the quality of the water while the population draws water directly from the lake and washes in it, thus affecting the bordering populations' health.
- The lack of a treatment facility for wastewater and various waste types.

LAKE TANGANYIKA AUTHORITY (LTA):

The Lake Tanganyika Authority (LTA) was established in December 2008 as the management body of an institution that includes the Conference of Ministers, the Management Committee and the Secretariat.

The LTA's mission is to ensure protection and conservation of biological diversity and sustainable use of the natural resources of Lake Tanganyika and its basin. The LTA's work depends on the Strategic Action Plan



(SAP) recommendations. The SAP priorities include the efficiency of the operations of the LTA bodies, improving community infrastructure and water treatment, developing the capacity of stakeholders for sustainable management of fisheries resources, reducing water pollution and sediment flows in the Lake, and establishing an integrated regional monitoring system. The implementation of a framework for a fisheries management plan, which is part of the LTA Strategic Action Programme, is essential to ensure management and protection of the aquatic ecosystem, improving the conditions for exploitation and development of the sustainable fisheries sector. The LTA's main partners are the European Union, the African Development Bank (AfDB), Nordic Development Fund, FAO, UNDP, Global Environment Facility, IUCN, UNEP and NIGLAS.

Compared to the challenges LTA must face, we find the same points observed for ABAKIR, namely continuous pollution of the lake waters as well as the behaviour of the population and the absence of a common policy on the environment and the management of liquid and solid waste between the five countries around the lake.

The two lakes (Kivu and Tanganyika) are linked via the Rusizi River and suffer a high pollution load mainly due to liquid and solid discharges into the waters of the two lakes. Pollution is spreading from one lake to another. Thus, coordination and cooperation between the two bodies is necessary to ensure effectiveness in protection of the two basins. We recommend the following:

- Create an enabling environment, including policy, legislation and regulation for management of transboundary or shared water resources;
- Strengthen cooperation between countries sharing the two entities, including through the development of joint projects and programmes;
- A convention must be drafted and ratified by both entities. This convention must define a common policy for management of liquid and solid discharges around the lake, as well as establishing a platform for data and information exchange on the lake water quality and the progress of the various projects implemented for protection of the two lakes' water.

k. ANALYSIS OF EXISTING PLANS / STRATEGIES

During our data collection mission, we became aware of the existence of several studies performed related to solid waste management. In particular, master plans and strategies for each city.

However, we found almost no implementation of these strategies and recommended actions, except in the case of Kigoma.

Several causes can be at the origin of this situation and the failure to pass from theoretical to practical. We can mainly mention:

- The guidelines and recommendations set out in the studies are not sufficiently detailed to be operational
- Economic and Institutional Non-Feasibility
- Lack of financial resources for implementation
- Lack of specialized skills in this area
- Management of waste is not a priority for the administration, which is forced to prioritise other sectors due to a lack of financial resources.

l. STAKEHOLDERS AND INTERESTED PARTIES

Stakeholder analysis makes it possible to understand the interests, needs and concerns of the different parties involved, to examine their respective roles, interests, and waste management capacity and to estimate the degree of collaboration among the different parties. It is also important to facilitate collection of baseline information from them.

Based on the information collected to date, and following an analysis, we have noted the following:



- The situation with regard to waste management in the 5 cities is facing many problems. The population does not yet widely perceive management of waste through collection and effective and environmentally friendly treatment as an economic, environmental and socio-cultural necessity.
- The public/private partnership is not highly developed in waste management: no specialized private companies are involved in collection, transport, treatment, recycling and recovery of waste.
- Financial resources allocated to management of sanitation activities are insufficient for the 5 cities; in health centres and in some hospitals, waste management suffers from a dramatic lack of financial support compared to resources allocated to medical care. This results in constraints throughout the process: demotivation of hygiene agents and low renewal rate of packaging equipment, rubbish cans, etc., and protection (gloves, masks, etc.).
- Legislation in the 5 countries exists but does not meet the cities' requirements. Well-considered strategies are in place at the national level, but the follow-up and actions are slow to take place; national regulations exist, but the municipalities do not receive or have the financial means (also due to the lack of tax revenue) to organize and control the collection in the territory.
- It is difficult to distinguish the hierarchical structure between the authority responsible for managing the waste, the collection operator, the controller and the citizen. Each blames the other for system malfunctioning.

Based on the documentation collected, we were able to rate stakeholders at the national, local and private levels as shown in the following table:

Country	Identified stakeholders
<u>Regional level</u>	• Lake Tanganyika Authority (LTA) • Lake Kivu-Ruzizi Basin Authority (ABAKIR)
<u>Kigoma, Tanzania</u>	The main actors are the Ministry of the Environment, sectoral ministries, regional secretariats, local government authorities, the National Environment Management Council (NEMC), the Environmental Appeals Tribunal and the National Environmental Advisory Committee (NEAC). Other actors include development partners, academic and research institutions, the private sector, civil society organizations, media, local communities and the general public. <u>Local Government:</u> • Kigoma/Ujiji Municipal Council (KUMC) <u>Communities:</u> • Community-based organisations formed by the LATAWAMA pre-collection project (22) <u>Private (Recycling):</u> • Umoja group
<u>Rusizi, Rwanda</u>	<u>National Authority:</u> • Ministry of Environment • Ministry of Infrastructure (MININFRA) • Public Utilities Regulatory Authority (RURA), • Rwandan Environmental Management Authority (REMA) • Water and Sanitation Corporation (WASAC) <u>Local Government:</u> • Rusizi Municipal Council <u>Private Sector:</u>



	• Main recycling companies in Rwanda¹¹ (Agroplast Ltd, Ecoplastic Ltd, Softpackaging Ltd, SOIMES Plastic Ltd, Electromax Ltd) • Greencare Rwanda Ltd, is a recycling company located in the Huye district, which transforms biodegradable waste into organic compost, and plastics and bags into eco-friendly paving stones
<u>Mpulungu,</u> <u>Zambia</u>	<u>National Institutions:</u> • Zambia Environmental Management Agency (ZEMA) • Ministry of Local Government and Housing (MLGH) • Water Resources Management Authority (WARMA) <u>Local Government:</u> • Mpulungu District Council
<u>Bujumbura</u> <u>Burundi</u>	<u>National Institutions:</u> • Ministry of Environment, Agriculture and Livestock (MEAE) • Ministry of Hydraulics, Energy and Mines (MHEM) • Rural Hydraulics and Sanitation Agency (AHAMR) • Burundi Office for Protection of the Environment (OBPE) • General Drinking Water and Basic Sanitation Administration • General Environment, Water Resources and Sanitation Administration • Administration of Health Promotion, Hygiene and Sanitation, within the MSPLS • Former “Burundi Municipal Technical Services (SETEMU)”: currently Department of the Environment, Hygiene and Sanitation and that of connection to public networks at the Burundian Office of Urban Planning, Housing and Construction <u>Local institutions:</u> • Bujumbura City Hall <u>Private Sector:</u> • Burundi Industrial Association • Federal Chamber of Commerce and Industries of Burundi • Public Service Delegation • Private sectors involved in waste management in Burundi <u>Development partners</u> • European Union • UNICEF WASH cluster • UNDP • National and International NGOs involved in waste management in Burundi <u>Local organizations</u> • Local associations¹²: Association Réveil au Développement des Activités Socio économiques (ARDASE), Association de Développement et de Lutte contre la Pauvreté (ADLP) • Initiatives: Biogas, tel: 62349421, • IRON& Steel pour les déchets métalliques, Quartier Industriel, près de l'OTRACO, Tél 61861983, GASAKA Pastic, Q.10 Ngagara , 79939965 • In terms of e-waste, there is a national association “Great Lakes Initiatives For Communities Empowerment” (GLICE), which manages electric and electronic waste.

¹¹ Circular Economy in Africa-EU Cooperation, Country report for Rwanda, European Commission / Trinomics, 2020
Bujumbura Wastewater and Sewage Sanitation Master Plan, 2013¹²



<u>Uvira</u> <u>DRC</u>	<u>National authorities and their missions:</u> • Ministry of Hydraulics and Environment: ensure sanitation of the environment, ensure sustainable management of water resources throughout the national territory, • Ministry of Environment and Rural Development: ensuring environmental remediation work and monitoring their implementation <u>Local Government and missions :</u> • National Rural Hydraulic Service (SNHR): this service initiates projects for drinking water access in rural and peri-urban areas of the DRC • The City Council: responsible for ensuring continuity of the public service and regulating it <u>Private service:</u> • REGIDESO: responsible for drinking water distribution throughout the national territory, both in urban and rural areas <u>Development partners:</u> • United Nations Development Programme (UNDP). • UNICEF WASH Cluster: Disseminate information, ensure an effective and quality response to different needs by avoiding duplication and gaps in the coverage of humanitarian assistance, establish partnerships between stakeholders, strengthen synergies. <u>National and International NGOs:</u> • Aid and protect vulnerable people and meet the needs of populations at risk
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The real difficulty, which is a major obstacle to development of a sustainable public waste collection service, is the question of financing. More specifically, assuming that the financial partners agree to economically support the capital expenditure of the first years, in the form of a gift, a loan or a mix of both, the recovery of operating expenses by fee collection remains a real challenge, given the domestic users' ability to pay.

We have retained the ratio of operating revenues to operating expenses as the services' financial sustainability indicator. When it is less than 100%, the service's financial sustainability is no longer guaranteed to the extent that it would no longer be able to finance its operating and maintenance costs and properly maintain its equipment.

As part of this study, we sought to assess each public waste collection and treatment service's ability to recover its operating costs and equipment renewal only by the fees or Tax on Household Waste Removal. More specifically, we have determined an average fee for the domestic user to balance the service financially, knowing that, during the transition to the pre-operational phase, a more complete tariff study will be necessary to calibrate pricing according to the household income levels; or to set up an incentive pricing (pay for only what is thrown away) to encourage organization of selective sorting upstream. This calculated average fee allows approximating the average fee level and financially balancing the service by recovering the operating and equipment renewal costs of the service.

m. BENCHMARKING ON DOMESTIC USERS' ABILITY TO PAY

Beyond the financial balance discussed above, a second important factor in the financing of public services is the ability to pay of users, and more particularly domestic users. This is why we have analysed some experiences from other African countries to assess this ability to pay. We found few references on the issue of



financing and domestic users' ability to pay. Those on which we have relied, nevertheless, are serious references since they are research work that has been performed based on field experiences and data collection in the field.

In Guinea Conakry, the average monthly pre-collection fee in 2010 was €0.6/month for low-income households, €1.2/month for middle-income households, and €1.8/month for high-income households. Annually, the pre-collection fee was therefore €7.2, €14.4 and €21.6 respectively for low-, middle- and high-income households.

Moreover, in 2011, the minimum wage in Guinea was fixed at 440,000 GNF per month (€52.2/month), or €626/year.¹³ The salary of a category A (average income) civil servant in the 1st step was approximately GNF 570,000 equivalent to €67/month, or €804 per year. The salary of a civil servant of the same category, but at the highest level, was 1,310,000 GNF per month, or €155.5 per month, equivalent to €1,866 per year.

Thus, compared to the income level, the fee paid by the low-income household is approximately 1.15% of its income, that paid by the middle-income household is 1.8% of its income and finally the high-income household pays 1.17% of its salary for pre-waste collection service.

These fee levels are approximately the same in other countries in West Africa. In Côte d'Ivoire, in working-class neighbourhoods, people regularly pay financial compensation to informal actors for collection of their waste. The amounts paid are around 1000 FCFA per month (1.5 euro). Compared to the minimum wage of 36,600 CFA, the willingness to pay is of the order of 2.7% of the household income.

For public drinking water and sanitation service, it is unanimously accepted (World Bank, OECD, EU, etc.) that the social acceptability threshold of bill payment is 3% of household income for drinking water, and 3% of household income for collective sanitation. Therefore, based on these references, we will use this rate of 3% as the maximum threshold of users' ability to pay for public solid waste collection service. At this stage of the financial analysis, it remains difficult to assess the fees' social acceptability threshold for local populations. Subsequently, a willingness to pay/ability to pay study must be conducted at each site. Based on the results of this tariff study, the fee levels may be scaled more precisely. In any case, if the acceptable fee level does not cover all operating expenses, the deficit must be covered by other sources of funding, subsidies or other mechanisms.

n. OTHER USERS' ABILITY TO PAY

The assessment of the ability to pay of other users such as public administrations, hospitals, shops or industries could not be performed. For each of these users, their ability to pay depends on their size, as well as the nature of their activity. When the data collected could be mobilized, we integrated these users in the field of fees, but this was not always possible for lack of data. Nevertheless, as we will see later, the main source of funding for public waste collection services remains the domestic, commercial and industrial fees.

3. SCENARIO FOR DEVELOPMENT OF SOLID WASTE MANAGEMENT MODALITIES

In the interim report, the team advanced possible scenarios for each city. The financial and economic calculations have been presented (the financial calculations and economic profitability of the modalities of

¹³ <https://www.invest.gov.gn/page/code-en-vigueur?onglet=code-du-travail#:~:text=Cependant%2C%20il%20existe%20un%20salaire,est%20de%20440%20000%20GNF>.



recovery of plastics and composting of organic materials are in **Appendix A**) in a summary way to provide a tool for (preliminary) decision support for decision-makers among governments and donors. The modes are as follows:

Clean City Scenario for Healthy Waste Collection and Disposal in Every City

The aim is to study for each city the possibility of setting up a municipal waste management system that ensures pre-collection, collection and disposal in a technical landfill of all the waste generated by the city; i.e., "a clean city." For this scenario, the necessary financial funds and the operating costs of the entire chain were calculated.

Plastic-Free Scenario for Plastic Collection and Recycling

In a second solution, we proposed the case of plastic recovery in each city. The system's operation is simple. This actually involves directing the circuit without state intervention. Citizens collect plastic waste (any type of plastic) and head to a platform for recovery, sorting, cleaning, grinding and production of pellets. This platform will be managed by a private company that buys the plastics brought back by the waste collectors and transforms them into granules for sale to the local market or for export (strong demand on an international scale). A feasibility study with a business plan for this platform must be conducted to detail this scenario's implementation and sustainable operation. In this report we have performed the financial calculations to determine the possible profitability for each city.

"Organic waste composting" scenario for organic material collection and composting

During the field mission in the cities concerned by this project, we noted the high demand and acceptability among the populations for organic composting products. Local associations have organized themselves to develop collection and composting activities. These initiatives remain insufficient and far from achieving satisfactory returns, despite the abundance of organic matter in the waste generated in cities. This is how we estimated the importance of studying this method of waste management and calculating the profitability of composting platforms.

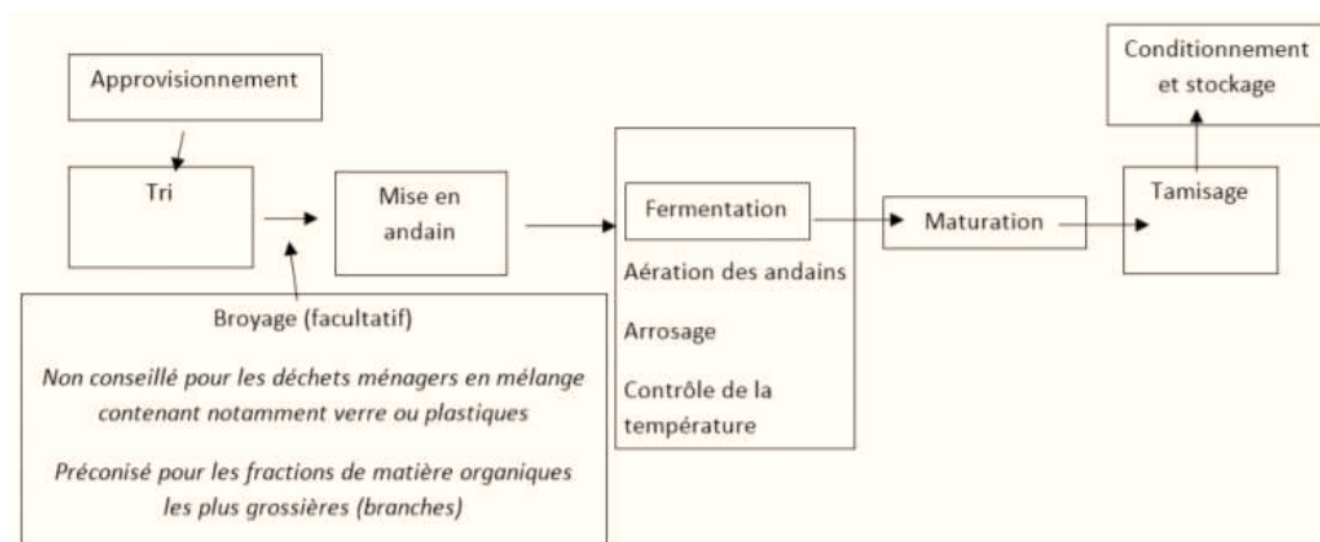
To ensure operation of such a platform, it is necessary to set up a system adapted according to the different sources of production. The following table provides information on the organization of the planned collection for each production source as well as the planned activities to recover as much organic matter as possible in each city. The composting platform operator is responsible for collection and transport of organic materials.

No.	Sources of organic waste production	Collection system	Activities/Actions to be performed
1	HOUSEHOLDS	Door to door (with tricycle suitable for collecting decomposable waste)	- Communication and awareness-raising on sorting organic waste - Provision of two regulatory bins - Purchase of organic waste if sorted well / motivation
2	STEPS	Grouping point: Installation of bins then recovery by tricycle	- Communication and awareness-raising on sorting organic waste - Presence of an agent to direct the discharge of organic waste into the bins - Provision of two authorised bins for restaurants and canteens - Recovery at source for restaurants and canteens - Purchase of organic waste that is well sorted / motivation for restaurants and canteens
3	BUS STATION	Same system as markets	



4	SLAUGHTERHOUSE	Grouping point: Installation of bins and recovery by tricycle	- Dedicated tray installation at each slaughterhouse - Agent for directing the discharge of organic waste into the bins and then recovery by tricycle
5	UNIVERSITIES AND CASERMES	Grouping point: Installation of 660 L bins and recovery by tricycle	- Communication and awareness-raising on sorting organic waste - Provision of bins for packaging organic waste and other types
6	HOTELS AND RESTAURANTS	Grouping point: Installation of bins and recovery by tricycle	- Communication, awareness on sorting organic waste - Sale of bins - Fees for collection of organic waste and transfer of other waste to landfill
7	GREEN WASTE / BIOMASS	At the source and after expression of need	- Establishment of a paid collection /call server service - Extension of the service - Market research to determine collection cost based on volume

The technique that will be used is windrowing on watertight platforms equipped with equipment necessary for the process (see process below):



More details are presented below for each scenario. Following the final choices and decisions on the scenarios to be further developed, complete feasibility studies must be conducted with an operational scheme for implementation.

a. WASTE MANAGEMENT IN THE CITY OF BUJUMBURA

Assumptions used¹⁴

- Specific waste production of 0.5 Kg/Hab./d
- Population growth rate of 7% per year
- 90% of the waste generated by the city of Bujumbura is unofficially dumped (usually in river ravines) and rainwater gutters.

¹⁴ Assumptions adopted by the experts following the field missions and findings.



- 75% collection of household and similar waste from 2024 to reach 95% in 2045. The collection rate does not exceed 95% because of the small, scattered neighbourhoods, which, although within the municipality boundaries, will not be served due to lack of access (unstructured urbanization) and remoteness (major constraint against the optimization of collection) found in the city of Bujumbura.
- Plastics represent 15% of the amount of waste collected, and the organic matter contained in this waste represents about 57%.
- 50% of the waste collected in easy access areas and 50% of the waste collected in difficult access areas, where mechanized collection is possible
- The collected waste is recovered in 14 m³ containers
- Waste density is 0.35 T/m³

SCENARIO 1: BUJUMBURA CLEAN CITY

This involves implementation of an integrated solid waste management system for the city, considering all types of waste (household, assimilated, industrial, green, from demolition, etc.). In this scenario, it is necessary to provide for:

- Technically: implementation of all the means necessary for management of waste throughout the value chain, considering the extraction of recoverable waste and its routing to the specific recycling channels. This scenario automatically provides for development of a waste treatment and final disposal centre, grouping or transfer points, one or more sorting platforms and a maintenance fleet of equipment. For mobile equipment, the collection and transfer vehicles best suited to the city must be provided, along with the containers and bins necessary for system's operation.
- Financially: this scenario requires large budgets for investment (civil engineering and mobile equipment), but for operation, ongoing funding mechanisms will ensure sustainability. Generally for this kind of scenario, it will be necessary to opt for Public-Private partnerships with a DBO (design build operate) contract or in BOT (build operate transfer) to lighten the burden on the state.
- Institutionally: in the case of Bujumbura, the feasibility of this type of scenario requires revision of the entire existing institutional and regulatory framework. Above all, it is a question of clarifying the current institutions' missions, strengthening the supervisory authorities, training a competent and ample staff in the municipality or the OBUHA, and reviewing the regulations for PPP frameworks.

For implementation of a pre-collection/collection system for household waste in the municipality of Bujumbura, 14 m³ containers should be installed on accessible city roads.

Pre-collection would be provided mainly by voluntary contribution as indicated in the overall MSW management scheme.

Below is the general waste management plan in the municipality of Bujumbura.

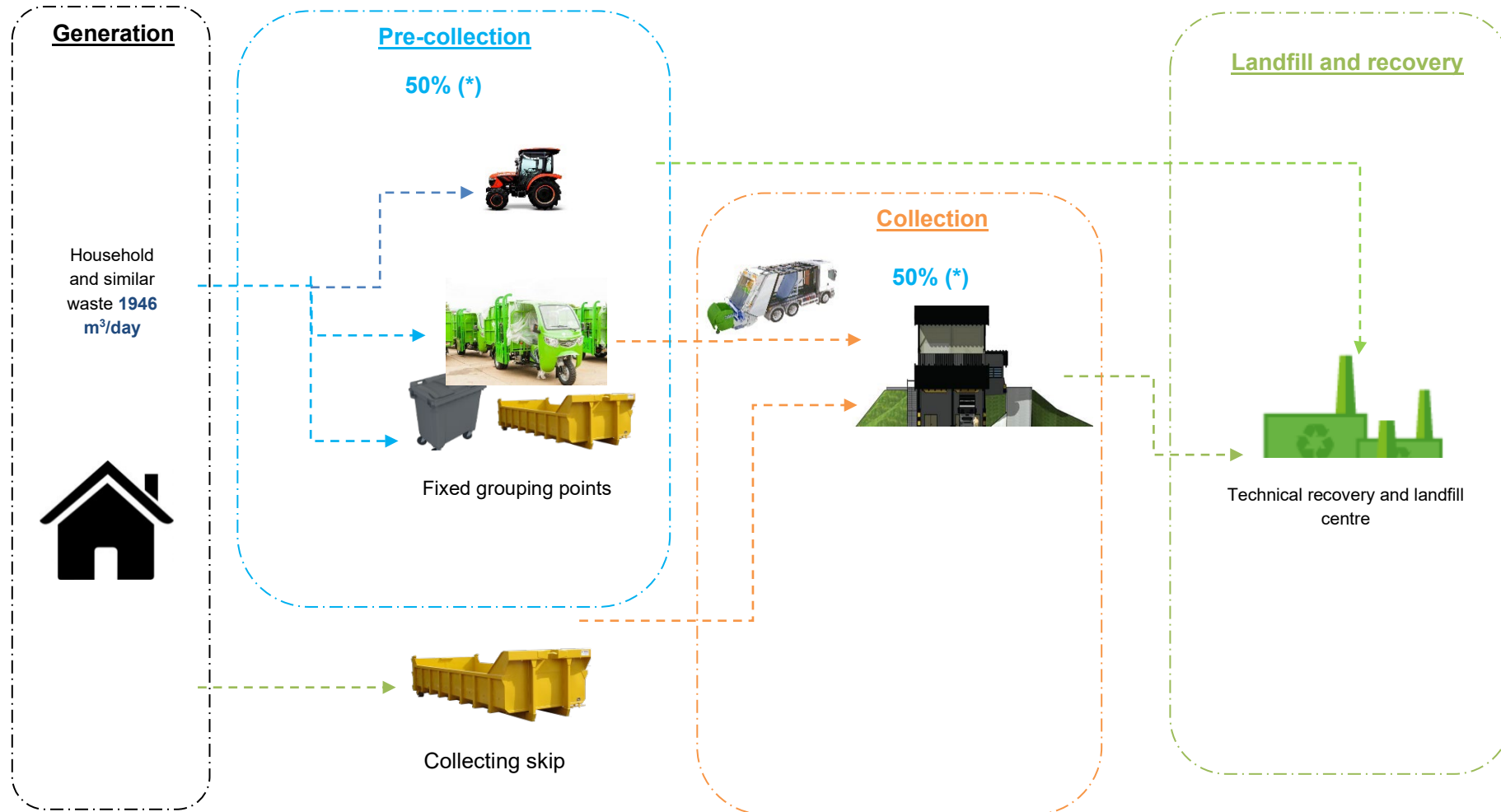


Figure 1: Diagram of household waste management organization in the municipality of Bujumbura in 2024 (collection rate of 75%)

(*): total quantity collected in the city



service

Based on the evolution of the population and waste generation up to 2045, the quantities of solid waste pre-collected, collected and transported are as follows:

Table 1: Estimation of pre-collection, collection and transport of household solid waste by 2024 to 2045 in Bujumbura

Years	2024	2030	2035	2040	2045
Production (m ³ /D)	1,946	2,921	4,097	5,746	8,059
Collection rate	75%	80%	85%	90%	95%
Total collectable volume per day (m ³)	1,460	2,337	3,482	5,171	7,656
Pre-collectable volume (50%) on non-vehicle roads	730	1,168	1,741	2,586	3,828
collectable volume (50%) in motorable roads with possible mechanized collection	730	1,168	1,741	2,586	3,828



Table 2: Summary of pre-collection, collection and transfer materials in Bujumbura by 2024-2045

Pre-collection material and staff						
Years		2024	2030	2035	2040	2045
Equipment	14 m³ bin	47	75	112	166	246
	5 m³ (4.2 tonne) bin	15	23	35	52	77
	14 m³ - Relay bin	13	22	32	48	70
	5 m³ (4.2 ton) bin + relay bin	5	7	11	14	21
	Tractors (3.5 Tonnes) 3m³	12	19	29	43	64
	BOM carts 5 m³	51	82	122	181	268
	Carts 3 m³	24	39	58	86	128
Personnel	Drivers	96	154	230	341	505
	Rubbish collectors	202	324	483	717	1,061
	Supervisors and site cleaners	116	120	130	135	140
	Pre-collection sector heads	16	16	20	20	26
	PRE-COLLECTION STAFF TOTAL	430	614	863	1,213	1,732



Equipment and personnel for collection and transport						
Years		2024	2030	2035	2040	2045
Equipment	Packers (16 m ³) / 2 rotations per day	26	42	62	92	137
	Amplirolls - bin lorries (4 bin lifts per day)	13	21	31	47	69
	skip lorries (4 bin lifts per day)	5	7	11	14	21
	Tipper (5 Tonnes)	-	-	-	-	-
Personnel	Drivers	48	77	114	169	249
	Rubbish collectors	96	153	228	338	500
	Supervisors	6	6	8	8	8
COLLECTION STAFF TOTAL		150	236	350	515	757



Transfer equipment and TC personnel and operation						
Years		2024	2030	2035	2040	2045
Equipment	Number of containers (30 m ³)	44	70	104	155	230
	Number of semi-trailer compactors (70 m ³)	2	3	5	7	11
	Number of containers (30 m ³) - Relay	7	12	17	26	38
	Number of semi-trailer compactors (70 m ³) - Relay	1	1	1	1	1
	Number of container lorries (2 skips at a time) and 4 rotations per day	7	12	17	26	38
	Number of lorries carrying semi-trailers-compactors	1	1	1	1	2
Personnel	Drivers	19	29	42	61	90
	Apprentice Drivers	19	29	42	61	90
	Supervisors	3	3	3	3	3
TOTAL TRANSFER STAFF		40	60	87	125	184

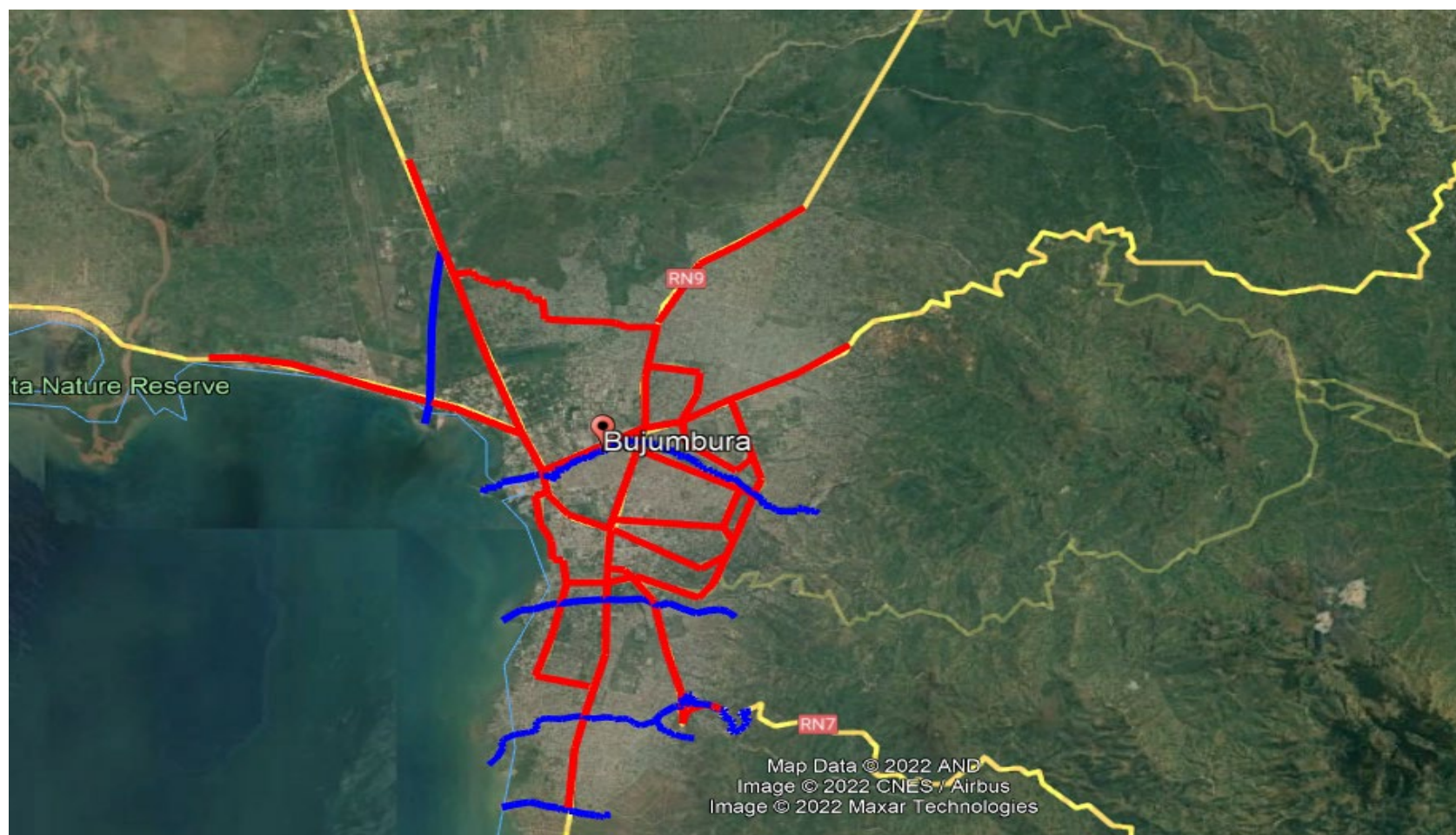


Figure 2: Manual cleaning routes¹⁵ (in blue with a length of 28,849 metres) and manual sweeping routes¹⁶ (in red with a length of 76,065 metres) in Bujumbura

¹⁵ Drainage of the main stormwater gutters that currently retain solid waste

¹⁶ Sweeping and cleaning the main axes and recovering the solid waste present



From 2024, the necessary equipment would be:

For the pre-collection:

- 12 tractors of 3 m³,
- 51 5m³ BOM carts
- 24 carts of 3 m³

These small machines would ensure waste collection in inaccessible areas, for a capacity of 730 m³/d. This number would evolve over time to reach 64 tractors, 268 BOMs of 5 m³ and 128 carts of 3 m³ in 2045 and a tonnage of 3,828 m³/d.

- 80 chests as follows: 47 chests of 14m³, 15 chests of 5m³, 13 chests of 14m³ and 5 chests of 5m³ with relay, from 2024 to reach a total of 414 chests in 2045.

For collection:

- 26 16 m³ packing bins
- 13 amplirolls lorries

These collection machines would ensure waste collection in accessible areas, for a capacity of 730 m³/d in 2024. This number of machines would evolve over time to reach 137 packers, 69 lorries in 2045 and a collection tonnage of 3,828 m³/d.

For the transfer:

In the case of Bujumbura, we have scheduled only one transfer station:

- 7 container lorries and 2 trunks at a time, this number would evolve over time to reach 38 lorries in 2045.
- 44 30 m³ containers in 2024 and 230 containers in 2045.

The following table details the list of staff to be hired in the TC in Bujumbura, which are evaluated at 21 agents:

Table 3: TC equipment and machinery table in Bujumbura

Weighbridge	2
Mechanical Workshop	2
Utility vehicle	4
Fuel storage device	2
Electronic kit (Weighing,...)	2
Fuel tanker lorry	2
Container lift	2
Reserve container 30 m ³	10

Table 4: TC staff table in Bujumbura



Station Manager	2
Controllers	8
Exploitation Leader	2
Weighting agent	8
Cleaning and maintenance agents	10
Drivers	8
Nurse	2
Attendant-Help	2
Total	42

The financial aspects

User fees

As indicated in the above report, currently no fees are applicable to all households. We will retain the following fee assumptions:

- **Household fees, willingness to pay and ability to pay.**
Currently, only some households pay for a waste collection service. Private companies offer their services in exchange for a payment of 5,000 FBU/month or 2.50 EUR/month or 30 EUR/year. However, at this level of fee, only the wealthiest households can pay for the service as they represent nearly 10% of the average household income in Burundi (280 EUR/year). However, we have used as hypothesis of availability to pay households for this service of the order of 3% of the average income. At this level, the average fee would be EUR 10/year.
- **The number of domestic fees.**
The number of domestic fees is expected to increase gradually between 2024 and 2045 at the rate of population growth. Based on an annual population growth rate of 7%, the number of domestic fees would reach 967,970 households in 2045 or 5,807,822 inhabitants. The rate of waste collection would also increase to 95% in 2045 thanks to a capacity building of the city's collection system.
- **The other fees.**
Other fees apply to hospitals, schools and other public institutions and industries. It has not been possible to obtain an accurate census of these. Below we propose our own estimate based on a review of data in existing reports and documents.

Assessment of the potential fees for industrial payers

- 63 schools in Bujumbura¹⁷
- 52 hospitals and clinics¹⁸
- 40-50 in the country¹⁹ (assumption: 1/3 of industries are in Bujumbura (16))
- Administration: no source available

The fee levels paid by all the users is presented in the table below.

¹⁷ <https://knoema.fr/atlas/Burundi/Bujumbura-Mairie/Number-of-Schools>

¹⁸ Identified on Google maps

¹⁹ <https://jimber.org/industrie-salon-promotion-investissement-economie-aib-burundi/#:~:text=Depuis%207%20ans%2C%20selon%20D%C3%A9sir%C3%A9,pilier%20de%20la%20croissance%20%C3%A9conomique%20%3F>



Table 5: Fee Level

	Fees (EUR/y)	Number
Households	10	241,000 (in 2024)
Industries	500	30
Administrations	500	100
Schools	20	65
Hospitals	500	52

Global funding for waste management

For the record, we used the following assumptions for financing of the scenario:

- The financial partners undertake financing of the first years' investments,
- The equipment operating and renewal costs are entirely financed by this service's operational revenues.

The table below shows the evolution of service revenues and expenses over the analysis period. The recovery ratio of operating expenses increases with the rate of increase in waste collection. Over the entire period, it exceeds 100%, indicating the service's financial capacity to ensure financing of its operation.

Table 6: Evolution of revenues and expenses in Bujumbura

Bujumbura	2024	2030	2035	2040	2045
Donor financing	€ 6,947,000	0	0	0	0
CAPEX	€ 6,947,000	€ 622,680	€ 1,424,840	€ 1,908,440	€ 2,405,460
OPEX	€ 1,696,800	€ 2,491,750	€ 3,921,430	€ 5,381,080	€ 7,004,754
Total expenses (Capex + Opex)	€ 8,643,800	€ 3,114,430	€ 5,346,270	€ 7,289,520	€ 9,410,214
Recipes	€ 1,787,531	€ 2,843,176	€ 4,221,330	€ 6,252,385	€ 9,239,039
Opex Recovery Ratio	105%	114%	108%	116%	132%

Over the entire period, the recovery rate for operating expenses and equipment renewal is 103% (average value over the entire analysis period). Details of revenues are presented in Appendix A, and the figure below shows changes in operating expenses and revenues.

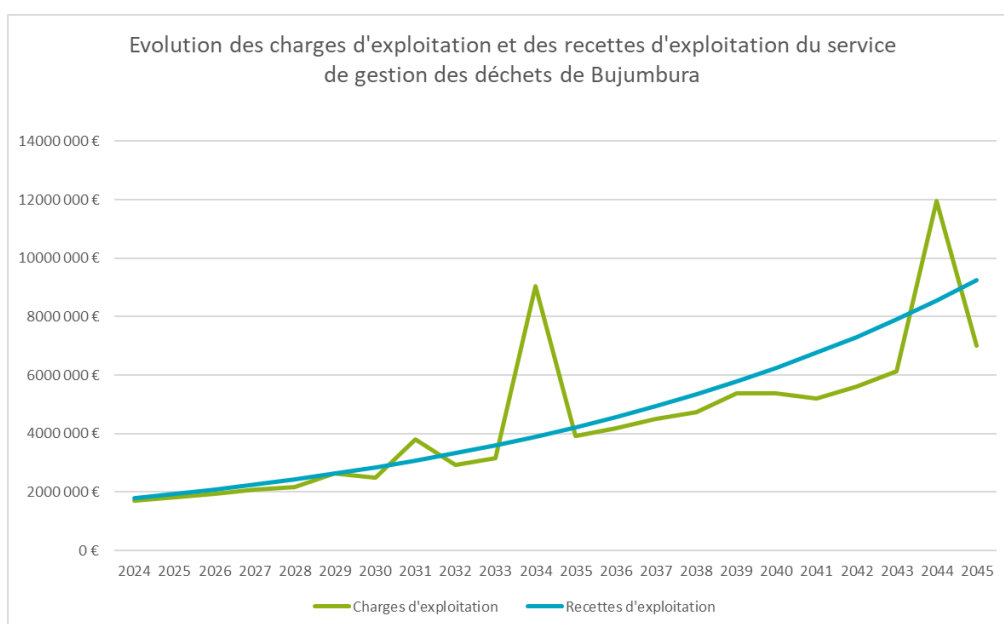


Figure 3: Evolution of expenses and revenues in Bujumbura

Over the entire period from 2024 to 2045, the revenues allow to cover overall operating expenses, ensuring sustainable financing of the municipal service operation. However, in some years, the renewal of heavy equipment (most equipment must be renewed every 10 years), whose lifespan is reduced, significantly weighs on the cash flow of the municipal service. During these pivotal years, particularly in 2034 and 2044, it will be appropriate for the municipal service to take out loans to finance this renewal.

The sensitivity of the results to the rate of collection of fees (rate of non-payment)

Taking the assumption of a 100% fee collection rate, over the whole period from 2024 to 2045, excluding the consideration of inflation rates and the rate of evolution of fee levels, the sum of royalty revenues amounts to EUR 100.7 million and that of operating expenses is EUR 97.7 million. The rate of operating expense recovery from fee revenues would exceed 100% from the first year of operation.

In other words, the municipal service would be able to cover its operating expenses, a loan model to smooth the peaks of cash deficit for the years 2034 and 2044.

These results were evaluated for deterioration in the rate of unpaid domestic users. With a fee collection rate of 75% on households, *i.e.* a default rate of 25%, the results would deteriorate.

The service's financial sustainability is extremely sensitive to the rate of fee collection. At a threshold of 80%/85%, the service's financial sustainability is no longer guaranteed.

Table 7: Opex Recovery Ratio

Non-payment rate	50%	30%	20%	10%
Min	22%	30%	35%	39%
Max	66%	93%	106%	119%



In other words, a significant effort must be made to encourage households to pay their fees.

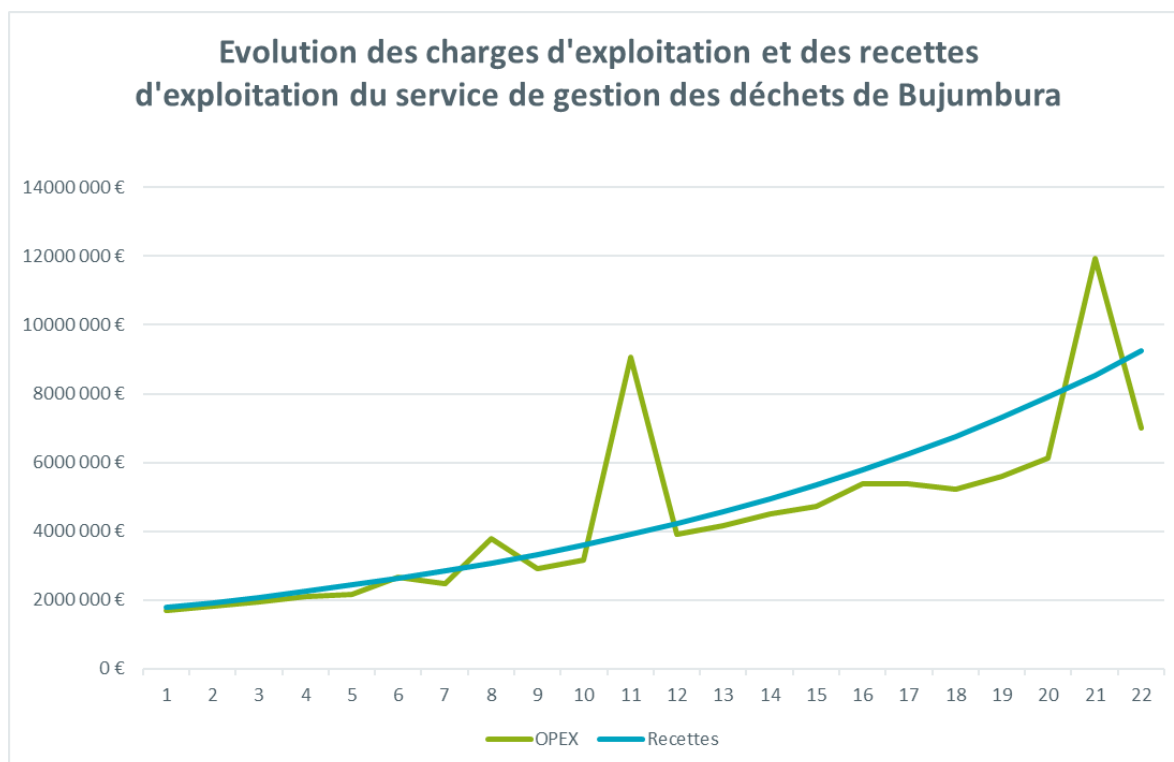


Figure 4: Evolution of operating expenses and revenues for a 20% non-payment rate

Conclusion financial charges in Bujumbura

This financial analysis focuses on the financial sustainability of the waste management service for the city of Bujumbura. The results presented above are highly dependent on the technical dimension of the service and the assumptions made on the service fees.

Given the assumptions made above, **the waste management service for the city of Bujumbura could be financially sustainable, provided that operating costs are controlled and a fee collection rate of nearly 85% is guaranteed.**

The choice of this service's operation mode, in management or in delegation of public service, has no impact on these financial results. This is a political choice that belongs to the Burundian authorities.

SCENARIO 2: PLASTIC-FREE BUJUMBURA

The average composition of household and similar waste in Bujumbura is as follows:

- Fermentable waste (57%),
- Glass and ceramics (15%) as well as metals, paperboard, textiles, leathers,
- Plastics that represent between 2 and 8%.
- Biomedical products and other hazardous waste were also identified at a rate of 2% of the quantity of MSW sorted.

Table 8: Quantity of plastic to be recovered in Bujumbura



Amount of plastic collected (15%)					
	2024	2030	2035	2040	2045
Total collectable volume per day (m ³)	219	351	522	776	1,148
Plastic volume that can be collected per day in inaccessible areas	109	175	261	388	574
Plastic volume that can be collected per day in accessible areas	109	175	261	388	574

The rate of plastics collected represents 15% of the total amount of waste collected in Bujumbura; in 2024 this amount would be 109 m³/ day in inaccessible areas and accessible areas, to reach a total volume of 574 m³/ day per area in 2045.

These figures show that the development of a scenario that ensures only plastic waste recovery could be very interesting for the city's population because it does not require a lot of financial resources, but rather public will and a good involvement of the citizen.

The operation of this scenario would require a fairly large investment at the beginning, since the city of Bujumbura does not currently have any infrastructure or equipment, but the return on investment would be interesting.

The economic calculations for this scenario are in Appendix A.

SCENARIO 3: BUJUMBURA COMPOSTS ITS ORGANIC WASTE

The implementation of this scenario requires development of the sorting practice at the source. With the separation of organic household waste, it would be possible to avoid contact of the waste to be composted with toxic household waste (batteries, aerosols, dishwashing products, paints, inks,...). Source sorting ensures the production of good quality compost without risk to human health.

Table 9: Quantity of Organic Matter to be Recovered in Bujumbura

Quantity of organic matter collected (57%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	832	1,332	1,985	2,948	4,364
Volume of organic material that can be collected in inaccessible areas	416	666	992	1,474	2,182
Volume of organic material that can be collected in accessible areas	416	666	992	1,474	2,182

The table above shows that the percentage of organic material contained in the collected waste is very high and represents 75% of the total amount. this quantity is 832 m³ in 2024 and would reach 4,364 m³ in 2045.



The initial investment should cover the development of composting platforms by district or by sector, acquisition of shovels and inverters-ventilators for the windrows, acquisition of means of waste collection and transfer (containers, vehicles, ...), development of a controlled landfill, ...

The operation of this scenario does not require large investments at the outset. The return on investment would be interesting. The system could operate privately without state intervention.

The economic calculations for this scenario are in Appendix A.

b. WASTE MANAGEMENT IN KIGOMA

Assumptions used²⁰

- Specific production of 0.533 kg/inhabitant/d
- A population growth rate of 2.4% per year
- 75% collection of household and similar waste from 2024 (314 m³/d) to reach 95% in 2045 (656 m³/d). The collection rate does not exceed 95% because of the small, scattered neighbourhoods which, although within the municipality boundaries, will not be served due to lack of access (unstructured urbanization) and remoteness (major constraint against the optimization of collection) found in the city of Kigoma.
- Plastics represent 10% of the amount of waste collected, and the organic matter contained in this waste represents about 60%.
- 60% of waste collected in unserviced roads and 40% of waste collected in serviced roads where mechanized collection is possible (the amount of waste on inaccessible roads is greater than the amount of serviced waste).
- The collected waste is recovered in 14 m³ containers
- Waste density of 0.35 T/m³

SCENARIO 1: KIGOMA CLEAN CITY

The Kigoma clean city scenario would be implemented with the strengthening of the current management system to achieve an integrated solid waste management system for the city, considering all types of waste (household, assimilated, industrial, green, from demolition, etc.). In this scenario, it will be necessary to provide for:

- Technically: reinforcement of pre-collection and collection equipment by other more appropriate vehicles (pick-up lorries, compactors) and better sized grouping containers (larger volume for example) while considering road conditions throughout the city. Development of at least three transfer centres in the city, equipped with large containers and transfer stations. Sorting platforms to develop recycling channels as well as improving the operation of the landfill to optimize its volume and landfill capacity.
- Financially: this scenario requires large budgets for investment (civil engineering and mobile equipment), but for operation, ongoing funding mechanisms will ensure sustainability. Generally for this type of scenario, Public-Private partnerships are preferable, with a DBO (design build operate) or BOT (build operate transfer) contract to lighten the burden on the state.
- Institutionally: for the case of Kigoma, this scenario's feasibility requires strengthening of the municipality's capacities (especially in waste management and control techniques) and a revision of the regulations relating to PPP frameworks, ...

For the implementation of a pre-collection/collection system for household waste in the city of Kigoma, 14 m³ containers would be installed at the city level in the roads that are accessible.

²⁰ Assumptions adopted by the experts following the field missions and findings.



Pre-collection is provided mainly by voluntary contribution as indicated in the overall MSW management plan. Below is the general waste management plan in the city of Kigoma.

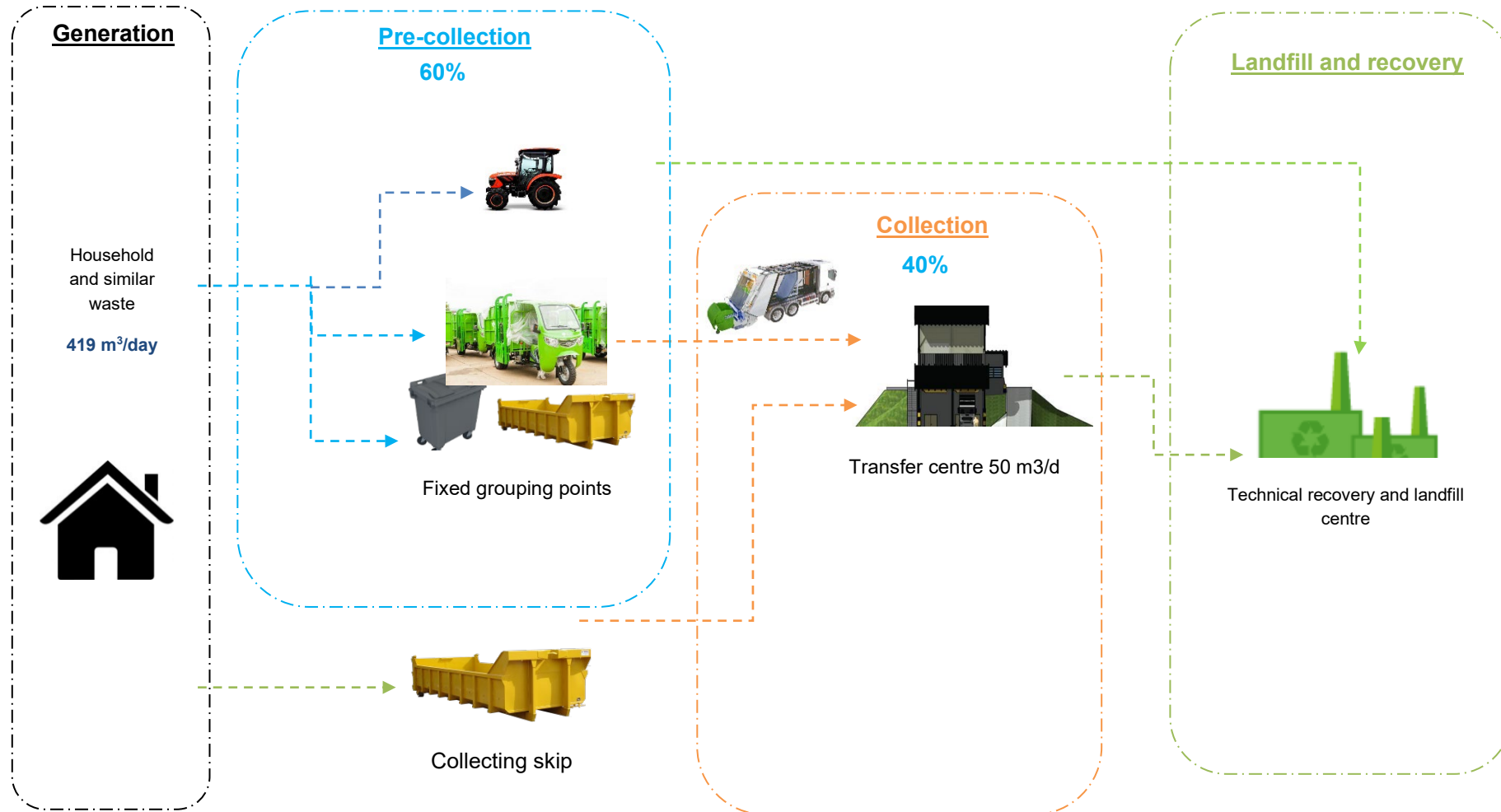


Figure 5: Diagram of household waste management organization in the city of Kigoma in 2024 (75% collection rate)



Determination of the means of the MSW collection and transport service

Based on the evolution of the population and waste generation up to 2045, the quantities of solid waste pre-collected, collected and transported would be as follows:

Table 10: Estimation of pre-collection, collection and transport of household solid waste from 2024 to 2045 in Kigoma

Years	2024	2030	2035	2040	2045
Production [m³/day]	419	484	544	613	690
Collection rate	75%	80%	85%	90%	95%
Total collectable volume per day (m³)	314	387	462	552	656
Pre-collectable volume (60%) on unserviced roads	189	232	277	331	393
Quantity collectable (40%) on serviced roads, mechanized collection possible	126	155	185	221	262



Table 11: Summary of pre-collection, collection and transfer materials in Kigoma by 2024-2045

Pre-collection equipment and staff						
Years		2024	2030	2035	2040	2045
Equipment	14 m ³ box	12	15	18	21	25
	5 m ³ (4.2 tonne) box	4	5	6	7	8
	14 m ³ - Relay box	3	4	5	6	7
	5 m ³ (4.2 ton) box + relay box	2	2	3	3	3
	Tractors (3.5 Tonnes) 3m ³	3	4	5	6	7
	BOM carts 5 m ³	13	16	19	23	28
	Carts 3 m ³	6	8	9	11	13
Personnel	Drivers	25	31	37	44	52
	Rubbish collectors	52	64	77	92	109
	Supervisors and site cleaners	116	120	130	135	140
	Pre-collection sector heads	16	16	20	20	26
	PRE-COLLECTION STAFF TOTAL	209	231	264	290	327

Equipment and personnel for collection and transport						
Years		2024	2030	2035	2040	2045
Equipment	Packers (16 m ³) / 2 rotations per day	4	6	7	8	9
	Amplirolls - bin lorries (4 bin lifts per day)	3	4	5	6	7
	skip lorries (4 bin lifts per day)	1	1	2	2	2
	Tipper (5 Tonnes)	-	-	-	-	-
Personnel	Drivers	10	12	14	17	20
	Rubbish collectors	18	22	26	31	37



	Supervisors	6	6	8	8	8
	COLLECTION STAFF TOTAL	34	40	49	56	66

Transfer equipment and TC personnel and operation						
Years		2024	2030	2035	2040	2045
Equipment	Number of containers (30 m ³)	9	12	14	17	20
	Number of semi-trailer compactors (70 m ³)	0	1	1	1	1
	Number of containers (30 m ³)– Relay	2	2	2	3	3
	Number of semi-trailer compactors (70 m ³) - Relay	1	1	1	1	1
	Number of container lorries (2 skips at a time) and 4 rotations per day	2	2	2	3	3
	Number of lorries carrying semi-trailers-compactors	1	1	1	1	2
Personnel	Drivers	6	6	7	8	10
	Apprentice Drivers	6	6	7	8	10
	Supervisors	3	3	3	3	3
	TOTAL TRANSFER STAFF	14	16	18	20	24



Figure 6: Manual sweep routes in Kigoma (length 40,854 metres)



From 2024, the necessary equipment would be:

For pre-collection:

- 3+ tractors of 3 m³,
- 13+ 5m³ BOM carts
- 6+ carts of 3 m³

These small machines would ensure collection of 60% of waste in inaccessible areas where roads are not serviced, for a collection capacity of 189 m³/d. This number would evolve over time to reach 7 tractors, 28 5m³ BOMs and 13 3m³ carts in 2045 and a tonnage of 656 m³/d.

- 21 chests as follows: 12 chests of 14m³, 4 chests of 5m³, 3 chests of 14m³ and 2 chests of 5m³ with relay, from 2024 to reach a total of 43 chests in 2045.

For collection:

- 4 16 m³ packing bins
- 3 amplirolls lorries

These machines would ensure collection of 40% of the waste on the serviced roads where mechanical collection is possible, for a capacity of 126 m³/d in 2024. This number of machines would evolve over time to reach 9 packing bins, 7 lorries in 2045 for a collection capacity of 262 m³/d.

For the transfer:

In the case of Kigoma, we estimated only one transfer station:

- 2 container lorries, 2 bins at a time, this number would evolve over time to arrive in 2045 to 3 lorries.
- 1 semi-trailer compactor of 70 m³ from 2024 to 2045.
- 11 30 m³ containers in 2024 and 23 containers in 2045.

The following table details the list of staff to be hired in the TC in Kigoma, which are estimated at 42 officers.

Table 12: Table of TC equipment and machinery in Kigoma

Weighbridge	2
Mechanical Workshop	2
Utility vehicle	4
Fuel storage device	2
Electronic kit (Weighing,...)	2
Fuel tanker lorry	2
Container lift	2
Reserve container 30 m ³	10

Table 13: TC staff table in Kigoma

Station Manager	2
Controllers	8
Exploitation Leader	2
Weighting agent	8
Cleaning and maintenance agents	10



Drivers	8
Nurse	2
Attendant-Help	2
Total	42

Financial aspects in Kigoma

From a financial viewpoint, an integrated system must be established for management of the city's solid waste, considering all types of waste (household, assimilated, industrial, green, from demolition, etc.).

The assumptions used are based on data collected in the field and on existing study reports.

Investments in equipment

The investment programme is based on a gradual increase in the waste management system's technical capacity. The equipment necessary for the service's proper functioning, as well as the quantity, are presented in the table below. The quantities of equipment indicated in the table represent the status of stocks in the year in question. Thus, in 2045 the stock of 14m³ bins should be 25.

Table 14: Demand for equipment in Kigoma

	2024	2030	2035	2040	2045
Pre-collection Equipment					
bins of 14m ³	12	15	18	21	25
Boxes of 5m ³	4	5	6	7	8
14m ³ relay bins	3	4	5	6	7
5m ³ bins + Relay bins	2	2	3	3	3
3m ³ tractors	3	4	5	6	7
5m ³ BOM cars	13	16	19	23	28
3m ³ carts	6	8	9	11	13
Collection and transmission material					
14m ³ packing bins	4	6	7	8	9
Amplirolls bin lorries	3	4	5	6	7
Bin lorries	1	1	2	2	2
Transfer Equipment					
30m ³ containers	9	12	14	17	20
Semi-trailer compactor 70m ³	-	1	1	1	1
30m ³ Relay Containers	2	2	2	3	3
Semi-trailer compactor (70m ³) – relay	1	1	1	1	1
Container lorries 2 bins at a Time	2	2	2	3	3
Sweeping Equipment					
Baskets	164	164	164	164	164
Sweep lorries	5	5	5	5	5
Drainage Equipment					
Drainage lorries	4	4	4	4	4
Produced Drain Loaders	2	2	2	2	2
Autoscrubber Great Canals	1	1	1	1	1

The assumption used in this scenario relates to investments made sequentially in the years indicated in the table above, *i.e.* in 2030, 2035, 2040 and 2045. As the city is of medium size and the population growth rate is 2.4%, there is no need to envisage a gradual increase in the technical capacity (in terms of personnel, equipment, etc.) of the municipality.

Annual operating expenses



- Equipment operating cost

The operating costs of mechanical equipment are estimated at 20% of the investment cost of the equipment. The table below shows the amount of annual equipment operating expenses.

Table 15: Equipment operating costs in Kigoma

	Unit operating cost per year
Pre-collection Equipment	
3m³ tractors	€ 2,400
5m³ BOM cars	€ 4,000
3m³ carts	€ 3,000
Collection and transmission material	
14m³ packing bins	€ 14,000
Amplirolls bin lorries	€ 17,000
Bin lorries	€ 12,000
Tipper	€ 13,000
Transfer Equipment	
Semi-trailer compactor 70m³	€ 18,000
Semi-trailer compactor (70m³)-relay	€ 18,000
Container lorries 2 bins at a Time	€ 14,000
Sweeping Equipment	
Sweep lorries	€ 10,000
Drainage Equipment	
Drainage lorries	€ 14,000
Produced Drain Loaders	€ 14,000
Autoscrubber Great Canals	€ 16,000

- Annual staff costs

A reinforcement of municipal staff is envisaged and the increase in staff between 2024 and 2045 is indicated in the table below.

Table 16: Evolution of the number of staff in Kigoma

		2024	2030	2035	2040	2045
PRE-COLLECTION	SUPERVISORS	19	19	20	20	21
	DRIVERS	24	31	37	44	52
	STREET CLEANERS	52	64	77	92	109
	SUPERVISOR	116	120	130	135	140
COLLECTION	SUPERVISORS	19	19	20	20	21
	DRIVERS	10	12	14	17	20
	STREET CLEANERS	18	22	26	31	37
	SUPERVISOR	0	0	0	0	0
TRANSFER	SUPERVISORS	3	3	3	3	3
	DRIVERS	6	6	7	8	10
	STREET CLEANERS	6	6	7	8	10
	SUPERVISOR	0	0	0	0	0
SWEEPING	SUPERVISORS	5	5	5	5	5
	DRIVERS	5	5	5	5	5
	STREET CLEANERS	274	274	274	274	274
	SUPERVISOR	0	0	0	0	0



Regarding salaries, we use the assumption of a salary of 900 EUR per year for drivers and rubbish collectors. The salary of supervisors and supervisors would be 1,100 EUR, corresponding to the average salary of Tanzania.

Table17: Salaries of staff in Kigoma

Wages	In EUR/year
SUPERVISORS	€ 1,100
DRIVERS	€ 900
STREET CLEANERS	€ 900
SUPERVISOR	€ 1,100

- Equipment renewal

The equipment renewal costs are assumed to be borne by the municipality, and their renewal rate depends on their technical life.

User fees

Tanzania already has a system of charges, this rubbish collection fee amounts per month to:

- 2000 to 5000 TSH depending on the size of each household,
- 10,000 TSH for shops,
- 100,000 TSH for hotels

Domestic charges.

We assume that the number of domestic fees will gradually increase between 2024 and 2045 at the rate of population growth, with an ultimate goal of 95% of the waste collected in 2045 thanks to capacity building of the city's collection system. Moreover, the annual growth rate of the population being 2.4%, the number of domestic debtors would also increase to reach 57,706 households in 2045 or 288,531 inhabitants.

We will use the assumption of an average fee of 30 EUR/year, corresponding to 2.7% of the average Tanzanian household income.

The number of shops and hotels²¹

It has not been possible to obtain an accurate census of these. Below we propose our own estimate based on a review of the data. Thus, we estimate that 32 hotels and 141 businesses in Kigoma currently pay the fees. The growth of hotels and businesses by 2045 has been estimated based on current ratios, namely one hotel per 1,257 households and one business per 285 households. These ratios remain stable until 2045.

Table 18: Fee rate for different users

Current fee focus	Current fees		Current fees	
	TZS/month	TZS/year	€/month	€/year
Households (5 persons on average per household)	3,500	42,000	2	18

²¹ <https://fr.cybo.com/TZ/kigoma/>



Shops	10,000	120,000	4	52
Hotels	100,000	1,200,000	43	516

Global funding for waste management

We used the following assumptions for financing of the scenario.

- The financial partners support the first investments of 2024; the municipality can finance other investments.
- Equipment operating and renewal costs are fully covered by the service's operational revenue (equipment operating costs, personnel costs) and equipment renewal).

Revenues from operations

Operating revenues increase with the number of charges paid and the rate of waste collection. The latter, as indicated in the table below, increases from 75% in 2024 to 95% in 2045. The table below illustrates revenues in 2024, 2030, 2035 and 2045.

Table 19: Revenue evolution for the period from 2024 to 2045 in Kigoma

		2024	2030	2035	2040	2045
Households paying the fees		40,218	43,808	47,366	51,036	54,821
Hotels		32	35	38	40	44
Shops		141	154	166	179	192
Rate of waste collection		75%	80%	85%	90%	95%
Fees EUR/year						
Households	€ 30	€ 1,206,537	€ 1,314,237	€ 1,420,985	€ 1,531,087	€ 1,644,628
Shops	€ 52	€ 7,332	€ 7,332	€ 7,332	€ 7,332	€ 7,332
Hotels	€ 521	€ 16,672	€ 16,672	€ 16,672	€ 16,672	€ 16,672
TOTAL		€ 1,230,541	€ 1,338,241	€ 1,444,989	€ 1,555,091	€ 1,668,632

The city's revenues increase by EUR 1.2 million in 2024 to reach nearly EUR 1.7 million in 2045.

The Table below indicates the financial results for the city of Kigoma. Over the analysis period, operating revenues would be sufficient to cover operating expenses. Years 2040 and 2045 would be characterized by cost recovery rates of less than 100% due to investments for equipment renewal.

Table 20: Financial results in Kigoma from 2024 to 2045

Kigoma	2024	2030	2035	2040	2045
Donor financing	€ 2,023,580	0	0	0	0
CAPEX	€ 2,023,580	€ 448,140	€ 340,760	€ 732,920	€ 923,440
OPEX	€ 925,900	€ 952,800	€ 1,074,317	€ 1,168,400	€ 1,339,100
Total operating expenses and renewal	€ 2,949,480	€ 1,400,940	€ 1,415,077	€ 1,901,320	€ 2,262,540
Recipes	€ 3,254,121	€ 1,340,383	€ 1,449,255	€ 1,561,548	€ 1,677,348
Opex Recovery Ratio	110%	96%	102%	82%	74%



For the rest of the years, over the time horizon of this financial analysis, 21 years from 2024 to 2045, the figure below presents the changes in operating costs and equipment renewal, as well as the service's operating revenues.

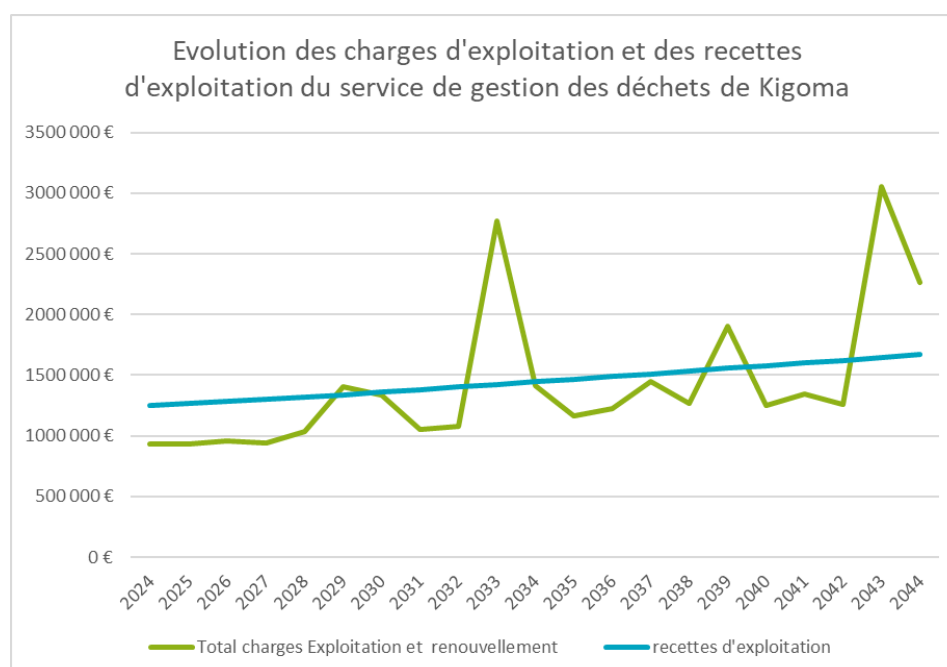


Figure 7: Evolution of operating expenses and operating revenues in Kigoma

Over the entire period from 2024 to 2045, the recovery rate for operating expenses is 140%. The peak loads can be explained by the renewal of certain equipment at the end of its service life, but also by investments in increasing the capacity of the waste collection service.

The renewal of investments in the years 2033, 2039 and 2044, which will generate cash deficits, can be financed on the one hand by loans and on the other hand by the accumulated cash of the operator. These financing operations are part of the classic pace of the operation of a company.

Under the assumptions made above, the service's short-term financial sustainability can be considered assured.

The results' sensitivity to the rate of non-payment

Although the results presented above are rather encouraging, they nevertheless ignore a reality on the ground, namely the rate of non-payment.

The ratio of the recovery of the operating expenses by the fees for different assumptions of the unpaid rates is presented in the table below.

Table 21: Opex Recovery Ratio



Non-payment rate	50%	30%	20%	10%
Min	63%	88%	100%	113%
Max	70%	98%	113%	127%

The service's financial balance is still preserved for unpaid rates of 20%. Below this threshold, the service would create a margin for financing part of its investments, and above this threshold, the financial balance of the recovery of operating expenses by revenue from broken royalties would be balanced. In the latter case, the financial sustainability of the service would no longer be guaranteed.

Conclusion of financial statements in Kigoma

This analysis provides an overview of the financial viability of a waste management service for the City of Kigoma. Given the assumptions made above, the waste management service could be financially sustainable, provided it maintains a default rate of less than 20%.

The choice of this service's operation mode, under the management or delegation of public service, is a political choice that belongs to the Tanzanian authorities. Any option selected will require further financial and pricing analysis.

SCENARIO 2: PLASTIC FREE KIGOMA

The average composition of plastic waste in Kigoma is 10%.

Table 22: Quantity of plastic to be recovered in Kigoma

Amount of plastic collected (10%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	31	39	46	55	66
Collectable plastic volume in inaccessible areas	19	23	28	33	39
Collectable plastic volume in accessible areas	13	15	18	22	26

The rate of plastics collected is about 10% of the total amount of waste collected in Kigoma, in 2024 this amount would represent 13 m³ regarding accessible areas and 31 m³ regarding inaccessible areas, to reach a total volume of 66 m³ in 2045.

These figures show that the development of a scenario that ensures plastic waste recovery only could be very interesting for the population of the city. This kind of scenario does not require great financial means, but just the installation of a recycling unit in the city to reduce transport costs to Dar Es Salaam or Arusha.

In this scenario, provision should be made for arrangement of sorted plastic grouping units equipped with scales, crushers, compactors and big-bags, the supply of 2 m³ containers in sufficient number in the neighbourhoods, the acquisition of vehicles for collecting these containers, and provision of a controlled landfill.

The operation of this scenario would require a fairly large investment at first, but the return on investment would be interesting.

The economic calculations for this scenario are in Appendix A.



SCENARIO 3: KIGOMA COMPOSTS ITS ORGANIC WASTE

In this scenario, the city benefits from the acceptability to the population of composts from household and similar waste. Some citizens are currently composting their waste and that of their neighbours at home.

The implementation of this scenario requires development of the sorting practice at the source. This involves separating organic household waste to avoid contact of the waste to be composted with toxic household waste (batteries, aerosols, dishwashing products, paints, inks,...). Source sorting ensures the production of good quality compost without risk to human health.

This scenario does not require a lot of financial resources, but rather awareness and training at the population level. We recommend, in case of choice of this scenario, to start with a pilot district in which to intensify awareness and training and closely follow the progress of composting implementation in a small platform (analysis of the compost quality every quarter for example).

If the pilot project works, it will be easier to create other composting platforms in the city, depending on the quantities generated per neighbourhood.

This scenario also requires implementation of a door-to-door collection system or a voluntary collection system to waste storage areas in two containers (one for organic and the other for the rest of the waste).

The state could intervene for the system of separate collection, development of the platform and rental to private citizens. The system could operate privately - a private entity that collects containers of organic waste, routes them to the composting platform and then sells the product to farmers.

We estimate production of more than 30,000 tonnes of compost per year. Very interesting potential for this sector.

With this scenario, it would be necessary to provide the development of composting platforms by district or by sector, acquisition of shovels and inverters-ventilators for the windrows, acquisition of means of waste collection and transfer (containers, vehicles, ...), development of a controlled landfill, ...

There will be no large investments at the outset and the return on the investment would be interesting. The system could operate privately without state intervention.

Table 23: Quantity of Organic Matter to be Recovered in Kigoma

Quantity of organic matter collected (60%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	189	232	277	331	393
Collectable organic material volume in inaccessible areas	113	139	166	199	236
Collectable organic material volume in accessible areas	75	93	111	132	157

The rate of organic material collected in Kigoma represents 60% of the total amount of waste collected. In 2024, the volume collected in the inaccessible areas would represent 113 m³ while the volume collected in the accessible areas would be 75 m³, this volume would evolve over time to reach 236 m³ in the inaccessible areas and 157 m³ in the accessible areas.



The economic calculations for this scenario are in Appendix A.

C. WASTE MANAGEMENT IN MPULUNGU

Assumptions used²²

- Specific production of 0.5 kg/inhabitant/d
- Population growth rate of 7% per year; indeed, the population represents 29,100 inhabitants in 2024 to reach 310,689 inhabitants in 2045.
- 75% collection of household and similar waste from 2024 (20 m³/d) to reach 95% in 2045 (102 m³/d). The collection rate does not exceed 95% because of the small, scattered neighbourhoods which, although within the municipality boundaries, will not be served due to lack of access (unstructured urbanization) and remoteness (major constraint against the optimization of collection) found in the city of Mpulungu.
- Plastics represent 10% of the amount of waste collected, and the organic matter contained in this waste represents about 65% (the amount of waste on inaccessible roads is greater than the amount of waste on serviced roads).
- 60% of the waste collected on unserviced roads and 40% of the waste collected on serviced roads where mechanized collection is possible.
- The waste collected is recovered in 14 m³ containers.
- Waste density is 0.35 T/m³

SCENARIO 1: MPULUNGU CLEAN CITY

Given the city's small size in terms of surface area and population, an integrated solid waste management system does not require many resources.

²² Assumptions adopted by the experts following the field missions and findings.



Figure 8: Diagram of household waste management organization in the city of Mpulungu in 2024 (75% collection rate)



Based on the evolution of the population and waste generation up to 2045, the quantities of solid waste pre-collected, collected and transported are as follows:

Table 24: Estimation of pre-collection, collection and transport of household solid waste from 2024 to 2045 in Mpulungu

Years	2024	2030	2035	2040	2045
Production (m ³ /d)	26	39	54	76	107
Collection rate	75%	80%	85%	90%	95%
Total collectable volume per day (m ³)	20	31	46	68	102
Pre-- collectable volume (60%) on unserviced roads	12	19	28	41	61
Quantity collectable (40%) on serviced roads, mechanized collection possible	8	12	18	27	41



Table 25: Summary of pre-collection, collection and transfer materials in Mpulunga by 2024-2045

Pre-collection equipment and staff						
Years		2024	2030	2035	2040	2045
Equipment	14 m ³ box	1	1	2	3	4
	5 m ³ (4.2 tonne) box	0	0	1	1	1
	14 m ³ - Relay box	1	1	1	2	2
	5 m ³ (4.2 ton) box + relay box	0	0	0	0	0
	Tractors (3.5 Tonnes) 3m ³	0	0	0	1	1
	BOM carts 5 m ³	1	1	2	3	4
	Carts 3 m ³	0	1	1	1	2
Personnel	Drivers	2	2	4	5	8
	Rubbish collectors	3	5	8	11	17
	Supervisors and site cleaners	116	120	130	135	140
	Pre-collection sector heads	16	16	20	20	26
	PRE-COLLECTION STAFF TOTAL	136	144	161	172	191



Equipment and personnel for collection and transport						
Years		2024	2030	2035	2040	2045
Equipment	Packers (16 m ³) / 2 rotations per day	0	2	3	3	3
	Amplirolls - bin lorries (4 bin lifts per day)	1	1	1	2	2
	skip lorries (4 bin lifts per day)	0	0	0	0	0
	Tipper (5 Tonnes)	-	-	-	-	-
Personnel	Drivers	2	4	5	5	6
	Rubbish collectors	2	12	13	14	16
	Supervisors	6	6	8	8	8
COLLECTION STAFF TOTAL		10	22	25	27	30



Transfer equipment and TC personnel and operation						
Years		2024	2030	2035	2040	2045
Equipment	Number of containers (30 m ³)	1	1	1	2	3
	Number of semi-trailer compactors (70 m ³)	0	0	0	0	0
	Number of containers (30 m ³) - Relay	0	0	0	0	1
	Number of semi-trailer compactors (70 m ³) - Relay	1	1	1	1	1
	Number of container lorries (2 skips at a time) and 4 rotations per day	0	0	0	0	1
	Number of lorries carrying semi-trailers-compactors	1	1	1	1	2
Personnel	Drivers	2	2	3	3	4
	Apprentice Drivers	2	2	3	3	4
	Supervisors	3	3	3	3	3
	TOTAL TRANSFER STAFF	7	8	8	9	11

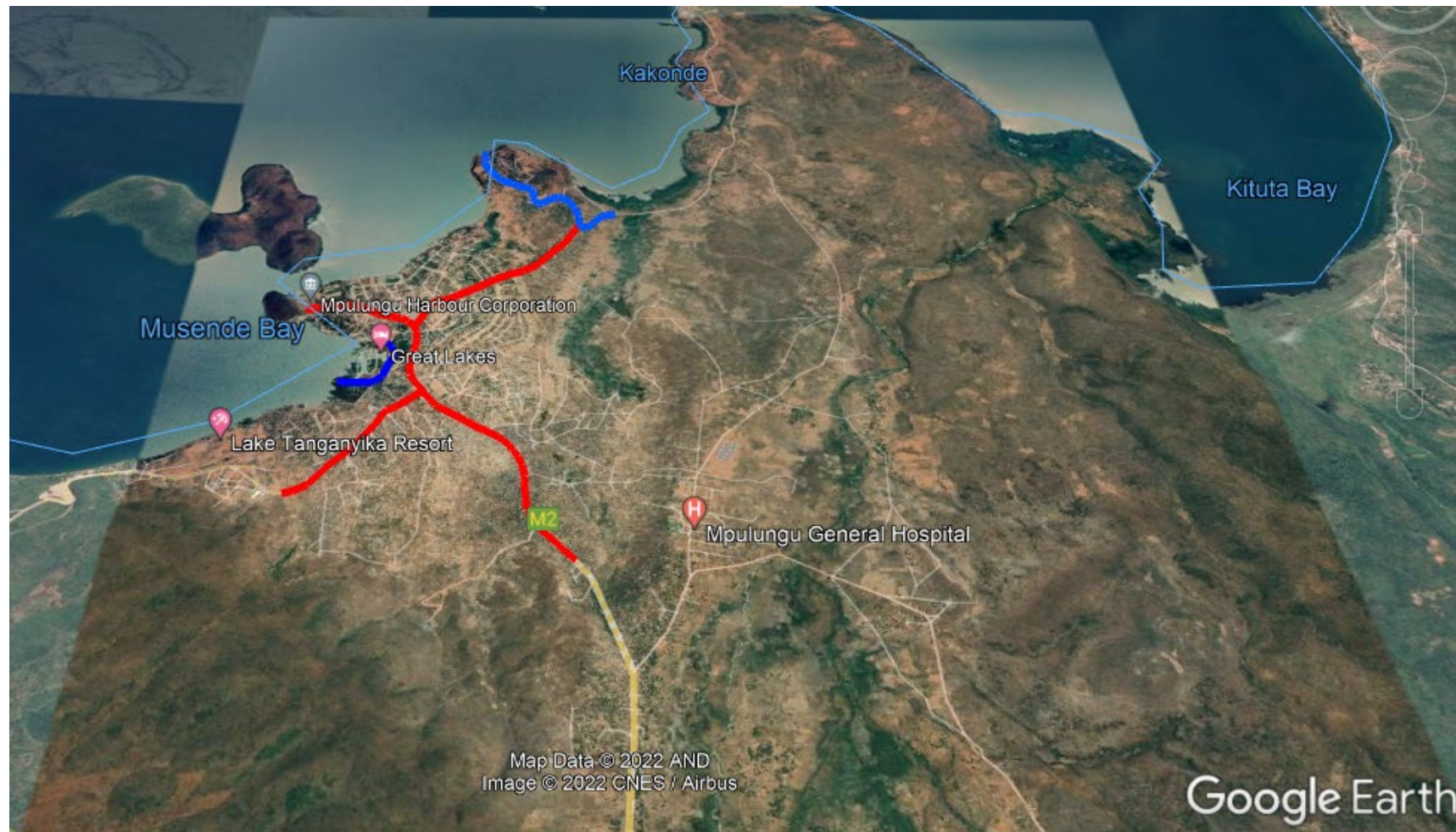


Figure9: Manual sweeping routes to Mpulungu (in red with a length of 7,320 metres) and manual cleaning routes (in blue with a length of 2,946 metres)



From 2024, the necessary equipment would be:

For pre-collection:

- From 1 BOM cart of 5 m³, this small machine will ensure collection of 60% of the waste in inaccessible areas where roads are not serviced for 12 m³/d.

This number of small machines will evolve over time to arrive at 1 tractor of 3 m³, 4 BOM of 5 m³ and 2 carts of 3 m³ in 2045 and a tonnage of 61 m³/d.

- 2 bins including one 14m³ and one 14m³ relay from 2024 to reach a total of 7 bins in 2045 (4 chests of 14m³, 1 bin of 5m³ and 2 relay bins of 14m³).

For collection:

1 ampliroll lorry: this collection machine would ensure collection of 40% of the waste on the serviced roads where mechanical collection is possible, for a collection capacity of 8 m³/d in 2024. This number of machines would evolve over time to reach 2 compacting bins of 14 m³ from 2030 and 3 bins in 2045, 2 lorries in 2045 which would ensure collection of 41 m³/d.

For the transfer:

In the case of Mpulungu, we estimated a single transfer station

- 1 lorry carrying semi-trailer compactors; the number would change over time to arrive in 2045 at 2 lorries.
- 1 semi-trailer of 70 m³ from 2024 to 2045.
- 1 30 m³ container in 2024 and 4 containers in 2045 (3 30 m³ containers and 1 30 m³ relay container).

The following table details the list of staff to be hired in the TC in Mpulungu, estimated at 4 officers:

Table 26: TC equipment and machinery table in Mpulungu

Weighbridge	2
Mechanical Workshop	2
Utility vehicle	4
Fuel storage device	2
Electronic kit (Weighing,...)	2
Fuel tanker lorry	2
Container lift	2
Reserve container 30 m ³	10

Table 27: TC staff table in Mpulungu

Station Manager	2
Controllers	8
Exploitation Leader	2
Weighting agent	8
Cleaning and maintenance agents	10
Drivers	8
Nurse	2



Attendant-Help	2
Total	42

The financial aspects

From a financial viewpoint, an integrated system must be established for management of the city's solid waste, considering all types of waste (household, assimilated, industrial, green, from demolition, etc.).

The assumptions used are based on data collected in the field as well as a review in existing reports.

In this scenario, provision should be made for:

Investments in equipment

A gradual increase in the capacity of the waste management system is envisaged. The equipment necessary for the system's proper functioning, as well as their quantity are summarized in the table below:

Table 28: Evolution of collection equipment in Mpulungu

	2024	2030	2035	2040	2045
Pre-collection Equipment					
Bin of 14m3	1	1	2	3	4
Skip of 5m3	-	-	1	1	1
Relay bins of 14m3	1	1	1	2	2
5m3 bins + relay bins	-	-	-	-	-
3m3 tractors	-	-	-	1	1
5m3 BOM Cars	1	1	2	3	4
Carts of 3m3	-	1	1	1	2
Collection and transmission material					
14m3 packing bins	-	2	3	3	3
Amplirolls bin lorries	1	1	1	2	2
Bin lorries	-	-	-	-	-
Tipper	-	-	-	-	-
Transfer Equipment					
30m3 containers	1	1	1	2	3
Semi-trailer compactor 70m3	-	-	-	-	-
30m3 Relay Containers	-	-	-	-	1
Semi-trailer compactor (70m3)-relay	1	1	1	1	1
Container lorries 2 bins at a Time	-	-	-	-	1
Sweeping Equipment					
Baskets	30	30	30	30	30
Sweep lorries	1	1	1	1	1
Drainage Equipment					
Drainage lorries	1	1	1	1	1
Produced Drain Loaders	1	1	1	1	1
Autoscrubber Great Canals	1	1	1	1	1

In this scenario, we used the assumption that investments are made only in certain years. The city, being medium-sized (even with a population growth rate of 7%), needs only slight technical reinforcement over the years.

Thus, after an initial investment in the equipment purchase, an investment in additional equipment is envisaged in 2030, 2035, 2040 and 2045 to gradually strengthen the technical capacity of the city.



Annual operating expenses

- Equipment operating expenses

Equipment operating expenses are estimated at **20% of the purchase price of the equipment**. The table below summarizes all the equipment for which operating expenses are planned, and their annual value.

Table 29: Equipment operating costs in Mpulungu

	Unit operating cost per year
Pre-collection Equipment	
3m3 tractors	€ 2,400
5m3 BOM Cars	€ 4,000
Carts of 3m3	€ 3,000
Collection and transmission material	
14m3 packing bins	€ 14,000
Amplirolls bin lorries	€ 17,000
Bin lorries	€ 12,000
Tipper	€ 13,000
Transfer Equipment	
Semi-trailer compactor 70m3	€ 18,000
Semi-trailer compactor (70m3)-relay	€ 18,000
Container lorries 2 bins at a Time	€ 14,000
Sweeping Equipment	
Sweep lorries	€ 10,000
Drainage Equipment	
Drainage lorries	€ 14,000
Produced Drain Loaders	€ 14,000
Autoscrubber major channels	€ 16,000

- Annual staff costs

In the envisaged scenario, reinforcement of the city staff is necessary. The pace of staff reinforcement between 2024 and 2045 is presented in the table below.



Table 30: Evolution of staff retained in Mpulungu

		2024	2030	2035	2040	2045
PRECOLLECTE	SUPERVISEURS	6	6	7	7	8
	CHAUFFEURS	2	2	4	5	8
	EBOUEURS	3	5	8	11	17
	SURVEILLANT	116	120	130	135	140
COLLECTE	SUPERVISEURS	6	6	7	7	8
	CHAUFFEURS	2	4	5	5	6
	EBOUEURS	2	12	13	14	16
	SURVEILLANT	0	0	0	0	0
TRANSFERT	SUPERVISEURS	3	3	3	3	3
	CHAUFFEURS	2	2	3	3	4
	EBOUEURS	2	2	3	3	4
	SURVEILLANT	0	0	0	0	0
BALAYAGE	SUPERVISEURS	1	1	1	1	1
	CHAUFFEURS	1	1	1	1	1
	EBOUEURS	51	51	51	51	51
	SURVEILLANT	0	0	0	0	0

Regarding salaries, we use the assumption of an annual salary of EUR 1,500²³ per year for drivers and rubbish collectors. The salary of supervisors and supervisors is hypothetically set at EUR 2,600.

Table 31: Salaries of staff in Mpulungu

Wages	in EUR/year	In Kwc/year
SUPERVISORS	€ 2,600	72,000
DRIVERS	€ 1,500	42,000
STREET CLEANERS	€ 1,500	42,000
SUPERVISOR	€ 2,600	72,000

- Equipment renewal

The equipment is renewed at the date its technical life ends. These renewals generate investments to be financed by the municipality or the operator in charge of the operation.

User fees

- Household fees, willingness to pay and ability to pay.

Currently, only some households pay for waste collection service. The average salary in Zambia is EUR 1,430/year, and assuming an ability to pay of 3% of income, the average fee would be approximately **EUR 43/year**.

- The number of domestic fees.

We assume that the number of domestic fees will gradually increase between 2024 and 2045, and that the city's waste collection capacity will reach 95% in 2045 through capacity building of the city's collection system.

²³ The average salary in Zambia is US \$119 per month, or US \$1,430 per year.



Moreover, the annual growth rate of the population being 7%, the number of domestic charges would also increase to reach **57,706 households in 2045** or 310,689 inhabitants.

- The other charges.

Other charges apply to hospitals, schools and other public institutions as well as industries. It has not been possible to obtain an accurate census of the latter and is therefore not included in the financial analysis presented below. However, even if these other charges were included, the additional revenues would not significantly improve profitability; the system would therefore have to be subsidised for the first 8 years to cover OPEX.

Global funding for waste management

We used the following assumptions for financing of the scenario.

- The financial partners support the investments,
- The service's operational revenues finance the operating and renewal costs

Table 32: Financial results in Mpulungu

Mpulungu	2024	2030	2035	2040	2045
Donor financing	€ 472,680	0	0	0	0
Capex	€ 472,680	€ 158,600	€ 105,840	€ 276,080	€ 220,980
Equipment operating costs and renewal	€ 533,700	€ 754,700	€ 764,640	€ 970,220	€ 975,320
Total Capex + Opex	€ 1,006,380	€ 913,300	€ 870,480	€ 1,246,300	€ 1,196,300
Revenues from operations	€ 403,315	€ 645,618	€ 962,107	€ 1,428,782	€ 2,115,271
Opex Recovery Ratio	76%	86%	126%	147%	217%

In the first years, the waste collection service would have some difficulty recovering its operating costs (ratio less than 100%). It is only from 2031, that the financial situation of the service becomes balanced. This means that for the first few years, Mpulungu's service should be supported financially, in the form of a loan to ensure its financial balance.

For the rest, **over the entire period from 2024 to 2045, the ratio of recovery of operating expenses and equipment renewal would be an average of 146%.**

Over the economic evaluation's time horizon, from 2024 to 2045, the figure below presents the changes in the service's operating expenses and operating revenues. The financial partners bear the first year investments.

Operating income would gradually increase as the number of paying households increased.

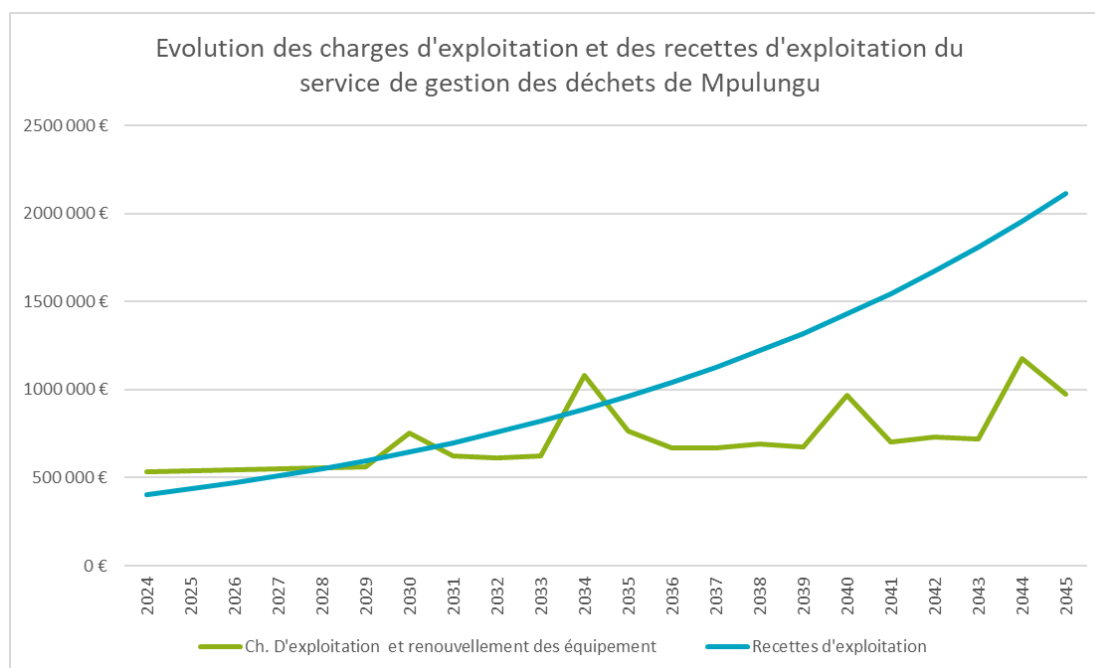


Figure 10: Changes in operating expenses and operating revenues in Mpulungu

It appears that operating revenues are growing at a faster pace than operating expenses. While in the first years, the service would not be able to recover all of its operating expenses, generating a cash deficit; in the longer term, these expenses would be largely covered and the expense recovery ratio higher than 100% from 2031.

In operational terms, this means the department would have to take out a loan to cover its cash deficits in the first few years. A more detailed financial analysis can be performed through a more in-depth technical feasibility study.

Sensitivity of financial equilibrium to non-payment rate

The figure below illustrates the sensitivity of the financial balance for a fee collection rate of 70%; i.e., a 30% non-payment rate.

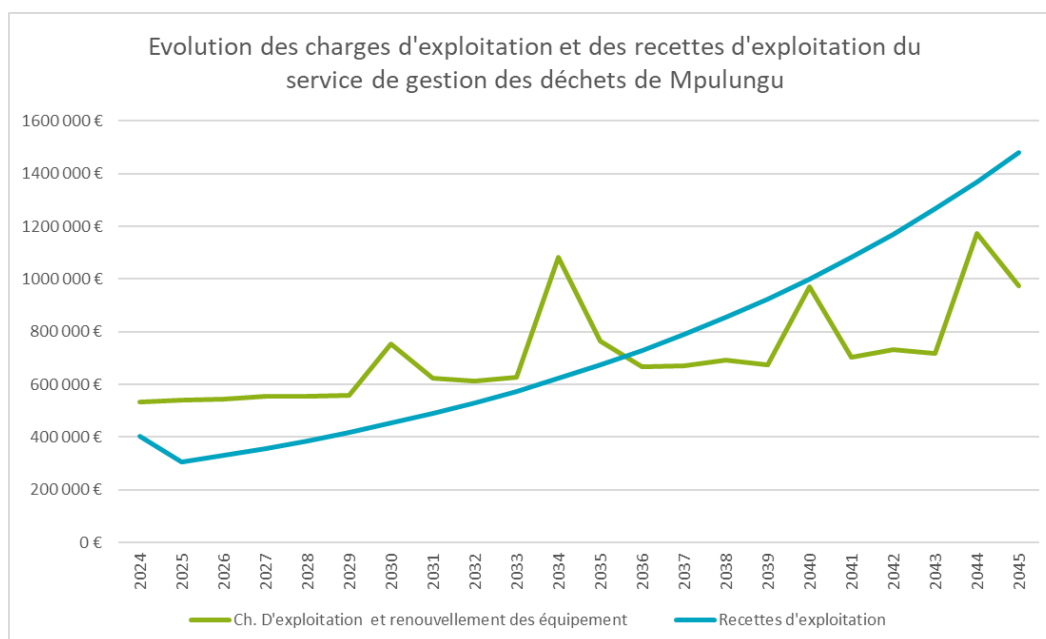


Figure 11: Changes in operating expenses and operating revenues in Mpulungu

The service's financial balance nevertheless appears maintained, but the date to reach this balance would be postponed to 2036.

The table below presents the results of the ratio of recovery of operating expenses for different rates of non-payment up to 50%. Over the period from 2024 to 2045, this rate increases at the rate of demography, but also at the rate of waste collection (see Table 4 in the Appendix).

Table 33: Opex Recovery Ratio

Non-payment rate	50%	30%	20%	10%
Min	40%	57%	65%	73%
Max (in 2045)	126%	176%	202%	227%

Financial conclusions for Mpulungu

This financial analysis provides an initial overview of the financial viability of a waste management service for the city of Mpulungu. In view of the above assumptions, and subject to the dimension of investment programmes and operating costs, the waste management service for the city of Mpulungu could be financially sustainable.

The choice of the operation mode for this service, under the management or delegation of public service is a political choice that belongs to the Zambian authorities. Any option selected will require further financial and pricing analysis.

SCENARIO 2: MPULUNGU COMPOSTS ITS WASTE

As analysed in the interim report, the quantities of plastics generated in this city would not allow the establishment of a plastics recycling chain (lack of financial profitability given the small quantities). However, composting of organic waste remains an option for the city in case it is practiced individually by the population



or through a platform operated by the municipality. This kind of investment with a quantity of organic matter of about 15 tonnes per day (at best) is not very profitable and does not attract private enterprise.

Table 34: Quantity of organic matter to be recovered in Mpulungu

Quantity of organic matter collected (65%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	13	20	30	44	66
Collectable organic material volume in inaccessible areas	8	12	18	27	40
Collectable organic material volume in accessible areas	5	8	12	18	26

The amount of organic matter collected represents about 65% of the total amount of waste collected in Mpulungu; in 2024 this amount would represent 8 m³ in inaccessible areas and 5 m³ in accessible areas, to reach a total volume of 66 m³ in 2045.

The economic calculations for this scenario are in Appendix A.

d. WASTE MANAGEMENT IN UVIRA

Assumptions used²⁴

- Specific production of 0.5 kg/inhabitant/d
- Population growth rate of 4.5% per year; 326,196 inhabitants in 2024 to reach 980,361 inhabitants in 2045.
- 75% collection of household and similar waste from 2024 (442 m³/d of collectable volume) to reach 95% in 2045 (1,411 m³/d). The collection rate does not exceed 95% because of the small, scattered neighbourhoods which, although within the municipality boundaries, will not be served due to lack of access (unstructured urbanization) and remoteness (major constraint against the optimization of collection) found in the city of Uvira.
- Plastics represent 14% of the amount of waste collected, and the organic matter contained in this waste represents about 60%.
- 80% of waste collected on unserviced roads and 20% of waste collected on serviced roads where mechanized collection is possible (the amount of waste on inaccessible roads is greater than the amount of serviced waste).
- The collected waste is recovered in 14 m³ containers
- Waste density of 0.35 T/m³.

As already stated in the interim report, the case of the city of Uvira is specific and the identification of feasible and adequate scenarios required a thorough reflection and which considered the following conditions:

- No road infrastructure, a large part of the city is inaccessible
- No land reserves
- Local authorities with low power and lack of enforcement of regulations (especially environmental)
- Unmotivated public service staff (no salary)

²⁴ Assumptions adopted by the experts following the field missions and findings.



These conditions have led us to two possible scenarios. The scenario of the implementation of an integrated solid waste management system for the city is not feasible given the size of the city, the anarchy of urbanization, as well as the inaccessibility of a large part of the neighbourhoods. However, the two proposed scenarios will require a minimum of waste collection and transportation facilities and a final disposal site.

SCENARIO 1: PLASTIC FREE UVIRA

Technically: provision of sorted plastic collection units, equipped with scales, crushers, compactors and big-bags; supply of 2 m³ containers in sufficient numbers in the neighbourhoods; acquisition of collection vehicles for these containers (the containers will be placed in places accessible to lorries); provision of a controlled landfill.

Financially: the operation of this scenario will require a fairly large investment at the beginning, but the return on investment would be interesting given the quantities to be recovered.

Institutionally: no radical changes, but rather some reinforcements among the supervisory authorities.

Table 35: Quantity of plastics to be recovered in Uvira

Amount of plastic collected (14%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	62	86	114	150	198
Collectable plastic volume in inaccessible areas	49	69	91	120	158
Collectable plastic volume in accessible areas	12	17	23	30	40

The rate of plastics collected represents 14% of the total amount of waste collected in Uvira; in 2024 this amount would represent 49 m³ in inaccessible areas and 12 m³ in accessible areas, to reach a total volume of 198 m³ in 2045.

The economic calculations for this scenario are in Appendix A.

SCENARIO 2: UVIRA COMPOSTS ITS WASTE

In this scenario, we take advantage of the acceptability to the population of composts from household and similar waste. Some associations are currently setting up pilot composting projects.

The implementation of this scenario requires development of the sorting practice at the source. This involves separating organic household waste to avoid contact of the waste to be composted with toxic household waste (batteries, aerosols, dishwashing products, paints, inks,...). Source sorting ensures the production of good quality compost without risk to human health.

We recommend starting with a pilot district in which to intensify awareness and training and closely monitor the progress of the composting implementation in a small platform (analysis of the compost quality each quarter for example).

If the pilot project works, it will be easier to create other composting platforms in the city, depending on the quantities generated per neighbourhood.

Technically: development of composting platforms by district or sector, acquisition of shovels and inverters-ventilators for the windrows, acquisition of means of waste collection and transfer (containers, vehicles, ...).



Financially: no big investments in the beginning. The return on investment would be interesting. The system can operate privately without state intervention.

Institutionally: strengthening of the authorities' means of control.

Table 36: Quantity of organic matter to be recovered in Uvira

Quantity of organic matter collected (60%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	265	368	488	643	846
Volume of organic material that can be collected in inaccessible areas	212	295	390	515	677
Volume of organic material that can be collected in accessible areas	53	74	98	129	169

The amount of organic matter collected is about 60% of the total amount of waste collected at Uvira; in 2024 this amount represents 212 m³ in inaccessible areas and 53 m³ in accessible areas, to reach a total volume of 846 m³ in 2045.

The economic calculations for this scenario are in Appendix A.

e. ORGANIZATION AND EXECUTION OF THE PRE-COLLECTION SERVICE, COLLECTION AND TRANSPORT OF MSW TO RUSIZI

Assumptions of collection used²⁵

- A specific production of 0.6 kg/inhabitant/d.
- A population growth rate of 2.8% per year, 400,859 inhabitants in 2024 to reach 997,159 inhabitants in 2045.
- Plastics represent 6% of the amount of waste collected, and the organic matter contained in this waste represents about 60%.
- Waste density is 0.35 T/m³.

SCENARIO 1: COMPOSTING PLATFORM

This would involve investing in a large PPP project for development of a large platform for treatment and composting of waste generated by the city and its surroundings.

The municipality would coordinate between the platform operator and the waste collection company. For the implementation of this project, the current landfill operating contract should be considered. The operator would be paid per ton buried and according to the quantities planned while preparing the specifications.

Technically: development of a waste sorting and composting platform (1 ha), mobile equipment (loader, windrow turner, tractor, etc.), organic waste collection containers, etc.

²⁵ Assumptions adopted by the experts following the field missions and findings.



Institutional: strengthening of the municipality's capacities to ensure monitoring and control of the platform as well as the compost quality.

Financially: the investment cost would not be very high, especially in the case of a PPP and in the case of a collection ensured by another entity.

Table 37: Quantity of organic matter to be recovered in Rusizi

Quantity of organic matter collected (60%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	419	528	644	782	948
Volume of organic material that can be collected in inaccessible areas	84	106	129	156	190
Volume of organic material that can be collected in accessible areas	335	422	515	626	758

The amount of organic matter collected would represent 60% of the total amount of waste collected in Rusizi in 2024; this amount would equal 84 m³ in inaccessible areas and 335 m³ in accessible areas, to reach a total volume of 948 m³ in 2045.

The economic calculations for this scenario are in Appendix A.

4. CONCLUSIONS ON SOLID WASTE MANAGEMENT

The situation of solid waste management in the main cities of the Lake Tanganyika basin explains the deterioration of water quality. Poor management (or total absence of the system) contributes directly to the transport of waste to their unique receiving environment: the lakes (Kivu and Tanganyika) and the Rusizi River. Following this study, we considered that this problem is linked to two main factors: the complicated institutional framework and the techno-economic aspect.

The institutional scheme for solid waste management in the countries of the Lake Tanganyika region is positioned between a central authority and a local authority. This institutional positioning has clearly impacted the waste sector's governance system, has put the municipalities in rather uncomfortable situations and negatively impacted the performance of the programmes implemented in this sector.

To improve the institutional framework, the set-up of a dedicated information system on waste (typologies, quantities, collection rates, recycling rates, equipment, final destinations, etc.) was recommended at the national and regional levels, which is shared and made available to all sector players. This system will provide information at the local, national and regional levels. It will be accessible to public and private actors by providing an opportunity for both to get involved in the management of the system, but also to benefit from the exchange of data, information and experience on the various waste-related issues as part of an information sharing mechanism. This will bring together regularly updated data and lessons learned from previous experiences in this area. This recommendation will be enriched by the creation of a coordination platform between the LTA and ABAKIR regional authorities.



There is also a need for capacity building of the various stakeholders. Targeted training plans, by stakeholder category and according to specific needs, should be developed in support of the implementation of the strategy and permanent readjustments that would be made according to the observed developments.

From a technical and economic viewpoint, the establishment of a circular economy in the cities concerned was recommended, especially as the regulatory frameworks in the countries currently allow it. Work on the technical aspects of the integrated waste management strategy is strongly recommended.

To prepare the ground for the circular economy, the team studied and proposed several scenarios for integrated solid waste management for each city. Finally, according to the quantitative and qualitative diagnosis of waste and its management in the 5 cities and the technical-economic feasibility, we selected the scenarios for collection and recovery of organic material in the 5 cities and recycling of plastic waste in the cities of Bujumbura, Uvira and Kigoma. For the city of Mpulungu, the implementation of a waste collection and disposal system is economically feasible, but without the plastic recycling chain (because of the lack of economic profitability).

In this report, details and specifications of each recommendation have been presented, as well as a reminder of priority and urgent actions to be considered in future development or technical assistance programmes to the LTA.



5. PART B: SANITATION OF THE CITY OF BUJUMBURA

A - DESCRIPTION OF THE EXISTING SITUATION

1. Institutional

The same institutional problem arises for solid waste and liquid sanitation in the city of Bujumbura. The institutional framework is marked by a multiplicity of actors with poorly defined areas of competence resulting in overlapping responsibilities. Resource and logistical deficiencies and the collaboration framework are challenges to be overcome. Implementing decrees such as Decree-Law No. 1/41 of 26 November 1992 on the establishment and organization of the hydraulic public domain are often not very explicit. Regulatory texts are insufficient in number and content, and sometimes encounter difficulties in their application. The area of liquid and solid waste management is characterized by an insufficient level of funding. The inadequacy of the approaches adopted, the facilitation techniques and the absence of a communication and behaviour change plan for the two sectors of liquid and solid sanitation remain constraints to be overcome. The plan's purpose is to promote knowledge, behavioural change and awareness of sanitation. Another institutional problem is the frequent changes in the responsibilities of ministries. From a regulatory viewpoint, we note that current regulatory problems hinder the implementation of decentralization, in particular the absence of regulatory provisions delimiting the competences of the State and local administrations. Competences in terms of solid waste management and sanitation are not clearly transferred: two parallel planning systems coexist, at municipal and government level (OBUHA). The competences of the former SETEMU have been vaguely transferred and have not been accompanied by a handover and transfer of knowledge and financial resources: the Department of the Environment, Hygiene and Sanitation (DEHA) is currently not able to conduct its new missions. The newly allocated human resources are insufficient to cope with these new competences, both in terms of quantity and quality.

In Bujumbura City Hall, the sanitation sector is not organized autonomously. Responsibilities and competences in this area are almost exhausted, which leads to difficulties in implementing a coherent and integrated liquid sanitation strategy. The infrastructures performed during ad hoc neighbourhood development and real estate projects are not part of a master plan, which limits the desirable capitalization of experiences and the standardization of equipment and the economy of scale that could result. To meet the costs of equipment and operation of sanitation facilities, OBUHA mainly uses the Ministry of Finance by proposing estimated costs of various rehabilitation of sanitation infrastructure²⁶. This lack of individualization of the revenues allocated to the sanitation service and the low revenues from these revenues, combined with the very high costs of investment and operation of sanitation facilities, have caused this sector to suffer a great delay compared to other urban facilities.

The provisions that govern the sanitation sector exist but remain scattered in other areas. One can refer to sanitation through: the policy of hygiene, safety and public health; the code of sanitation, the legislation on urban planning and the rules governing the public domain. The general sanitation principles are not the subject of a homogeneous text; most of these texts are very old and are legislative in nature, with all the advantages and disadvantages for the implementation of a provision and the corresponding possibilities of interpretation. Municipal decrees are not sufficient to fill the gaps in these texts, and often remain imprecise with regard to the mandatory nature of sanitation and treatment, as well as for the guideline values or standards of wastewater discharges into the various natural environments, despite the existence of the prohibition, expressly formulated, of discharges of wastewater without purification into the receiving environments.

²⁶ Source: Presidential Decree of 24 May 2019 establishing the Burundian Office of Urban Planning, Housing and Construction (OBUHA) - Decree No. 100/079 of 24 May 2019 OBUHA mission



2. Sector capacity and potential improvements

The sanitation infrastructure in the city of Bujumbura aims to improve the overall health situation of the environment in its various components. The network contains infrastructure capable of conducting wastewater management processes including the collection, treatment and disposal of liquid waste, with sanitation systems based on technological solutions such as the Buterere wastewater treatment plant. These systems can also follow a more decentralized and simple approach with for example dry toilets and septic tanks. Improving sanitation, in particular in the city of Bujumbura, can be based on improving sanitation infrastructure, but also on behaviour change strategies in personal hygiene, for example by promoting regular hand washing.

3. Economic aspect

Wastewater and greywater can be safely treated and used for agriculture, forestry and aquaculture to alleviate the growing physical and economic water shortage.

Nutrients can be drawn from faecal sludge and municipal waste. This process is crucial for millions of rural and peri-urban farmers struggling with impoverished soils who must feed themselves and the growing urban population, in a context of increasing climate change.

Energy from faecal sludge and other organic waste can be recovered and converted into biogas, heat and electricity. Access to energy is essential to enable smallholder farmers to build productive capacity and generate income from it, but also to improve the households' quality of life.

National economies are weakened by the need to spend significant funds on health care and medicines, while many days of work are lost due to illnesses resulting from inadequate sanitation - WHO Report 2020.

The sanitation component is not sufficiently integrated into national policies and programmes. The investment cost of basic infrastructure is very high. The sanitation data indicate constraints regarding establishment of an appropriate financing mechanism in the field of urban wastewater management.

The wastewater treatment fees in the city of Bujumbura do not exist because the polluter-pays system is not applied at the time of this study. It should be noted that the construction of collective equipment for wastewater management is very expensive, difficult for the community to bear. Most of the collective work is performed with the financing of the State and certain donors.

4. Service level and Infrastructure

The Burundian Office of Urban Planning, Housing and Sanitation (OBUHA) is in charge of the operation and management of wastewater and sanitation in the city of Bujumbura. The sewage treatment plant of the city of Bujumbura is characterized by lagoon systems with 3 successive lagoon basins each comprising two anaerobic basins, two optional basins and two maturation basins with a treatment capacity of 440,000 inhabitants equivalent per day. The existing infrastructure consists of:

- Twenty (20) sludge drying beds measuring 4 x 50 m each.
- A coarse screen (10 cm spacing of the bars) with manual cleaning in two parallel lines;
- De-sanding in two parallel rows in static trapezoidal section desanders;



- An Archimedean screw lift with 3 screws with a capacity of 350 L/s and a lifting height of 4.5 m, with a free space for a 4th screw
- Three (3) pumping stations SP1, SP2 and SP3 discharging into the networks
- Pretreatment and lifting, 3 basin supply channels, a treated water discharge channel, a basin outlet structure and operating building

B - INVENTORY OF TECHNICAL AND FINANCIAL PARTNERS AND BUSINESS PLANS

During this study we identified key technical and financial partners in the sanitation sector such as the European Union, the African Development Bank, the World Bank, UNDP, UNICEF, etc. who provide technical expertise, resource mobilization (funds), coordination of sanitation activities in the country as well as participation in the monitoring and evaluation of the implementation of the action plan in the sanitation sector.

The LATAWAMA 1 project funded by the European Union, contributes to implementation of the Lake Tanganyika Authority's strategic action plan, in particular on the information management component through development of the water quality monitoring network and the fight against pollution. The European Union, the donor of the LATAWAMA project, plans to commit, in 2024, a new budget of 27 million euro which will allow the financing of a new phase of this project. The LATAWAMA 2 programme aims to invest substantially in the environmental monitoring of lakes Tanganyika and Kivu in terms of quality, biodiversity and climate and quantitative data.

Among the actions, the EU also foresees rehabilitation of the sewerage network in the city of Bujumbura; as regards the other donors:

- The World Bank is financing sanitation work with the Local Development for Employment project and other projects in the process of formulating for sanitation;
- The African Development Bank has already made a country profile sanitation²⁷;
- UNDP contributes to the rehabilitation of river banks that cross the city of Bujumbura (the Ntangani River)
- UNICEF is the wash leader in Burundi and works largely in urban and rural areas for the construction of school, family and public latrines as well as awareness-raising on hygiene promotion, and drinking water access.

The technical and financial partners support the institutions listed below that have their business plans:

- The Burundian Office of Urban Planning, Housing and Construction "OBUHA" in charge of sanitation and exploitation of wastewater and responsible for:
 - Wastewater disposal, permanent monitoring of the Buterere treatment plant, as well as laboratory wastewater analysis results;
 - Regular cleaning according to the standards of the different watercourses and the wastewater network,
 - Ensure strict compliance with discharge standards;
 - Ensuring monitoring of existing wastewater systems;
 - Ensure compliance with hygiene, sanitation and environmental standards in the construction of buildings;
 - Proceed with connection of the buildings built to the networks of wastewater and public sewers;
 - Promote the public sewer system in urban centres and villages.
- The Ministry of Hydraulics, Energy and Mines (MHEM) with General Administration Drinking Water and Basic Sanitation (DGEPA). Its mission (Decree n. 100/086 OF 19 October 2020 on "missions, organization and functioning of the Ministry of Hydraulics, Energy and Mines") is:
 - Ensure drinking water quality at all levels of use;
 - Ensure in collaboration with all relevant Ministries, the planning, construction and management of the basic sanitation infrastructure;

²⁷ https://www.pseau.org/outils/ouvrages/bad_profil_sectoriel_eau_et_assainissement_du_burundi_2021.pdf



- Participate, in collaboration with the Ministry of Water and Sanitation, in the implementation and updating of the national sanitation policy and the necessary reforms;
 - Develop sectoral policy on drinking water and basic sanitation;
 - Develop and adopt an investment plan for basic sanitation infrastructure in rural, urban and peri-urban areas;
 - Prepare contracts (PPP) and/or as part of the public service delegation as part of the development of the basic sanitation sector;
 - Coordinate interventions in the basic sanitation sector;
 - Design mechanisms for the management of infrastructure and basic sanitation services among Municipalities and Communes;
 - Design the strategy for development of basic sanitation;
 - Develop norms and standards for the use of basic sanitation;
 - Prepare a draft tariff policy for rural and urban sanitation.
- The Ministry of Public Health and AIDS Control (MSPLS), through the Administration for Health Promotion, Hygiene and Sanitation, the mission of which is to:
 - Ensure compliance with basic hygiene, sanitation and environmental health standards with reference to strategic documents;
 - Conduct a baseline assessment of the quality of hygiene and sanitation services at all levels;
 - Develop, update and disseminate standards for all aspects of basic hygiene and sanitation;
 - Develop a plan to strengthen human, material and logistical capacities for hygiene and sanitation;
 - Determining water and beverage quality standards, in close collaboration with the technical services of the Ministry in charge of water;
 - Participate in wastewater management including runoff, domestic water, sewage, industrial wastewater and excreta in rural areas and small communities;
 - Participate in solid waste management in cities and rural areas;
 - In addition, the Department's missions include: (i) design and develop the national public health, hygiene and sanitation policy of public and private administrations, (ii) encourage and encourage the active participation of public and private administrations, national and international partners in the implementation of activities likely to support the national public health, hygiene and sanitation policy.
- Bujumbura City Council and the Municipalities, responsible for:
 - Drainage and regular disposal of household waste, sewage, wastewater and similar waste throughout their territory in accordance with the sanitation code;
 - Ensuring the implementation of household waste management systems and organizing the transport and intermediate and final storage of this waste, in accordance with the sanitation code;
 - From the maintenance and emptying of the temporary depots and transport of waste to the final landfill;
 - Enforce applicable laws;
 - Raise awareness among communities and promote citizen engagement in global sanitation.
- The Ministry of the Environment, Agriculture and Livestock (MINEAGRIE) through the General Administration for the Environment, Water Resources and Sanitation, in charge of:
 - Supervise the development, monitoring and follow-up of the implementation of the national sanitation policy, for the efficient disposal of wastewater and the fight against pollution of water resources in rural and urban areas;
 - Develop, approve and update tools for the planning and management of water resources and sanitation;
 - To implement the obligations of international and regional conventions and agreements on water resources and sanitation;
 - Develop water quality standards and guidelines on water supply and use and sanitation service agreements;



- Define the criteria of a reference laboratory for analysis and control of water quality at all levels of use;
 - Participate in the setting of participation rates for the sustainability of water resources and sanitation services, in consultation with the technical services concerned;
 - Design, develop and implement the comprehensive sanitation code and its implementing texts;
 - Implement the national awareness programme on sanitation and combating pollution from environmental resources;
 - Establish a programme to build capacity in water and sanitation and to combat pollution of water resources;
 - Promote and coordinate the implementation of decentralized municipal technical services for sanitation and pollution control;
 - Ensuring the setting of norms and standards for the efficient disposal of wastewater and the treatment of polluted water, in collaboration with the municipal technical services;
 - Ensure planning and monitoring and evaluation of sanitation activities;
 - Ensure development and implementation of the sanitation code and its implementing legislation;
 - Participate in the implementation and management of sanitation networks.
- The Burundian Office for the Protection of the Environment (OBPE) through the Water Quality Analysis Laboratory (the support of which by LATAWAMA is in progress).
 - The Ministry in charge of Finance which intervenes in the budgeting at the request of the sectoral Ministries, and in the joint setting of fees and taxes.

In addition, the European Union is planning the rehabilitation of the existing sewerage network with capacity building of OBUHA staff. Among the activities, the EU also commissioned Enabel to conduct the projects to rehabilitate the drying beds, digitise the network, and supply the laboratory equipment for the wastewater from the Bujumbura wastewater treatment plant. Among the National Development Plan of Burundi 2018-2027 sanitation actions are proposed such as the rehabilitation of rainwater and wastewater collectors.

C - INVESTMENT PLAN

This short-term investment plan specifies all the exceptional costs incurred during the existing network's rehabilitation phase and the estimated profit and loss account, which summarises operating expenses.

CAPEX	Quantity	Unit price	2023	2024	2025	2026	2027
Rehabilitation of the STEP	1	€ 700,000	€ 350,000	€ 350,000			
Rehabilitation of the Pipeline (linear metre)	300,000	€ 20	€ 3,000,000	€ 3,000,000			
Rehabilitation of pumping stations and replacement of equipment	3	€ 50,000	€ 75,000	€ 75,000			
Ancillary needs (connection box, inspection manhole, sewer manhole,...)	250	€ 368	€ 46,000	€ 46,000			
OBUHA agent training	20	€ 12,500	€ 125,000	€ 125,000			
Equipment agents (Computers and PPE) OBUHA	10	€ 1,500	€ 7,500	€ 7,500			



TOTAL			€ 3,603,500	€ 3,603,500			
OPEX	Quantity	Unit price	2023	2024	2025	2026	2027
Permanent workers	15	€ 420		€ 6,300	€ 6,300	€ 6,300	€ 6,300
Temporary workers	10	€ 300		€ 3,000	€ 3,000	€ 3,000	€ 3,000
Maintenance	4	€ 24,500		€ 98,000	€ 98,000	€ 98,000	€ 98,000
Maintenance	10	€ 6,899		€ 68,992	€ 68,992	€ 68,992	€ 68,992
TOTAL				€ 176,292	€ 176,292	€ 176,292	€ 176,292

Annual short term programme operating expenses

The table above presents a construction of the annual operating costs of the service under cruising conditions; that is, considering the actual needs of the services. As part of the priority actions, we have used wage assumptions slightly higher than the average Burundian income to encourage productivity.

OPEX	Quantity	Unit price	2023	2024
Permanent workers	15	€ 420		€ 6,300
Temporary workers	10	€ 300		€ 3,000
Maintenance	4	€ 24,500		€ 98,000
Maintenance	10	€ 6,899		€ 68,992
TOTAL				€ 176,292

This long-term investment plan specifies all the exceptional costs to which the network extension phase gives rise and the estimated income statement, which summarizes the operating expenses

CAPEX	Quantity	Unit price	2023	2024	2025	2026	2027
Network Extension (Linear Metre) ²⁸	300,000	€ 30	€ 2,250,000	€ 2,250,000	€ 2,250,000	€ 2,250,000	
Pumping stations	3	€ 70,000	€ 52,500	€ 52,500	€ 52,500	€ 52,500	
Construction of a new lagoon-type step.	1	€ 120,000,000	€ 30,000,000	€ 30,000,000	€ 30,000,000	€ 30,000,000	
Agent training	15	€ 30,000	€ 112,500	€ 112,500	€ 112,500	€ 112,500	
Agent equipment	40	€ 6,250	€ 62,500	€ 62,500	€ 62,500	€ 62,500	

²⁸ The extension considers the southern part of the city (Muha commune) including the Kinindo area and the Cibitoke, Ngagara, Buterere, Gihosha, Kinama, Kamenge areas of the Ntahangwa Commune, and the Buyenzi and Rohero areas of the Mukaza commune. The lower part of the city (Gatumba, Wide Kinindo, Mirror and Maramvya districts) cannot be reached by the sewer system given the topography, as the absence of gravity could lead to water stagnation. In this area individual latrines will be required. The 300 km will consider the population growth and cover the new growing neighbourhoods compared to the 128,553 linear metre of the current existing network.



TOTAL			€ 32,477,500	€ 32,477,500	€ 32,477,500	€ 32,477,500	
Opex	Quantity	Unit price	2023	2024	2025	2026	2027
Permanent workers	50	€ 420			€ 2,100	€ 4,200	€ 6,300
Temporary workers	50	€ 300			€ 1,500	€ 3,600	€ 5,700
Maintenance	10	€ 77,300			€ 77,300	€ 79,400	€ 81,500
Maintenance	20	€ 40,000			€ 800,000	€ 800,000	€ 800,000
TOTAL					€ 880,900	€ 887,200	€ 893,500
TOTAL CAPEX+OPEX			€ 32,477,500	€ 32,477,500	€ 33,358,400	€ 33,364,700	€ 893,500

Operating expenses

The expansion of the collection network generates additional operating expenses that are added to the short-term operating expenses of the program. Operating expenses are growing at the same rate as household connections. Staff were sized to eventually reach 50 permanent employees and 50 temporary employees. This staff is added to the short-term program staff. The annual operating costs of the municipal service, under running conditions, are estimated at EUR 937,600.

Opex	Quantity	Price/Unit Wage	2025	2030	2035	2038
Permanent workers	50	€ 420	€ 2,100	€ 12,600	€ 21,000	€ 21,000
Temporary workers	50	€ 300	€ 1,500	€ 12,000	€ 20,400	€ 20,400
Maintenance	10	€ 77,300	€ 77,300	€ 87,800	€ 96,200	€ 96,200
Maintenance	20	€ 40,000	€ 800,000	€ 800,000	€ 800,000	€ 800,000
Total			€ 880,900	€ 912,400	€ 937,600	€ 937,600

1. MAJOR AREAS OF INVESTMENT

The diagnosis performed as part of this study, shows the main areas of investment to meet the challenges in the sector:

- Rehabilitate existing infrastructure considering lagoon basins, primary, secondary and tertiary piping collectors and existing pumping stations, discharge pump, grease separator, retention or infiltration basin, connection box, manhole, sewers in the areas of Buterere, Bwiza, Downtown, Nyakabiga, Asian neighbourhood and Downtown in Rohero area and the Kigobe neighborhood in Gihosha area.
- The extension of the network through the installation of new collectors, new pumping stations in unconnected areas such as the Cibitoke, Ngagara, Buyenzi, Gihosha, Kinama, Kanebge, Buterere, Rohero and Kinindo areas.

2. BRIEF DESCRIPTION

The length of the wastewater collection network of the city of Bujumbura was estimated at 128,553 linear metres, according to the information currently available to OBUHA staff and the 2014 masterplan. The network



operates under pressure and gravity. It is composed of pipes of different nominal diameters: the discharge pipes of DN 700 and DN1200 for the section upstream of the step, DN 400 mm for primary collectors, DN300 mm for secondary collectors and DN200 mm for tertiary collectors.

Linear length of pipes					
Discharge line	Section downstream arrival of raw water at the STEP	Primary Collectors	Secondary Collectors	Tertiary Collectors	Total Linear Metres
DN 700	DN1200	DN400	DN300	DN200	
1.200	2.000	15.892	43,210	66,251	128,553

This table above shows the diameter of the existing network collectors and the linear metres of the collectors.

3. FINANCIAL ESTIMATE

The costs of rehabilitation and extension of the existing network include local labour, local materials in the sub-region including concrete nozzle, PVC/ HDPE pipes, anti-rams, electrical equipment, pumps and other plumbing materials, etc. Suppliers and factories that can supply the materials are present in the sub-region. The estimate is based on the price and availability of local materials at the regional level.

The total cost of the short-term programme and extension of the collective sewerage network amounts to EUR 137.1 million; with a first short-term component of EUR 7.2 million and a long-term component of almost EUR 130 million.

CAPEX	Total	2023	2024	2025	2026
Short-term programme	€ 7,207,000	€ 3,603,500	€ 3,603,500		
Long-term programme	€ 129,910,000	€ 32,477,500	€ 32,477,500	€ 32,477,500	€ 32,477,500
TOTAL	€ 137,117,000	€ 36,081,000	€ 36,081,000	€ 32,477,500	€ 32,477,500

D - CAPACITY BUILDING PLAN

Continuous Capacity Building for OBUHA Agents ²⁹					
Expected outcomes	Activities/Sessions	2023	2024	2025	2026
Result 1: Capacity building for 35 people through training to improve operational performance in the sanitation sector	Word, Excel, Power Point (Advanced)	x			x
	Digitalisation		x		x
	Design and management of databases		x		x
	Statistical software		x	x	
	Water quality monitoring	x	x		

²⁹ Continuing education is particularly important in times of accelerated change, such as those under way today in Burundi, which is trying to reorient its sanitation system towards sanitation for all. A continuing education system consists of a set of interrelated elements involving the personnel, policy, planning, activities and equipment of sanitation institutions and programmes.



	Water quality analysis	x	x		x
	Sector management and governance	x			x
	Leadership and Management		x	x	
	Maintenance/Care/ Rinsing	x		x	
	Sanitation business model (market study, marketing, pit drainage business, the sanitation chain, treatment and recovery, management of drainage sludge)		x	x	
Resulting 2 reinforcements of the legislative framework	Legislative Revision	x			

The capacity building plan presented above can cover all agents and new OBUHA units, to further develop their capacities during the short- and long-term programmes. To sustain capacity building in the sanitation sector, continuous training will be considered to maintain a constant level of knowledge for new units to strengthen the team and in view of possible resignations and dismissals. This plan will identify opportunities for weaknesses identified by the permanent agents and the new units.

6 CONCLUSIONS ON THE SANITATION OF THE CITY OF BUJUMBURA

The analysis of the liquid sanitation situation in Bujumbura, from the institutional and technical-economic viewpoint, as well as the infrastructure and service level in the city, showed significant shortcomings and gaps. The major problems are the deteriorating sanitation works, lack of maintenance, deterioration of the pumping stations, the service network of very variable quality (characterized by its obsolescence) and the problems regarding unofficial connections by the populations served, especially in the city centre. Another problem is the lack of awareness among the population; the team found a lack of interest on the part of the population in the issues of sanitation, purification and reuse of wastewater. The establishment of facilities for the disposal and treatment of domestic discharges is rarely considered a priority by the population.

Almost all autonomous systems of liquid sanitation are septic tanks, without appropriate purifying elements. The study, with a very broad regional vision of the area, made it possible to adopt the technical, operational and financial provisions to provide, at the lowest possible cost, the best possible solution to the problems posed by the collection, transport, discharge or reuse of wastewater from the agglomeration, while ensuring effective protection against pollution of the Lake Tanganyika environment.

The institutional and organisational structures to be established were also analysed. The provisions studied to achieve these objectives are detailed in scenarios for a first priority stage of a short-term project, in particular leading to a significant improvement in the current sanitation situation while meeting the development prospects of the agglomeration (by rehabilitating the existing network, equipping the step and training the staff of OBUHA).

The interaction between the master plan for urban development and the master plan for the supply of drinking water is very strong and it would be desirable for the master plan for wastewater treatment also to be



considered. Despite the efforts made by OBUHA, the works and facilities for sanitation/treatment, discharge or reuse of wastewater, have not accompanied the intense urbanization of the city of Bujumbura. This urbanization has led to the break-up of the former urban perimeters, the extension of peripheral neighbourhoods and the proliferation of spontaneous and unsafe habitat, accompanied by the development of the drinking water supply network. It is also worth noting the extension and development of industrial units, without being accompanied in parallel by the establishment of systems for pretreatment of the flows of pollution generated. The clearing of structures is not done regularly, and rainwater drains are often used to dispose of waste resulting from street sweeping. Some problems encountered in the case of rainwater originate from the fact that urbanization occupies the natural space for the flow of rainwater.

In this study we analysed the techno-economic aspects of the rehabilitation of existing infrastructure and the extension of the network through the installation of new manifolds and pumping stations in unconnected areas. Capacity building is a main focus for improving the situation, the sustainability of the solutions to be implemented, as well as the financing of the system through a fee to be paid by the users of the network and the treatment (population, industrialists, traders, etc.).

7 APPENDICES

Appendix A - Financial calculations and economic profitability of the methods for recovery of plastics and composting of organic materials



APPENDIX A

FINANCIAL CALCULATIONS AND PROFITABILITY FOR RECYCLING AND COMPOSTING METHODS FOR EACH CITY

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INTRODUCTION

The circular economy is a production and consumption model that aims to ensure that materials remain in the economy longer, reducing the use of virgin raw materials and waste generation and, as a result, harm to society and the environment. The circular economy is based on sustainable design, maintenance, repair, re-use, remanufacturing, restoration and recycling of products. In general, recycling is considered beneficial for the environment and the economy. It alleviates resource shortages by reducing raw material consumption, reducing the amount of waste sent to landfills and extending materials' useful life. In addition, reducing the amount of waste sent to landfills and incinerators reduces soil, water and air pollution.

Recycling can lead to significant savings. It prevents a high percentage of the materials' value from being lost to the economy after brief use. This is particularly the case for plastic packaging materials, for which an estimated 95% of value is lost, or \$80-120 billion per year.¹ In this case, recycling avoids the costs associated with extraction and production of new raw materials and with landfilling or incineration of waste.

Numerous studies have shown financial profitability to the private sector by investing in the circular economy. In addition, case studies have shown that waste treatment is also a sector in which, by reducing negative externalities, the economic benefits to the general community far outweigh the sector's investment and operating costs.²

The analysis below, conducted on the 5 countries of the Lake Tanganyika basin, does not reflect how the circular economy of plastic economic contributes for each State concerned.

The analysis below is intended to shed light on the financial profitability of plastic waste recovery and compost recovery.

As explained in the final report, the system's operation is simple. Citizens collect plastic waste (any type of plastic) and head to a platform for recovery, sorting, cleaning, grinding and production of pellets. This platform will be managed by a private company that buys the plastics brought back by the collectors (**hereinafter referred to as raw material**), and transforms them into granules for sale to the local market or for export (strong international demand).

To do this, we used a number of working assumptions, which had no effect on the financial analysis results.

- **Working assumption 1:** Our calculations ignored all the operator charges that correspond to transfers such as VAT or other environmental taxes. Indeed, these taxes correspond to levies on consumers, and are paid to the State which is the final beneficiary. These transfers have no impact on the sector's financial profitability.
- **Working assumption 2:** For the rest, we assumed an inflation rate of 2% per year on raw materials purchase costs and on wages. Regarding the selling prices of recycled plastic, we assume that in the coming years, the technological gains associated with recycling would offset inflation effects.
- **Working assumption 3:** To simplify the assessment exercise, for the recycled plastic sector, but also for compost, we assume that only one private company is engaged in inflation effects. This assumption is realistic since here the sector's financial profitability is evaluated based on the volumes produced, and not the number of sector actors. In addition, as we will see in the

¹ Ellen MacArthur Foundation (2016) World Economic Forum, The New Plastics Economy. Rethinking the future of plastics, 2016

² Medina-Mijangos et al. Environ Sci Eur, (2021), The economic assessment of the environmental and social impacts generated by a light packaging and bulky waste sorting and treatment facility in Spain: a circular economy example.

results presented above, there is indeed a threshold effect of quantities of finished products below which the sector is not profitable. Multiplying the actors would then amount to multiplying the sector's fixed costs, reducing profitability and discouraging private companies.

Nevertheless, the presence of a single economic player in the monopolistic market would provide an incentive to seek significant margins by increasing the market selling prices of the final products. We believe that this risk remains limited for two reasons. The first is that the products resulting from the recovery remain in competition with substitute products on the local market. This means that even in a monopoly situation, the economic operator is subject to a competitive market. The second reason is that while opportunities are international opportunities, the international market is also a competitive market.

Note to the reader

We present in detail the case of plastic recovery in Bujumbura. For other cities, to the extent that we use the same assumptions, we will only present the results from financial simulations.

1 - PLASTIC RECOVERY IN BURUNDI

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The necessary investments consist of the following: administrative buildings; a waste receiving yard; a sorting, washing and grinding unit, and finally, a storage shed.

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

Total investments amount to €600,000.

Infrastructures/units	Area (m²)	price in €	service life
Administrative buildings	150	€200,000	50
Waste receiving area	400	€150,000	50
Sorting, washing and grinding unit	250	€150,000	20
Storage shed for sorted and compressed products	300	€100,000	50
Total		600,000	

The equipment consists of technical devices, office furniture, computer hardware and rolling stock. For the first month of operation, working capital valued at €1,200,000 would be necessary to purchase raw materials and consumables.

Description	Amount (€)	Service life
Technical equipment	€500,000	10
Office furniture	€50,000	10
IT Equipment	€15,000	5
Rolling Stock	€200,000	10
Working capital	€1,200,000	1
Total Investments	€1,965,000	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses
- other current expenses,
- purchase of raw materials.

Personnel expenses

Forty-one people would be needed to run the company. Staff details are given in the table below, with the assumptions made on salaries.

Staff increase is associated with the collectable quantities' growth rate in the following proportions:

- every five years, an additional 10 workers join the team.
- every 5 years, 2 commercial drivers and a truck driver are recruited.

Annual staff costs amount to €133,200 for the first year.

Headings	Salary cost/month	Number of people	Annual cost in €
Director General	€700	1	€8,400
Technical Manager	€500	1	€6,000
Sales Manager	€400	1	€4,800
Administrative Assistant	€300	1	€3,600
Workers	€250	30	€90,000
Utility Car Driver	€250	4	€12,000
Truck Driver	€300	1	€3,600
Guards	€200	2	€4,800
Total		41	€133,200

Other current expenditures

The other operating charges correspond to those indicated in the table below. They amount to €168,000/year.

Headings	Annual expenditure in €
Electricity	€15,000
Water	€10,000
Telephone and Internet	€3,000
Insurance and stamps	€10,000
Equipment maintenance	€50,000
Vehicle maintenance	€20,000
Fuel	€50,000
Purchase of personal protection equipment (PPE) and clothing	€10,000
Total	€168,000

Purchase of raw materials

Raw material is purchased locally. The purchasing cost of one tonne was estimated at €300. Collectable volumes represent approximately 15% of the plastic waste amount; see table below.

Amount of plastic collected (15%)					
	2024	2030	2035	2040	2045
Total collectable volume per m ³	219	351	522	776	1,148
Daily collectable quantity (Tonnes)	77	123	183	271	402
Annual collectable quantity (Tonnes)	27,968	44,753	66,215	97,968	144,950

C. REVENUE

Revenue consists of recycled plastic sales. The quantities of plastic produced are approximately in the same proportions as the quantities purchased; losses related to the process are estimated between 1% and 2%. We will retain a conservative assumption of 2% process-related loss.

• Benchmark on the selling price

A sales price benchmark for a tonne of recycled plastic illustrates the wide variety of prices depending on the final product quality. Below we present 3 price references per tonne.

Source 1: price per tonne of pellets: <https://www.spaceagro.com/price-plastic-granule/expprice-plastic-granule.html>

- Producer selling price in Algeria: 58,000 Algerian Dinars including VAT (396€FOB on 06-02-23)
- Purchase price for a factory in Vietnam: USD 325/tonne CIF HaiPhong-Vietnam

- Sale price Tunisia: 570 USD / tonne for export to Europe
- Belgium based company sells at 650€/tonne.

Source 2: https://fr.made-in-china.com/tag_search_product/Plastic-Granules-Recycled_yhogern_1.html

At the Made in China site, recycled plastic ranges from US \$600 to US \$2,000 per tonne.

Source 3: <https://www.ucaplast.fr/> Union of Trade Unions of SMEs in Rubber and Plastics.

DOUANES : Le prix moyen des matières est obtenu à partir des ventes en volumes et en valeurs, à l'exportation et à l'importation, en mars 2017.

PRIX DES MATIÈRES					
Matières	Prix (en € par tonne)	Tendance	Matières	Prix (en € par tonne)	Tendance
Pebdl	1273	+			
PEbd	1366	+	PR (Autres)	4398	+
PEhd	1253	+	Résines phénoliques	2127	+
PP	1241	+	PUR	3291	+
PP copolymères	1405	+	Résines mélaminiques	853	+
PSE	1650	-	Silicones	5707	+
PS	1638	+	CA-U (acétate de cellulose)	-	
SAN	1952	+	Déchets PE	337	+
ABS	2169	+	Déchets styréniques	333	+
PVC non mélangé	912	+	Déchets PVC	369	+
PVC-P (mélangé et plastifié)	1752	+	Déchets PP	479	+
PVC-U (mélange, non plastifié)1726	1246	+	SBR et XSBR (latex)	1027	+
PVDC	3164	+	E-SBR	1870	+
PTFE	12697	-	SBS	2267	+
PVDF	13723	+	S-SBR (en balles)	1855	+
PVAC	1470	4	BR	2103	+
PMMA	3126	-	CIIR (plaques)	2432	-
POM	2550	-	DEIR (plaques)	4090	+
Époxydes	3821	+	SBR et XSBR (plaques)	1863	+
PC	2822	+	CR (latex)	3225	-
PET	961	-	CR (plaques)	3994	-
UP (polyester insaturé)	1983	-	EPDM	2233	-
PA (-6 -11 -12 -6,6 -6,9 -6,10 -6,12	3087	+	EVA	4015	+

Source: Direction générale des douanes.

For our study's purposes, we assumed that the final product was not high-end. We selected an approximate selling price of 450 €/tonne, among the lowest observed in the producer/supplier and wholesaler markets.

• Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€12,333,888	€18,248,729	€27,000,092	€39,948,259	€59,105,851
Quantity produced in tonnes	27,409	40,553	60,000	88,774	131,346
Unit price €/tonne	450	450	450	450	450

d. FINANCIAL PROFITABILITY

Financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€12,333,888	€18,248,729	€27,000,092	€39,948,259	€59,105,851
Expenses								
Investments	m²	Price Per Unit/Fixed						
Administrative buildings	150	200,000	200,000	0	0	0	0	178,313
Waste receiving area	400	150,000	150,000	0	0	0	0	133,735
Sorting, washing and grinding unit	250	150,000	150,000	0	0	0	0	0
Storage shed for sorted and compressed products	300	100,000	100,000	0	0	0	0	89,156
Equipment renewal								
Technical equipment	500,000	10	500,000	0	0	0	0	- €668,676
Office furniture	50,000	10	50,000	0	0	0	0	- €66,868
IT Equipment	15,000	5	15,000	0	0	0	0	- €17,831
Rolling Stock	200,000	10	200,000	0	0	0	0	- €267,471

Personnel expenses								
Headings	Salary €/year	No. of persons						
Director General	8,400	1	-	8,400		10,240		
Technical Manager	6,000	1	-	6,000	9,274		11,305	12,482
Sales Manager	4,800	1	-	4,800	6,624	7,314	8,075	8,916
Administrative Assistant	3,600	1	-	3,600	5,300	5,851	6,460	7,133
Workers (+2/y)	3,000	30	-	90,000	3,975	4,388	4,845	5,349
Utility Car Driver	3,000	4	-	12,000	132,490	182,849	242,256	312,049
Truck Driver	3,600	1	-	3,600	20,006	29,548	40,861	53,350
Guards	2,400	2	-	4,800	7,353	11,849	17,200	23,537
					5,300	5,851	6,460	7,133
Current expenses								
	Share per year	Annual expenditure						
Electricity	15,000	1	-	15,000	16,561	18,285	20,188	22,289
Water	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Telephone and Internet	3,000	1	-	3,000	3,312	3,657	4,038	4,458
Insurance and stamps	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Equipment maintenance	50,000	1	-	50,000	55,204	60,950	67,293	74,297
Vehicle maintenance	20,000	1	-	20,000	22,082		26,917	29,719
						24,380		
Fuel	50,000	1	-	50,000	55,204	60,950	67,293	74,297
Purchase of personal protection equipment (PPE) and clothing	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Raw material								
	Purchase price							
Purchase of aggregates €/tonne	300	-	-	8,390,400	12,414,101		27,175,686	40,208,062
						18,367,409		
Working capital								
	1,200,000	1	-	1,200,000				
Total expenses								
				1,365,000	9,891,600	12,789,908	18,830,091	27,739,255
								40,268,010
Cash Flow (€)								
				- 1,365,000	2,442,288	5,458,821	8,170,001	12,209,004
								18,837,841
IRR								
								217%

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

2024 represents the year of investments; the first year of operation will be in 2025, which is why staff support costs and current expenses are expected from 2025.

All other elements being the same, and given the conservative assumptions on sales prices, **a recycled plastic recovery system would clearly be profitable**. The internal return rate - IRR - indicator of return on investment is approximately 217% over a 20-year operating period.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. Financial profitability is always guaranteed for a selling price of €325 per tonne. This becomes zero for a selling price below €312/tonne.

Selling price of finished product €/tonne	316	325	400	450
IRR	0%	17%	129%	217%

The same exercise is not necessary for a variation in the raw materials purchase price, since what guarantees the sector's financial profitability is the difference between the selling and purchase prices. This difference should be approximately €10 per tonne for a profitability of 17%. The break-even point corresponding to the selling price which covers all costs is €316/tonne.

As we will see later, the case of Bujumbura is particularly profitable because of the plastic waste volumes to be treated.

2 - PLASTIC RECOVERY IN KIGOMA

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The necessary investments consist of the following: administrative buildings; a waste receiving yard; a sorting, washing and grinding unit, and finally, a storage shed.

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods.

The total investment amount is €420,000.

Infrastructures/units	Area (m ²)	price in €	service life
Administrative buildings	100	€150,000.00	50
Waste receiving area	300	€100,000.00	50
Sorting, washing and grinding unit	200	€100,000.00	20
Storage shed for sorted and compressed products	200	€70,000.00	50
Total		€420,000.00	

The equipment consists of technical equipment, office furniture, computer equipment and rolling stock. For the first month of operation, necessary working capital would be valued at €150,000 to purchase raw materials and consumables.

Description	Amount (€)	Service life
Technical equipment	€350,000	10
Office furniture	€25,000	10
IT Equipment	€10,000	5
Rolling Stock	€160,000	10
Working capital	€150,000	1
Total equipment and WC	€695,000	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses,
- other current expenses,
- purchase of raw materials.

Personnel expenses

The table below indicates the staff required and the salary costs. The annual staff costs amount to €126,600.

Headings	Salary cost/month	Number of people	Annual cost in €
Director General	€900	1	€10,800
Technical Manager	€650	1	€7,800
Sales Manager	€650	1	€7,800
Administrative Assistant	€400	1	€4,800
Workers	€300	20	€72,000
Utility Car Driver	€350	3	€12,600
Truck Driver	€400	1	€4,800
Guards	€250	2	€6,000
Total		30	€126,600

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €106,000/year.

Headings	Annual expenditure in €
Electricity	€10,000
Water	€7,000
Telephone and Internet	€2,000
Insurance and stamps	€6,000
Equipment maintenance	€35,000
Vehicle maintenance	€16,000
Fuel	€25,000

Purchase of personal protection equipment (PPE) and clothing	€5,000
Total	€106,000

Purchase of raw materials

Raw material is purchased locally. The purchase cost per tonne has been estimated at €300. Quantities that can be collected represent approximately 15% of the quantity of plastic; see table below.

	2025	2030	2035	2040	2045
Purchase of Raw Material	1,204,500	1,430,568	1,699,066	2,017,958	2,396,701
Quantity produced in tonnes	4,015	4,769	5,664	6,727	7,989
Unit price €/tonne	300	300	300	300	300

C. REVENUE

Revenue consists of recycled plastic sales. Losses related to the process are estimated at between 1% and 2%. We will retain a conservative assumption of 2% process-related loss.

Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2025 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€1,770,615	€2,102,935	€2,497,627	€2,966,398	€3,523,150
Quantity produced in tonnes	3,935	4,673	5,550	6,592	7,829
Unit price €/tonne	450	450	450	450	450

d. FINANCIAL PROFITABILITY

Financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€1,770,615	€2,102,935	€2,497,627	€2,966,398	€3,523,150
Expenses								
Investments	m2							
Administrative buildings	100	150,000	150,000	0	0	0	0	133,735
Waste receiving area	300	100,000	100,000	0	0	0	0	89,156
Sorting, washing and grinding unit	200	100,000	100,000	0	0	0	0	0
Storage shed for sorted and compressed products	200	70,000	70,000	0	0	0	0	62,409
Equipment renewal								
Technical equipment	350,000	10	350,000	0	0	0	0	-
Office furniture	25,000	10	25,000	0	0	0	0	-
IT Equipment	10,000	5	10,000	0	0	0	0	-
Rolling Stock	160,000	10	160,000	0	0	0	0	-
Personnel expenses								€213,976
Headings	Salary €/year	No. of persons	-	0	0	0	0	0
Director General	10,800	1	-	10,800	11,924	13,165	14,535	16,048
Technical Manager	7,800	1	-	7,800	8,612	9,508	10,498	11,590
Sales Manager	7,800	1	-	7,800	8,612	9,508	10,498	11,590
Administrative Assistant	4,800	1	-	4,800	5,300	5,851	6,460	7,133
Workers (+2/y)	3,600	20	-	72,000	119,241	175,535	242,256	320,965
Utility Car Driver	4,200	3	-	12,600	23,371	36,248	51,552	68,449
Truck Driver	4,800	1	-	4,800	5,347	5,956	6,633	7,387
Guards	3,000	2	-	6,000	6,624	7,314	8,075	8,916
Current expenses	Purchase price	Annual expenditure	-					
Electricity	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Water	7,000	1	-	7,000	7,729	8,533	9,421	10,402
Telephone and Internet	2,000	1	-	2,000	2,208	2,438	2,692	2,972

Insurance and stamps	6,000	1	-	6,000	6,624	7,314	8,075	8,916
Equipment maintenance	35,000	1	-	35,000	38,643	42,665	47,105	52,008
Vehicle maintenance	16,000	1	-	16,000	17,665	19,504	21,534	23,775
Fuel	25,000	1	-	25,000	27,602	30,475	33,647	37,149
Purchase of personal protection equipment (PPE) and clothing	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Raw material	Purchase price							
Purchase of raw materials	300	-	-	1,204,500	1,430,568	1,699,066	2,017,958	2,396,701
Working capital	150,000	1	-	150,000				
Total expenses			965,000	1,587,100	1,736,631	2,091,365	2,511,128	2,564,220
Net Cash Flow			€965,000	€183,515	€366,304	€406,262	€455,270	€958,930
IRR			32%					

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the conservative assumptions on sales prices, **a recycled plastic recovery sector would be profitable for Kigoma**. The internal return rate - IRR - indicator of return on investment would be approximately 32% over a 20-year operating period.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. Financial profitability is guaranteed for a selling price of €400 per tonne. The break-even point corresponding to the selling price which covers all costs is €396/tonne.

Selling price of finished product €/tonne	396	400	425	450
IRR	0%	5%	20%	20%

The same exercise is not necessary for a variation in the raw materials purchase price, since what guarantees the sector's financial profitability is the difference between the selling and purchase prices. This difference should be approximately €125 per tonne to ensure a profitability of 20%.

Compared to the case of the city Bujumbura, the break-even point of Kigoma at the price of €396 is higher (€316/tonne). The difference is in scale returns attributable to the plastic waste amount to be treated.

3 - PLASTIC RECOVERY IN MPULUNGU

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

The total investment amount is €420,000.

Infrastructures/units	Area (m²)	price in €	service life
Administrative buildings	100	€150,000.00	50
Waste receiving area	200	€100,000.00	50
Sorting, washing and grinding unit	200	€100,000.00	20
Storage shed for sorted and compressed products	150	€70,000.00	50
Total		420,000	

The equipment consists of technical equipment, office furniture, computer equipment and rolling stock. For the first month of operation, required working capital is valued at €15,000 to purchase raw materials and consumables.

Description	Amount (€)	Service life
Technical equipment	€300,000	10
Office furniture	€20,000	10
IT Equipment	€10,000	5
Rolling Stock	€150,000	10
Working capital	€15,000	1

Total Investments	€495,000
--------------------------	-----------------

b. OPERATING EXPENSES - OPEX

Personnel expenses

The table below indicates the staff required and the salary costs. The annual staff costs amount to €98,400.

Headings	Salary cost/month	Number of people	Annual cost in €
Director General	800	1	€9,600
Technical Manager	600	1	€7,200
Sales Manager	600	1	€7,200
Administrative Assistant	400	1	€4,800
Workers	300	14	€50,400
Utility Car Driver	350	2	€8,400
Truck Driver	400	1	€4,800
Guards	250	2	€6,000
Total		23	€98,400

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €89,000/year.

Headings	Annual expenditure in €
Electricity	7,000
Water	5,000
Telephone and Internet	2,000
Insurance and stamps	5,000
Equipment maintenance	30,000
Vehicle maintenance	15,000
Fuel	20,000
Purchase of personal protection equipment (PPE) and clothing	5,000
Total	€89,000

Purchase of raw materials

Raw material is purchased locally. The purchase cost per tonne has been estimated at €300. Quantities that can be collected represent approximately 15% of the quantity of plastic; see table below.

	2025	2030	2035	2040	2045
Purchase of Raw Material	€74,730	€110,823	€164,349	€243,727	€361,443
Quantity produced in tonnes	249	369	548	812	1,205
Unit price €/tonne	300	300	300	300	300

c. REVENUE

Revenue consists of recycled plastic sales. Losses related to the process are estimated at between 1 and 2%. We will retain a conservative assumption of 2% process-related loss.

Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

	2025	2030	2035	2040	2045
--	------	------	------	------	------

Purchase of Raw Material	1,204,500	1,430,568	1,699,066	2,017,958	2,396,701
Quantity produced in tonnes	4,015	4,769	5,664	6,727	7,989
Unit price €/tonne	300	300	300	300	300

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Year			2024	2025	2030	2035	2040	2045
Total revenue			€	€109,853	€162,910	€241,593	€358,279	€531,322
Expenses								
Investments	m2							
Administrative buildings	100	150,000	150,000	0	0	0	0	133,735
Waste receiving area	200	100,000	100,000	0	0	0	0	89,157
Sorting, washing and grinding unit	200	100,000	100,000	0	0	0	0	0
Storage shed for sorted and compressed products	150	70,000	70,000	0	0	0	0	62,410
Equipment renewal								
Technical equipment	300,000	10	300,000	0	0	0	0	- €401,206
Office furniture	20,000	10	20,000	0	0	0	0	- €26,747
IT Equipment	10,000	5	10,000	0	0	0	0	- €11,888
Rolling Stock	150,000	10	150,000	0	0	0	0	- €200,603
Personnel expenses								
Salary	€/year	No. of persons	-	0	0	0	0	0
Headings								
Director General	9,600	1	-	9,600	10,599	11,702	12,920	14,265
Technical Manager	7,200	1	-	7,200	7,949	8,777	9,690	10,699
Sales Manager	7,200	1	-	7,200	7,949	8,777	9,690	10,699
Administrative Assistant	4,800	1	-	4,800	5,300	5,851	6,460	7,133
Workers (+2/y)	3,600	14	-	50,400	75,519	105,321	140,509	181,880
Utility Car Driver	4,200	2	-	8,400	14,004	20,684	28,602	37,345
Truck Driver	4,800	1	-	4,800	10,029	16,296	23,757	32,596
Guards	3,000	2	-	6,000	6,624	7,314	8,075	8,916
Current expenses	Purchase price	Annual expenditure						
Electricity	7,000	1	-	7,000	7,729	8,533	9,421	10,402
Water	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Telephone and Internet	2,000	1	-	2,000	2,208	2,438	2,692	2,972
Insurance and stamps	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Equipment maintenance	30,000	1	-	30,000	33,122	36,570	40,376	44,578
Vehicle maintenance	15,000	1	-	15,000	16,561	18,285	20,188	22,289
Fuel	20,000	1	-	20,000	22,082	24,380	26,917	29,719
Purchase of personal protection equipment (PPE) and clothing	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Raw material	Purchase price							
Purchase of aggregates €/tonne	300	-	-	74,730	110,823	164,349	243,727	361,443
Working capital	15,000	1	-	15,000				
Total expenses			900,000	277,130	347,061	457,561	603,214	442,083
Net Cash Flow			- €900,000	- €167,277	- €184,151	- €215,968	- €244,935	- €89,239
IRR								

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a recycled plastic recovery sector would not be profitable in Mpulungu**. The lack of profitability is due to the fact that the quantities of recycled products are largely insufficient to cover fixed costs and staff costs. The break-even point for a tonne of recycled plastic would be €950, making it unlikely to be marketed.

There is therefore a threshold effect. To ensure profitability, the value chain should be of a minimum size in terms of quantities produced.

4 - PLASTIC RECOVERY IN UVIRA

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

The total investment amount is €440,000.

Infrastructures/units	Area (m²)	price in €	service life
Administrative buildings	100	€150,000	50
Waste receiving area	300	€100,000	50
Sorting, washing and grinding unit	250	€120,000	20

Storage shed for sorted and compressed products	200	€70,000	50
Total		440,000	

The equipment consists of technical equipment, office furniture, computer equipment and rolling stock. For the first month of operation, required working capital is valued at €300,000 to purchase raw materials and consumables.

Description	Amount (€)	Service life
Technical equipment	€350,000	10
Office furniture	€25,000	10
IT Equipment	€10,000	5
Rolling Stock	€160,000	10
Working capital	€300,000	1
Total Investments	€845,000	

b. OPERATING EXPENSES - OPEX

Personnel expenses

The table below indicates the staff required and the salary costs. The annual staff costs amount to €144,600.

Headings	Salary cost/month	Number of people	Annual cost in €
Director General	900	1	€10,800
Technical Manager	650	1	€7,800
Sales Manager	650	1	€7,800
Administrative Assistant	400	1	€4,800
Workers	300	25	€90,000
Utility Car Driver	350	3	€12,600
Truck Driver	400	1	€4,800
Guards	250	2	€6,000
Total		35	€144,600

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €106,000/year.

Headings	Annual expenditure in €
Electricity	€10,000
Water	€7,000
Telephone and Internet	€2,000
Insurance and stamps	€6,000
Equipment maintenance	€35,000
Vehicle maintenance	€16,000
Fuel	€25,000
Purchase of personal protection equipment (PPE) and clothing	€5,000
Total	€106,000

Purchase of raw materials

Raw material is purchased locally. The purchase cost per tonne has been estimated at €300. Quantities that can be collected represent approximately 15% of the quantity of plastic; see table below.

Year	2025	2030	2035	2040	2045
Purchase of raw material	1,204,500	1,430,568	1,699,066	2,017,958	2,396,701
Quantity produced in tonnes	7,901	10,425	13,754	18,147	23,943
Unit price €/tonne	300	300	300	300	300

c. REVENUE

Revenue consists of recycled plastic sales. Losses related to the process are estimated at between 1 and 2%. We will retain a conservative assumption of 2% process-related loss.

Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€1,770,615	€2,102,935	€2,497,627	€2,966,398	€3,523,150
Quantity produced in tonnes	7,743	10,216	13,479	17,784	23,464
Unit price €/tonne	450	450	450	450	450

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€3,484,341	€4,597,223	€6,065,555	€8,002,864	€10,558,942
Expenses								
Investments	m2							
Administrative buildings	100	150,000	150,000	0	0	0	0	133,735
Waste receiving area	300	100,000	100,000	0	0	0	0	89,157
Sorting, washing and grinding unit	250	120,000	120,000	0	0	0	0	-
Storage shed for sorted and compressed products	200	70,000	70,000	0	0	0	0	62,410
Equipment renewal								
Technical equipment	350,000	10	350,000	0	0	0	0	- €468,073
Office furniture	25,000	10	25,000	0	0	0	0	- €33,434
IT Equipment	10,000	5	10,000	0	0	0	0	- €11,888
Rolling Stock	160,000	10	160,000	0	0	0	0	- €213,976
Personnel expenses								
Headings	Salary €/year	No. of persons	-	0	0	0	0	0
Director General	10,800	1	-	10,800	11,924	13,165	14,535	16,048
Technical Manager	7,800	1	-	7,800	8,612	9,508	10,498	11,590
Sales Manager	7,800	1	-	7,800	8,612	9,508	10,498	11,590
Administrative Assistant	4,800	1	-	4,800	5,300	5,851	6,460	7,133
Workers (+2/y)	3,600	25	-	90,000	99,367	109,709	121,128	133,735
Utility Car Driver	4,200	3	-	12,600	13,911	15,359	16,958	18,723
Truck Driver	4,800	1	-	4,800	5,300	5,851	6,460	7,133
Guards	3,000	2	-	6,000	6,624	7,314	8,075	8,916
Current expenses	Purchase price	Annual expenditure						
Electricity	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Water	7,000	1	-	7,000	7,729	8,533	9,421	10,402
Telephone and Internet	2,000	1	-	2,000	2,208	2,438	2,692	2,972
Insurance and stamps	6,000	1	-	6,000	6,624	7,314	8,075	8,916
Equipment maintenance	35,000	1	-	35,000	38,643	42,665	47,105	52,008
Vehicle maintenance	16,000	1	-	16,000	17,665	19,504	21,534	23,775
Fuel	25,000	1	-	25,000	27,602	30,475	33,647	37,149
Purchase of personal protection equipment (PPE) and clothing	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Raw material	Purchase price							
Purchase of aggregates €/tonne	300	-	-	2,370,300	3,127,363	4,126,228	5,444,125	7,182,954
Working capital	300,000	1	-	300,000				
Total expenses			985,000	2,920,900	3,404,045	4,431,708	5,781,400	7,113,263
Net Cash Flow			- €985,000	€563,441	€1,193,178	€1,633,847	€2,221,464	€3,445,679
IRR			82%					

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the conservative assumptions on sales prices, **a recycled plastic recovery sector would be profitable for Uvira**. The internal return rate - IRR - indicator of return on investment would be approximately 82% over a 20-year operating period.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. Financial profitability would always be guaranteed for a selling price of €400 per tonne. This becomes zero for a selling price below €336/tonne.

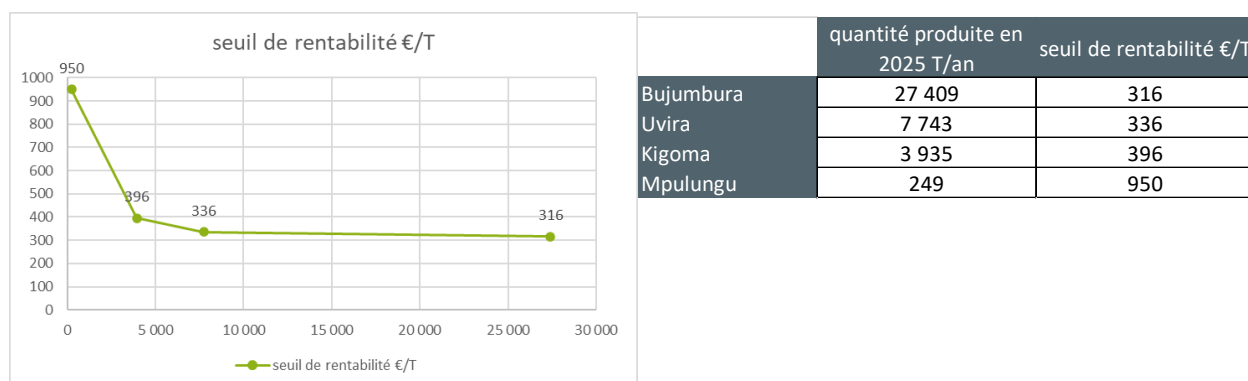
Selling price of finished product €/tonne	336	350	400	450
IRR	0%	13%	47%	82%

The same exercise is not necessary for a variation in the raw materials purchase price, since what guarantees the sector's financial profitability is the difference between the selling and purchase prices. The break-even point is €336 per tonne of recycled plastic.

5 - CONCLUSION AND WARNING

The results presented above should be taken with caution. This is an overall assessment of the financial profitability of a plastic waste recovery sector. Going further would require an analysis of the different technologies associated with each type of recycling, and the local markets and exports associated with the finished products.

Nevertheless, it appears that for the plastic recovery sector to be financially profitable, it would require scaling it to a production volume above a certain threshold. The tables and figure below illustrate this relationship between the product quantity and break-even point.



The examples presented above show that for the three cities of Bujumbura, Kigoma and Uvira, recyclable plastic waste is large enough to allow the emergence of a market for recycled plastic.

This is not the case in Mpulungu, where the plastic waste volumes are too low to guarantee a financially viable business model for recycled plastic.

6 - COMPOST RECOVERY IN BURUNDI

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods.

The total investment amount is €992,500.

Infrastructures/units	Area (m²)	Unit price excl. VAT	Total cost excl. VAT €	Service life
Unloading and sorting area	2,000	100	200,000	50
waste sorting storage area	1,000	150	150,000	50
Grinding area for green waste and/or nitrogenous matter	300	150	45,000	50
Composting platform	5,000	100	500,000	50
Compost Crushing and Sifting Area	300	150	45,000	50
Storage and bagging area	300	100	30,000	50
Office area, cloakroom and guard lodge	150	150	22,500	50
Total			€992,500	

For other equipment and technical equipment, the table below presents the details of the requirements as well as the associated costs. All technical equipment and materials are renewed at the end of their service life.

Description	Quantity	Unit price excl. VAT	Total price excl. VAT €	Service life
Desk with Armchair	2	153	306	5
Visitor chair	4	16	64	5
Storage cabinet	1	230	230	10
Computer	1	457	475	5
Printer	1	380	380	5
Video projector	1	457	457	5
Loaner motorcycle for connections	6	610	3,660	7
Tricycles	8	2,290	18,320	7
Dump lorry	2	22,900	45,800	10
Wheeled backhoe loader	2	22,900	45,800	10
Vegetable mills	2	1,530	1,530	10
Horn mills	2	1,530	1,530	10
Compost mills	2	1,530	1,530	10
Manual stand sieve 2cm mesh	4	152	608	10
Waste containers	3,000	5	15,000	4
660L trays	50	420	21,000	4
Waste bags	200,000	0.07	14,000	1
Work coveralls	20	23	460	2
Charcoal masks	20	8	160	1
Gloves	100	0.76	76	1
Face mask	100	0.15	15	1
Safety footwear	20	16	320	1
Boots	20	8	160	1
Wheelbarrows	5	25	125	5
Excavators	5	4	20	1
Racks/Forks	5	2	10	1
Machetes	5	1.5	7.5	1
Branded 50Kg Bags	60,000	0.27	16,200	1
Total			€188,244	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses,
- other current expenses,
- purchase of raw materials.

Personnel expenses

At start-up, 44 people would be needed to run the operating company. Details of staff and staff costs are provided in the table below. The last column indicates the need for additional staff as compost production increases.

At the rate of growth of collectable quantities, an increase in staff would be necessary every 5 years, with:

- 2 additional people are added to the team for sorting and receiving of waste,
- 4 additional people for collection,
- 1 guard,
- 1 commercial agent every 10 years or half of full time every 5 years, and
- 2 Drivers

Annual staff costs amount to €235,200 for the first year.

Headings	Salary/month	No. of persons	Salary Cost €/year	Additional staff: 5 years
Head of Unit	800	1	9,600	0
Receipt of waste /Sorting and stacking	500	12	72,000	2
Collectors /sorting aid	400	15	72,000	4
Guard/Production Support	300	3	10,800	1
Sales agents	500	1	6,000	0.5
Driver	450	12	64,800	2
Total		44	€235,200	

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €43,500/year.

Headings	Annual expenditure in €
Electricity	8,000
Water	6,000
Telephone and Internet	1,000
Insurance and stamps	5,000
Vehicle and equipment maintenance	12,000
Fuel	10,000
Purchase of personal protection equipment (PPE) and clothing	1,500
Electricity	8,000
Total	€43,500

Purchase of raw materials

In other West African countries, the cost per tonne of household solid waste is approximately 11,000 FCFA (equivalent to €16).³ We will assume that raw material is purchased locally, at a price of €15 per tonne. This price would increase at the rate of inflation (see table below).

Year	2025	2030	2035	2040	2045
Cost of purchase of Raw Mat.	€1,594,155	€3,739,445	€6,265,500	€10,497,946	€17,589,476
Gross quantity in tonnes	106,277	112,898	171,330	260,004	394,574
Unit price €/tonne	15	17	18	20	22

C. REVENUE

The proceeds are from the sale of compost. Only 70% of the total amount of organic material is compostable, the other 30% is fine material that is removed after waste sifting.

The final product is sold locally.

For our study's purposes, we assumed a sales price per tonne of compost of 30€/tonne, based on local consultations during the field phase. This price is lower than the price per tonne of compost in Europe,

³ GIZ, 2019, Gestion et recyclage de déchets organiques en Côte d'Ivoire

which varies between €39 and €55 per tonne. The selling price evolves at the same rate as that of raw material; i.e., 2% per year.

Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€2,231,817	€3,739,445	€6,265,500	€10,497,946	€17,589,476
Quantity produced in tonnes	74,394	112,898	171,330	260,004	394,574
Unit price €/tonne	30	33	37	40	45

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Appendix A – Contract FWC 300025407 - Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€2,231,817	€3,739,445	€6,265,500	€10,497,946	€17,589,476
Quantity produced in tonnes			- €	74,394	112,898	171,330	260,004	394,574
Unit price €/tonne	30		- €	30	33	37	40	45
Expenses								
Investments	m2	Unit price						
Unloading and sorting area	2,000	100	200,000	-	-	-	-	178,314
waste sorting storage area	1,000	150	150,000	-	-	-	-	133,735
Grinding area for green waste and/or nitrogenous matter	300	150	45,000	-	-	-	-	40,121
Composting Platform	5,000	100	500,000	-	-	-	-	445,784
Compost Crushing and Sifting Area	300	150	45,000	-	-	-	-	40,121
Storage and bagging area	300	100	30,000	-	-	-	-	26,747
Office area, cloakroom and guard lodge	150	150	22,500	-	-	-	-	20,060
Equipment renewal	Quantity	Unit price	-					
Technical equipment	-	-	-					-543
desk with armchair	2	153	306	-	-	-	-	5,547
visitor chair	4	16	64	-	-	-	-	27,767
storage cabinet	1	230	230	-	-	-	-	-27,223
computer	1	457	457	-	-	-	-	-27,223
printer	1	380	380	-	-	-	-	-1,819
video projector	1	457	457	-	-	-	-	-1,819
Loaner motorcycle for connections	6	610	3,660	-	-	-	-	-1,819
Tricycles	8	2,290	18,320	-	-	-	-	-361
Dump lorry	2	22,900	45,800	-	-	-	-	-22,289
Wheeled backhoe loader	2	22,900	45,800	-	-	-	-	-31,205
Vegetable mills	2	1,530	3,060	-	-	-	-	-543
Horn mills	2	1,530	3,060	-	-	-	-	5,547
Compost mills	2	1,530	3,060	-	-	-	-	27,767
Manual stand sieve 2cm mesh	4	152	608	-	-	-	-	-27,223
Waste containers	3,000	5	15,000	-	-	-	20,592	-27,223
660L trays	50	420	21,000	-	-	-	28,828	
Waste bags	200,000	0	14,000	14,280	15,766	17,407	19,219	
Work coveralls	20	23	460	-	518	-	631	
Charcoal masks	20	8	160	163	180	199	220	
Gloves	100	1	76	78	86	94	104	
Face mask	100	0	15	15	17	19	21	
Safety footwear	20	16	320	326	360	398	439	
Boots	20	8	160	163	180	199	220	
Wheelbarrows	5	25	125	-	-	-	-	
Excavators	5	4	20	20	23	25	27	
Racks/Forks	5	2	10	10	11	12	14	
Machetes	5	2	8	8	8	9	10	
Branded 50Kg Bags	60,000	0.27	16,200	16,524	18,244	20,143	22,239	
Personnel expenses								
Headings	Salary Cost €/year	No. of persons	-					
Head of Unit	9,600	1	-	9,600	10,599	11,702	12,920	14,265
Receipt of waste /Sorting and stacking	6,000	12	-	72,000	92,743	117,023	145,354	178,314
Collectors /sorting aid	4,800	15	-	72,000	100,692	134,577	174,425	221,109
Guard/Production Support	3,600	3	-	10,800	15,899	21,942	29,071	37,446
Sales agents	6,000	1	-	6,000	9,937	14,628	20,188	26,747
driver	5,400	12	-	64,800	83,469	105,321	130,818	160,482
Current expenses	per year							
Electricity	8,000	1	-	8,000	8,833	9,752	10,767	11,888
Water	6,000	1	-	6,000	6,624	7,314	8,075	8,916
Telephone and Internet	1,000	1	-	1,000	1,104	1,219	1,346	1,486
Insurance and stamps	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Vehicle and equipment maintenance	12,000	1	-	12,000	13,249	14,628	16,150	17,831
Fuel	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Purchase of personal protection equipment (PPE) and clothing	1,500	1	-	1,500	1,656	1,828	2,019	2,229
Raw material	Purchase price							
Purchase of raw materials	15	-	-	-	2,419,236	3,671,352	5,571,520	8,455,152
Working capital	1,732,846	1	1,732,846	-				
Total expenses			2,918,162	310,288	2,815,995	4,168,077	6,235,406	10,123,288
Cash Flow			- €2,918,162	€1,921,529	€923,450	€2,097,423	€4,262,539	€7,466,188
IRR				39%				

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a compost recovery system would be profitable**. The internal return rate - IRR - indicator of return on investment is approximately 39% over a 20-year operating period.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. Financial profitability would be guaranteed for a selling price of €30 per tonne. This becomes zero for a selling price below €18.5/tonne. **The break-even point for the domestic waste recovery sector on Bujumbura is 18.5 €/tonne.**

Selling price of finished product €/tonne	18.5	30	35	40
IRR	0%	39%	54%	70%

7 - COMPOST RECOVERY IN KIGOMA

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

The total investment amount is €372,500.

Infrastructures/units	Area (m²)	Unit price excl. VAT	Total cost excl. VAT €	Service life
Unloading and sorting area	1,000	100	100,000	50
waste sorting storage area	600	150	90,000	50
Grinding area for green waste and/or nitrogenous matter	150	150	22,500	50
Composting platform	1,000	100	100,000	50
Compost Crushing and Sifting Area	150	150	22,500	50
Storage and bagging area	150	100	15,000	50
Office area, cloakroom and guard lodge	150	150	22,500	50
Total			372,500	

For other equipment and technical equipment, the table below presents the details of the requirements as well as the associated costs. The total cost of the equipment would be €115,122. All technical equipment and materials are renewed at the end of their service life.

Description	Quantity	Unit price excl. VAT	Total price excl. VAT €	Service life
Desk with Armchair	2	153	306	5
Visitor chair	4	16	64	5
Storage cabinet	1	230	230	10
Computer	1	457	457	5
Printer	1	380	380	5
Video projector	1	457	457	5
Loaner motorcycle for connections	2	610	1,220	7
Tricycles	4	2,290	9,160	7
Dump lorry	1	22,900	22,900	10
Wheeled backhoe loader	1	22,900	22,900	10
Vegetable mills	1	1,530	1,530	10
Horn mills	1	1,530	1,530	10
Compost mills	1	1,530	1,530	10
Manual stand sieve 2cm mesh	2	152	304	10
Waste containers	3,000	5	15,000	4

660L trays	30	420	12,600	4
Waste bags	100,000	0	7,000	1
Work coveralls	20	23	460	2
Charcoal masks	20	8	160	1
Gloves	100	1	76	1
Face mask	100	0	15	1
Safety footwear	20	16	320	1
Boots	20	8	160	1
Wheelbarrows	5	25	125	5
Excavators	5	4	20	1
Racks/Forks	5	2	10	1
Machetes	5	2	8	1
Branded 50Kg Bags	60,000	0	16,200	1
Total			€115,122	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses
- other current expenses,
- purchase of raw materials.

Personnel expenses

At start-up, 26 people would be needed to run the operating company. Details of staff and staff costs are provided in the table below. The last column indicates the need for additional staff as compost production increases.

With the growth rate of collectable quantities, we have associated the increase of staff every 5 years:

- 2 additional people are added to the team for sorting and receiving of waste,
- 4 additional people for collection,
- 1 guard,
- 1 commercial agent every 10 years or half of full time every 5 years, and
- 2 Drivers

Annual staff costs amount to €139,800 for the first year.

Headings	Salary/month	No. of persons	Salary Cost €/year	Additional staff: 5 years
Head of Unit	800	1	9,600	0
Receipt of waste /Sorting and stacking	500	9	54,000	2
Collectors /sorting aid	400	9	43,200	4
Guard/Production Support	300	3	10,800	1
Sales agents	500	1	6,000	0.5
Driver	450	3	16,200	2
Total		26	€139,800	

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €35,000/year.

Headings	Annual expenditure in €
Electricity	8,000
Water	6,000
Telephone and Internet	1,000
Insurance and stamps	5,000

Maintenance of equipment and vehicles	12,000
Fuel	10,000
Purchase of personal protection equipment (PPE) and clothing	1,500
Electricity	8,000
Total	€35,000

Purchase of raw materials

Raw material is purchased locally. We assume a purchase cost of €15 per tonne, which increases at the rate of inflation; see table below.

Year	2025	2030	2035	2040	2045
Cost of purchase of Raw Mat.	€361,305	€337,291	€449,820	€599,891	€800,029
Gross quantity in tonnes	24,087	20,366	24,601	29,715	35,893
Unit price €/tonne	15	17	18	20	22

C. REVENUE

The proceeds would come from the sale of compost. Only 70% of the total amount of the organic material would be compostable, the remaining 30% would be fine materials that are removed after waste sifting.

The final product is sold locally.

For our study's purposes, we assumed a sales price per tonne of compost of 30€/tonne, based on local consultations during the field phase. This price is lower than the price per tonne of compost in Europe, which varies between €39 and €55 per tonne. The selling price evolves at the same rate as that of raw material; i.e., 2% per year.

Evolution of product volumes

The volumes produced in the first year, and therefore the first revenues are expected for the year 2025, the time of the provision of administrative buildings, the purchase of equipment and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€505,827	€674,583	€899,640	€1,199,781	€1,600,057
Quantity produced in tonnes	16,861	20,366	24,601	29,715	35,893
Unit price €/tonne	30	33	37	40	45

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Appendix A – Contract FWC 300025407 - Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Year			2024	2025	2030	2035	2040	2045
Total revenue				€505,827	€535,807	€567,565	€1,426,009	€1,510,528
Quantity produced in tonnes				16,861	17,510	18,184	33,281	34,562
Unit price €/tonne	30			30	31	31	43	44
Expenses								
Investments	<i>m2</i>	<i>Unit price</i>						
Unloading and sorting area	1,000	100	100,000					
waste sorting storage area	600	150	90,000					
Grinding area for green waste and/or nitrogenous matter	150	150	22,500					
Composting platform	1,000	100	100,000					
Compost Crushing and Sifting Area	150	150	22,500					
Storage and bagging area	150	100	15,000					
Office area, cloakroom and guard lodge	150	150	22,500					
Equipment renewal	<i>Quantity</i>	<i>Unit price</i>						
Technical equipment	-	-	-					- €
desk with armchair	2	153	306	-	-	-	-	455
visitor chair	4	16	64	-	-	-	-	95
storage cabinet	1	230	230	-	-	-	-	342
computer	1	457	457	-	-	-	-	679
printer	1	380	380	-	-	-	-	565
video projector	1	457	457	-	-	-	-	679
Loaner motorcycle for connections	2	610	1,220	-	-	-	-	-
Tricycles	4	2,290	9,160	-	-	-	-	-
Dump lorry	1	22,900	22,900	-	-	-	-	34,028
Wheeled backhoe loader	1	22,900	22,900	-	-	-	-	34,028
Vegetable mills	1	1,530	1,530	-	-	-	-	2,273
Horn mills	1	1,530	1,530	-	-	-	-	2,273
Compost mills	1	1,530	1,530	-	-	-	-	2,273
Manual stand sieve 2cm mesh	2	152	304	-	-	-	-	452
Waste containers	3,000	5	15,000	-	-	-	-	22,289
660L trays	30	420	12,600	-	-	-	-	18,723
Waste bags	100,000	0	7,000	7,140	7,283	7,428	10,198	10,402
Work coveralls	20	23	460	-	479	-	-	684
Charcoal masks	20	8	160	163	166	170	233	238
Gloves	100	1	76	78	79	81	111	113
Face mask	100	0	15	15	16	16	22	22
Safety footwear	20	16	320	326	333	340	466	476
Boots	20	8	160	163	166	170	233	238
Wheelbarrows	5	25	125	-	-	-	-	186
Excavators	5	4	20	20	21	21	29	30
Racks/Forks	5	2	10	10	10	11	15	15
Machetes	5	2	8	8	8	8	11	11
Branded 50Kg Bags	60,000	0.27	16,200	16,524	16,854	17,192	23,600	24,072
Personnel expenses								
Headings	Salary Cost €/year	No. of persons						
Head of Unit	9,600	1		9,600	9,792	9,988	13,711	13,985
Receipt of waste /Sorting and stacking	6,000	9		54,000	55,080	56,182	128,542	131,113
Collectors /sorting aid	4,800	9		43,200	44,064	44,945	143,967	146,847
Guard/Production Support	3,600	3		10,800	11,016	11,236	30,850	31,467
Sales agents	6,000	1		6,000	6,120	6,242	21,424	21,852
driver	5,400	3		16,200	16,524	16,854	69,413	70,801
Current expenses	-	-		-	-	-	-	-
Electricity	-	-		-	-	-	-	-
Water	DET. VERGE							
Telephone and Internet	8,000	1		8,000	8,160	8,323	11,426	11,654
Insurance and stamps	5,000	1		5,000	5,100	5,202	7,141	7,284
Vehicle and equipment maintenance	1,000	1		1,000	1,020	1,040	1,428	1,457
Fuel	4,000	1		4,000	4,080	4,162	5,713	5,827
Purchase of personal protection equipment (PPE) and clothing	6,000	1		6,000	6,120	6,242	8,569	8,741
Raw material	10,000	1		10,000	10,200	10,404	14,282	14,568

Purchase of raw materials	1,000	1	1,000	1,020	1,040	1,428	1,457
Working capital	Purchase price						
Total expenses	15			375,215	389,661	713,167	740,624
Cash Flow	375,215	1	375,215				
IRR			5%				

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a compost recovery system would be profitable, but little incentive for a private company.** The internal rate of return - IRR - indicator of return on investment would be approximately 5% over a 20-year period of operation, for a sales price of €30 per tonne of compost.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. Financial profitability is improved to 18% at a price of €35 per tonne. At this market price, the incentive to set up a private company is more realistic.

The break-even point for the domestic waste recovery sector on Kigoma is 28.5 €/tonne.

Selling price of finished product €/tonne	28.5	30	35	40
IRR	0%	5%	18%	30%

8 - COMPOST RECOVERY IN MPULUNGU

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

The total investment amount is €287,500.

Infrastructures/units	Area (m²)	Unit price excl. VAT	Total cost excl. VAT €	Service life
Unloading and sorting area	500	100	50,000	50
waste sorting storage area	500	150	75,000	50
Grinding area for green waste and/or nitrogenous matter	150	150	22,500	50
Composting platform	1,000	100	100,000	50
Compost Crushing and Sifting Area	100	150	15,000	50
Storage and bagging area	100	100	10,000	50
Office area, cloakroom and guard lodge	100	150	15,000	50
Total			287,500	

For other equipment and technical equipment, the table below presents the details of the requirements as well as the associated costs.

The total cost of the equipment is estimated at €70,601. All technical equipment and materials are renewed at the end of their service life.

Description	Quantity	Unit price excl. VAT	Total price excl. VAT €	Service life
Desk with Armchair	2	153	306	5
Visitor chair	4	16	64	5
Storage cabinet	1	230	230	10
Computer	1	457	457	5
Printer	1	380	380	5
Video projector	1	457	457	5
Loaner motorcycle for connections	2	610	1,220	7
Tricycles	2	2,290	4,580	7
Dump lorry	1	22,900	22,900	10
Wheeled backhoe loader	1	22,900	22,900	10

Vegetable mills	1	1,530	1,530	10
Horn mills	1	1,530	1,530	10
Compost mills	1	1,530	1,530	10
Manual stand sieve 2cm mesh	2	152	304	10
Waste containers	1,000	5	5,000	4
660L trays	10	420	4,200	4
Waste bags	10,000	0	700	1
Work coveralls	10	23	230	2
Charcoal masks	10	8	80	1
Gloves	50	1	38	1
Face mask	50	0	8	1
Safety footwear	10	16	160	1
Boots	10	8	80	1
Wheelbarrows	3	25	75	5
Excavators	3	4	12	1
Racks/Forks	3	2	6	1
Machetes	3	2	5	1
Branded 50Kg Bags	6,000	0	1,620	1
Total			70,601	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses,
- other current expenses,
- purchase of raw materials.

Personnel expenses

At start-up, 14 people would be needed to run the operating company. Details of staff and staff costs are provided in the table below. The last column indicates the need for additional staff as compost production increases.

Annual staff costs amount to €76,800 for the first year. There are no planned increases in staff to respond to increases in production.

Headings	Salary/month	No. of persons	Salary Cost €/year	Additional staff: 5 years
Head of Unit	800	1	9,600	0
Receipt of waste /Sorting and stacking	500	4	24,000	0
Collectors /sorting aid	400	4	19,200	0
Guard/Production Support	300	2	7,200	0
Sales agents	500	1	6,000	0
Driver	450	2	10,800	0
Total		14	76,800	

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €25,700/year.

Headings	Annual expenditure in €
Electricity	7,000
Water	3,000
Telephone and Internet	500
Insurance and stamps	2,000
Maintenance of equipment and vehicles	5,600
Fuel	7,000
Purchase of personal protection equipment (PPE) and clothing	600
Total	25,700

Purchase of raw materials

Raw material is purchased locally. We assume a purchase cost of €15 per tonne, which increases at the rate of inflation; see table below.

Year	2025	2030	2035	2040	2045
Cost of purchase of Raw Mat.	€24,285	€22,671	€30,235	€40,321	€53,774
Gross quantity in tonnes	1,619	1,369	1,654	1,997	2,413
Unit price €/tonne	15	17	18	20	22

C. REVENUE

The proceeds are from the sale of compost. Only 70% of the total amount of organic material is compostable, the remaining 30% is fine material that is removed after waste sifting.

The final product is sold locally.

For our study's purposes, we assumed a sales price per tonne of compost of 30€/tonne, based on local consultations during the field phase.

Evolution of product volumes

The volumes produced in the first year, and therefore the first revenues are expected for the year 2025, the time of the provision of administrative buildings, the purchase of equipment and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€33,999	€45,342	€60,469	€80,643	€107,547
Quantity produced in tonnes	1,133	1,369	1,654	1,997	2,413
Unit price €/tonne	30	33	37	40	45

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Appendix A – Contract FWC 300025407 - Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Year			2024	2025	2030	2035	2040	2045
Total revenue			€-	€33,999	€45,342	€60,469	€80,643	€107,547
Quantity produced in tonnes			€-	1,133	1,369	1,654	1,997	2,413
Unit price €/tonne	30		€-	30	33	37	40	45
Expenses								
Investments	m2	Unit price						
Unloading and sorting area	500	100	50,000	-	-	-	-	44,578
waste sorting storage area	500	150	75,000	-	-	-	-	66,868
Grinding area for green waste and/or nitrogenous matter	150	150	22,500	-	-	-	-	20,060
Composting platform	1,000	100	100,000	-	-	-	-	89,157
Compost Crushing and Sifting Area	100	150	15,000	-	-	-	-	13,374
Storage and bagging area	100	100	10,000	-	-	-	-	8,916
Office area, cloakroom and guard lodge	100	150	15,000	-	-	-	-	13,374
Equipment renewal	Quantity	Unit price	-					
Technical equipment	-	-	-					
desk with armchair	2	153	306	-	-	-	-	364
visitor chair	4	16	64	-	-	-	-	76
storage cabinet	1	230	230	-	-	-	-	137
computer	1	457	457	-	-	-	-	543
printer	1	380	380	-	-	-	-	452
video projector	1	457	457	-	-	-	-	543
Loaner motorcycle for connections	2	610	1,220	-	-	-	-	1,849
Tricycles	2	2,290	4,580	-	-	-	-	6,942
Dump lorry	1	22,900	22,900	-	-	-	-	13,611
Wheeled backhoe loader	1	22,900	22,900	-	-	-	-	13,611
Vegetable mills	1	1,530	1,530	-	-	-	-	909
Horn mills	1	1,530	1,530	-	-	-	-	909
Compost mills	1	1,530	1,530	-	-	-	-	909
Manual stand sieve 2cm mesh	2	152	304	-	-	-	-	181
Waste containers	1,000	5	5,000	-	-	-	6,864	7,430
660L trays	10	420	4,200	-	-	-	5,766	6,241
Waste bags	10,000	0	700	714	788	870	961	-
Work coveralls	10	23	230	-	259	-	316	-
Charcoal masks	10	8	80	82	90	99	110	-
Gloves	50	1	38	39	43	47	52	-
Face mask	50	0	8	8	8	9	10	-
Safety footwear	10	16	160	163	180	199	220	-
Boots	10	8	80	82	90	99	110	-
Wheelbarrows	3	25	75	-	-	-	-	-
Excavators	3	4	12	12	14	15	16	-
Racks/Forks	3	2	6	6	7	7	8	-
Machetes	3	2	5	5	5	6	6	-
Branded 50Kg Bags	6,000	0.27	1,620	1,652	1,824	2,014	2,224	-
Personnel expenses								
Headings	Salary Cost €/year	No. of persons	-					
Head of Unit	9,600	1	-	9,600	10,599	11,702	12,920	14,265
Receipt of waste /Sorting and stacking	6,000	4	-	24,000	39,747	58,512	80,752	106,988
Collectors /sorting aid	4,800	4	-	19,200	42,397	70,214	103,363	142,651
Guard/Production Support	3,600	2	-	7,200	11,924	17,554	24,226	32,096
Sales agents	6,000	1	-	6,000	9,937	14,628	20,188	26,747
driver	5,400	2	-	10,800	23,848	39,495	58,142	80,241
Current expenses	per year							
Electricity	7,000	1	-	7,000	7,729	8,533	9,421	10,402
Water	3,000	1	-	3,000	3,312	3,657	4,038	4,458
Telephone and Internet	500	1	-	500	552	609	673	743
Insurance and stamps	2,000	1	-	2,000	2,208	2,438	2,692	2,972
Vehicle and equipment maintenance	5,600	1	-	5,600	6,183	6,826	7,537	8,321
Fuel	7,000	1	-	7,000	7,729	8,533	9,421	10,402
Purchase of personal protection equipment (PPE) and clothing	600	1	-	600	662	731	808	892
Raw material	Purchase price							
Purchase of raw materials	15	-	-	-	29,334	35,433	42,799	51,697
Working capital	25,220	1	25,220	-				
Total expenses			383,321	105,262	199,469	282,233	393,641	199,423
Cash Flow			- €383,321	- €71,263	- €154,127	- €221,764	- €312,998	- €91,876
IRR			-%					

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a compost recovery system would not be profitable**. The internal return rate (IRR), which is an indicator of the return on investment, is negative over a period of 20 years of operation for a sales price of €30 per tonne of compost.

The break-even point for the household waste recovery sector in Mpulungu is 133 €/tonne, which is well above market prices.

We also simulated a subsidy of the entire start-up investment, but the break-even effect remains marginal as it is reduced to €126.5/tonne.

The economic model of the recovery of household waste into compost in Mpulungu would therefore not be sustainable.

9 - COMPOST RECOVERY IN UVIRA

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods.

The total investment amount is €372,500.

Infrastructures/units	Area (m²)	Unit price excl. VAT	Total cost excl. VAT €	Service life
Unloading and sorting area	1,000	100	100,000	50
Waste sorting storage area	600	150	90,000	50
Grinding area for green waste and/or nitrogenous matter	150	150	22,500	50
Composting platform	1,000	100	100,000	50
Compost Crushing and Sifting Area	150	150	22,500	50
Storage and bagging area	150	100	15,000	50
Office area, cloakroom and guard lodge	150	150	22,500	50
Total			372,500	

For other equipment and technical equipment, the table below presents the details of the requirements as well as the associated costs. The total is estimated at €115,122. All technical equipment and materials are renewed at the end of their service life.

Description	Quantity	Unit price excl. VAT	Total price excl. VAT €	Service life
Desk with Armchair	2.0	153.0	306	5
Visitor chair	4.0	16.0	64	5
Storage cabinet	1.0	230.0	230	10
Computer	1.0	457.0	457	5
Printer	1.0	380.0	380	5
Video projector	1.0	457.0	457	5
Loaner motorcycle for connections	2.0	610.0	1,220	7
Tricycles	4.0	2,290.0.	9,160	7
Dump lorry	1.0	22,900.0.	22,900	10
Wheeled backhoe loader	1.0	22,900.0.	22,900	10
Vegetable mills	1.0	1,530.0.	1,530	10
Horn mills	1.0	1,530.0.	1,530	10
Compost mills	1.0	1,530.0.	1,530	10
Manual stand sieve 2cm mesh	2.0	152.0	304	10

Waste containers	3,000.0.	5.0	15,000	4
660L trays	30.0	420.0	12,600	4
Waste bags	100,000.0.	0.1	7,000	1
Work coveralls	20.0	23.0	460	2
Charcoal masks	20.0	8.0	160	1
Gloves	100.0	0.8	76	1
Face mask	100.0	0.2	15	1
Safety footwear	20.0	16.0	320	1
Boots	20.0	8.0	160	1
Wheelbarrows	5.0	25.0	125	5
Excavators	5.0	4.0	20	1
Racks/Forks	5.0	2.0	10	1
Machetes	5.0	1.5	8	1
Branded 50Kg Bags	60,000.0.	0.3	16,200	1
Total			€115,122	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses
- other current expenses,
- purchase of raw materials.

Personnel expenses

At start-up, 26 people would be needed to run the operating company. Details of staff and staff costs are provided in the table below. The last column indicates the need for additional staff as compost production increases.

At the rate of growth of collectable quantities, staff would increase every 5 years at the following rate:

- 2 additional people are added to the team for sorting and receiving of waste,
- 4 additional people for collection,
- 1 guard,
- 1 commercial agent every 10 years or half of full time every 5 years, and
- 2 Drivers

Annual staff costs amount to €139,800 for the first year.

Headings	Salary/month	No. of persons	Salary Cost €/year	Additional staff: 5 years
Head of Unit	800	1	9,600	0
Receipt of waste /Sorting and stacking	500	9	54,000	2
Collectors /sorting aid	400	9	43,200	4
Guard/Production Support	300	3	10,800	1
Sales agents	500	1	6,000	0.5
Driver	450	3	16,200	2
Total		26	139,800	

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €35,000/year.

Headings	Annual expenditure in €
Electricity	8,000
Water	5,000
Telephone and Internet	1,000
Insurance and stamps	4,000
Maintenance of equipment and vehicles	6,000
Fuel	10,000
Purchase of personal protection equipment (PPE) and clothing	1,000
Total	35,000

Purchase of raw materials

Raw material is purchased locally. We assume a purchase cost of €15 per tonne, which would increase at the rate of inflation, see table below.

Year	2025	2030	2035	2040	2045
Cost of purchase of Raw Mat.	€507,900	€527,781	€783,487	€1,163,080	€1,726,583
Gross quantity in tonnes	33,860	31,869	42,849	57,612	77,463
Unit price €/tonne	15	17	18	20	22

C. REVENUE

The proceeds are from the sale of compost. Only 70% of the total amount of organic material is compostable, the remaining 30% is fine material that is removed after waste sifting.

- The final product is sold locally**

For our study's purposes, we assumed a sales price per tonne of compost of 30€/tonne, based on local consultations during the field phase.

- Evolution of product volumes**

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€711,060	€1,055,563	€1,566,974	€2,326,160	€3,453,165
Quantity produced in tonnes	23,702	31,869	42,849	57,612	77,463
Unit price €/tonne	30	33	37	40	45

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Appendix A – Contract FWC 300025407 - Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€711,060	€1,055,563	€1,566,974	€2,326,160	€3,453,165
Quantity produced in tonnes			- €	23,702	31,869	42,849	57,612	77,463
Unit price €/tonne	30		- €	30	33	37	40	45
Expenses								
Investments	m2	Unit price						
Unloading and sorting area	1,000	100	100,000	-	-	-	-	89,157
waste sorting storage area	600	150	90,000	-	-	-	-	80,241
Grinding area for green waste and/or nitrogenous matter	150	150	22,500	-	-	-	-	20,060
Composting platform	1,000	100	100,000	-	-	-	-	89,157
Compost Crushing and Sifting Area	150	150	22,500	-	-	-	-	20,060
Storage and bagging area	150	100	15,000	-	-	-	-	13,374
Office area, cloakroom and guard lodge	150	150	22,500	-	-	-	-	20,060
Equipment renewal	Quantity	Unit price	-					
Technical equipment	-	-	-					
desk with armchair	2	153	306	-	-	-	-	364
visitor chair	4	16	64	-	-	-	-	76
storage cabinet	1	230	230	-	-	-	-	137
computer	1	457	457	-	-	-	-	543
printer	1	380	380	-	-	-	-	452
video projector	1	457	457	-	-	-	-	543
Loaner motorcycle for connections	2	610	1,220	-	-	-	-	1,849
Tricycles	4	2,290	9,160	-	-	-	-	13,884
Dump lorry	1	22,900	22,900	-	-	-	-	13,611
Wheeled backhoe loader	1	22,900	22,900	-	-	-	-	13,611
Vegetable mills	1	1,530	1,530	-	-	-	-	909
Horn mills	1	1,530	1,530	-	-	-	-	909
Compost mills	1	1,530	1,530	-	-	-	-	909
Manual stand sieve 2cm mesh	2	152	304	-	-	-	-	181
Waste containers	3,000	5	15,000	-	-	-	20,592	- 22,289
660L trays	30	420	12,600	-	-	-	17,297	- 18,723
Waste bags	100,000	0	7,000	7,140	7,883	8,704	9,609	-
Work coveralls	20	23	460	-	518	-	631	-
Charcoal masks	20	8	160	163	180	199	220	-
Gloves	100	1	76	78	86	94	104	-
Face mask	100	0	15	15	17	19	21	-
Safety footwear	20	16	320	326	360	398	439	-
Boots	20	8	160	163	180	199	220	-
Wheelbarrows	5	25	125	-	-	-	-	-
Excavators	5	4	20	20	23	25	27	-
Racks/Forks	5	2	10	10	11	12	14	-
Machetes	5	2	8	8	8	9	10	-
Branded 50Kg Bags	60,000	0.27	16,200	16,524	18,244	20,143	22,239	-
Personnel expenses								
Headings	Salary Cost €/year	No. of persons	-					
Head of Unit	9,600	1	-	9,600	10,599	11,702	12,920	14,265
Receipt of waste /Sorting and stacking	6,000	9	-	54,000	72,869	95,082	121,128	151,567
Collectors /sorting aid	4,800	9	-	43,200	68,895	99,470	135,664	178,314
Guard/Production Support	3,600	3	-	10,800	15,899	21,942	29,071	37,446
Sales agents	6,000	1	-	6,000	9,937	14,628	20,188	26,747
driver	5,400	3	-	16,200	29,810	46,078	65,409	88,265
Current expenses	per year							
Electricity	8,000	1	-	8,000	8,833	9,752	10,767	11,888
Water	5,000	1	-	5,000	5,520	6,095	6,729	7,430
Telephone and Internet	1,000	1	-	1,000	1,104	1,219	1,346	1,486
Insurance and stamps	4,000	1	-	4,000	4,416	4,876	5,383	5,944
Vehicle and equipment maintenance	6,000	1	-	6,000	6,624	7,314	8,075	8,916
Fuel	10,000	1	-	10,000	11,041	12,190	13,459	14,859
Purchase of personal protection equipment (PPE) and clothing	1,000	1	-	1,000	1,104	1,219	1,346	1,486
Raw material	Purchase price							

Purchase of raw materials	15	-	-	-	682,897	918,189	1,234,551	1,659,915
Working capital	538,882	1	538,882	-				
Total expenses			1,026,503	199,248	957,059	1,279,557	1,737,460	1,818,892
Cash Flow			- €1,026,503	€511,812	€98,504	€287,417	€588,700	€1,634,273
IRR					21%			

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a compost recovery system would be profitable**. The internal rate of return - IRR - indicator of return on investment would be approximately 21% over a 20-year period of operation for a sales price of €30 per tonne of compost.

Sensitivity of findings

The table below presents the financial results' sensitivity to a change in finished product selling price. At this market price, the incentive to set up a private company would be more realistic.

The break-even point for the domestic waste recovery sector on Uvira is 23 €/tonne.

Selling price of finished product €/tonne	23	30	35	40
IRR	0%	21%	35%	49%

10 - COMPOST RECOVERY IN RUSIZI

a. REQUIRED INVESTMENTS AND EQUIPMENT - CAPEX

The table below presents the size of the infrastructure and units as well as the costs associated with each item. The lifetimes of each item enable calculating the investment renewal periods

The total investment amount is €665,500.

Infrastructures/units	Area (m²)	Unit price excl. VAT	Total cost excl. VAT €	Service life
Unloading and sorting area	1,500	100	150,000	50
waste sorting storage area	800	150	120,000	50
Grinding area for green waste and/or nitrogenous matter	200	150	30,000	50
Composting platform	3,000	100	300,000	50
Compost Crushing and Sifting Area	200	150	30,000	50
Storage and bagging area	200	100	20,000	50
Office area, cloakroom and guard lodge	100	150	15,000	50
Total			665,000	

For other equipment and technical equipment, the table below presents the details of the requirements as well as the associated costs. The total equipment costs are estimated at €120,962; All technical equipment and materials are renewed at the end of their service life.

Description	Quantity	Unit price excl. VAT	Total price excl. VAT €	Service life
Desk with Armchair	2.0	153.0	306	5
Visitor chair	4.0	16.0	64	5
Storage cabinet	1.0	230.0	230	10
Computer	1.0	457.0	457	5
Printer	1.0	380.0	380	5
Video projector	1.0	457.0	457	5
Loaner motorcycle for connections	6.0	610.0	3,660	7
Tricycles	4.0	2,290.0.	9,160	7
Dump lorry	1.0	22,900.0.	22,900	10
Wheeled backhoe loader	1.0	22,900.0.	22,900	10
Vegetable mills	1.0	1,530.0.	1,530	10
Horn mills	1.0	1,530.0.	1,530	10
Compost mills	1.0	1,530.0.	1,530	10
Manual stand sieve 2cm mesh	2.0	152.0	304	10
Waste containers	2,000.0.	5.0	10,000	4
660L trays	50.0	420.0	21,000	4
Waste bags	100,000.0.	0.1	7,000	1

Work coveralls	20.0	23.0	460	2
Charcoal masks	20.0	8.0	160	1
Gloves	100.0	0.8	76	1
Face mask	100.0	0.2	15	1
Safety footwear	20.0	16.0	320	1
Boots	20.0	8.0	160	1
Wheelbarrows	5.0	25.0	125	5
Excavators	5.0	4.0	20	1
Racks/Forks	5.0	2.0	10	1
Machetes	5.0	1.5	8	1
Branded 50Kg Bags	60,000.0.	0.3	16,200	1
Total			120,962	

b. OPERATING EXPENSES - OPEX

Operating expenses consist of:

- personnel expenses,
- other current expenses,
- purchase of raw materials.

Personnel expenses

At start-up, 27 people would be needed to run the operating company. Details of staff and staff costs are provided in the table below. The last column indicates the need for additional staff as compost production increases.

With the growth rate of collectable quantities, we have associated the increase of staff every 5 years:

- 2 additional people are added to the team for sorting and receiving of waste,
- 4 additional people for collection,
- 1 guard,
- 1 commercial agent every 10 years or half of full time every 5 years, and
- 2 Drivers

Annual staff costs amount to €145,200 for the first year.

Headings	Salary/month	No. of persons	Salary Cost €/year	Additional staff: 5 years
Head of Unit	800	1	9,600	0
Receipt of waste /Sorting and stacking	500	8	48,000	2
Collectors /sorting aid	400	8	38,400	4
Guard/Production Support	300	3	10,800	1
Sales agents	500	1	6,000	0.5
Driver	450	6	32,400	2
Total		27	145,200	

Other current expenditure

The other operating charges correspond to those indicated in the table below. They amount to €28,700/year.

Headings	Annual expenditure in €
Electricity	6,000
Water	4,000
Telephone and Internet	500
Insurance and stamps	3,000
Maintenance of equipment and vehicles	6,200
Fuel	8,000
Purchase of personal protection equipment (PPE) and clothing	1,000
Total	28,700

Purchase of raw materials

Raw material is purchased locally. We assume a purchase cost of €15 per tonne, which increases at the rate of inflation; see table below.

Year	2025	2030	2035	2040	2045
Cost of purchase of Raw Mat.	€802,815	€764,735	€1,040,660	€1,416,142	€1,927,101
Gross quantity in tonnes	53,521	46,176	56,914	70,148	86,459
Unit price €/tonne	15	17	18	20	22

C. REVENUE

The proceeds are from the sale of compost. Only 70% of the total amount of organic material is compostable, the remaining 30% is fine material that is removed after waste sifting.

The final product is sold locally.

For our study's purposes, we assumed a sales price per tonne of compost of 30€/tonne, based on local consultations during the field phase.

Evolution of product volumes

The volumes, and therefore the first revenues, produced in the first year, are expected for 2025, the time of provision of administrative buildings, equipment purchase and the recruitment and training of all staff.

The table below presents the projected revenues over the study period from 2024 to 2045.

Year	2025	2030	2035	2040	2045
Total revenue	€1,123,941	€1,529,471	€2,081,321	€2,832,283	€3,854,202
Quantity produced in tonnes	37,465	46,176	56,914	70,148	86,459
Unit price €/tonne	30	33	37	40	45

d. FINANCIAL PROFITABILITY

The financial profitability

The table below presents the financial profitability results of the operator in charge of the investment and operation.

Appendix A – Contract FWC 300025407 - Study on management of waste in the main cities of the Lake Tanganyika basin and liquid sanitation in Bujumbura

Year			2024	2025	2030	2035	2040	2045
Total revenue			- €	€1,123,941	€1,529,471	€2,081,321	€2,832,283	€3,854,202
Quantity produced in tonnes			- €	37,465	46,176	56,914	70,148	86,459
Unit price €/tonne	30		- €	30	33	37	40	45
Expenses								
Investments	m2	Unit price						
Unloading and sorting area	1,500	100	150,000	-	-	-	-	-
waste sorting storage area	800	150	120,000	-	-	-	-	133,735
Grinding area for green waste and/or nitrogenous matter	200	150	30,000	-	-	-	-	106,988
Composting platform	3,000	100	300,000	-	-	-	-	-
Compost Crushing and Sifting Area	200	150	30,000	-	-	-	-	267,471
Storage and bagging area	200	100	20,000	-	-	-	-	26,747
Office area, cloakroom and guard lodge	100	150	15,000	-	-	-	-	17,831
Office area, cloakroom and guard lodge	100	150	15,000	-	-	-	-	13,374
Equipment renewal	Quantity	Unit price	-					
Technical equipment	-	-	-					
desk with armchair	2	153	306	-	-	-	-	364
visitor chair	4	16	64	-	-	-	-	76
storage cabinet	1	230	230	-	-	-	-	137
computer	1	457	457	-	-	-	-	543
printer	1	380	380	-	-	-	-	452
video projector	1	457	457	-	-	-	-	543
Loaner motorcycle for connections	6	610	3,660	-	-	-	-	5,547
Tricycles	4	2,290	9,160	-	-	-	-	13,884
Dump lorry	1	22,900	22,900	-	-	-	-	13,611
Wheeled backhoe loader	1	22,900	22,900	-	-	-	-	13,611
Vegetable mills	1	1,530	1,530	-	-	-	-	909
Horn mills	1	1,530	1,530	-	-	-	-	909
Compost mills	1	1,530	1,530	-	-	-	-	909
Manual stand sieve 2 cm mesh	2	152	304	-	-	-	-	181
Waste containers	2,000	5	10,000	-	-	-	13,728	14,859
660L trays	50	420	21,000	-	-	-	28,828	31,205
Waste bags	100,000	0	7,000	7,140	7,883	8,704	9,609	-
Work coveralls	20	23	460	-	518	-	631	-
Charcoal masks	20	8	160	163	180	199	220	-
Gloves	100	1	76	78	86	94	104	-
Face mask	100	0	15	15	17	19	21	-
Safety footwear	20	16	320	326	360	398	439	-
Boots	20	8	160	163	180	199	220	-
Wheelbarrows	5	25	125	-	-	-	-	-
Excavators	5	4	20	20	23	25	27	-
Racks/Forks	5	2	10	10	11	12	14	-
Machetes	5	2	8	8	8	9	10	-
Branded 50Kg Bags	60,000	0.27	16,200	16,524	18,244	20,143	22,239	-
Personnel expenses								
Headings	Salary Cost €/year	No. of persons	-					
Head of Unit	9,600	1	-	9,600	10,599	11,702	12,920	14,265
Receipt of waste /Sorting and stacking	6,000	8	-	48,000	66,245	87,768	113,053	142,651
Collectors /sorting aid	4,800	8	-	38,400	63,595	93,619	129,203	171,181
Guard/Production Support	3,600	3	-	10,800	15,899	21,942	29,071	37,446
Sales agents	6,000	1	-	6,000	9,937	14,628	20,188	26,747
driver	5,400	6	-	32,400	47,696	65,826	87,212	112,338
Current expenses	per year							
Electricity	6,000	1	-	6,000	6,624	7,314	8,075	8,916
Water	4,000	1	-	4,000	4,416	4,876	5,383	5,944
Telephone and Internet	500	1	-	500	552	609	673	743
Insurance and stamps	3,000	1	-	3,000	3,312	3,657	4,038	4,458
Vehicle and equipment maintenance	6,200	1	-	6,200	6,845	7,558	8,344	9,213
Fuel	8,000	1	-	8,000	8,833	9,752	10,767	11,888
Purchase of personal protection equipment (PPE) and clothing	1,000	1	-	1,000	1,104	1,219	1,346	1,486
Raw material	Purchase price							
Purchase of raw materials	15	-	-	-	989,492	1,219,577	1,503,163	1,852,691
Working capital	837,095	1	837,095	-				
Total expenses			1,623,057	198,348	1,262,661	1,579,848	2,009,529	1,748,192
Cash Flow			- €1,623,057	€925,593	€266,810	€501,472	€822,755	€2,106,009
IRR			26%					

Note: the negative values of the equipment renewal that appeared in the table in 2045 correspond to the equipment's residual values in the last year of evaluation.

Given the assumptions about selling prices, **a compost recovery system would be profitable**. The internal rate of return - IRR - indicator of return on investment would be approximately 26% over a 20-year period of operation for a sales price of €30 per tonne of compost.

Sensitivity of findings

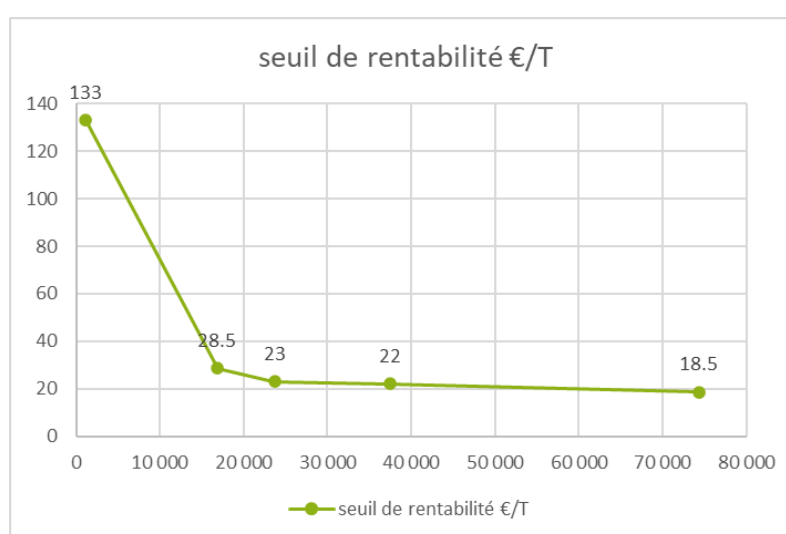
The break-even point for the domestic waste recovery sector on Rusizi would be 22 €/tonne.

Selling price of finished product €/tonne	22	30	35	40
IRR	0%	26%	41%	55%

11 - CONCLUSION AND WARNING

Like the plastic waste recovery sector, for the compost recovery sector to be financially profitable, it would require scaling it to a production volume above a certain threshold.

The table and figure below illustrate this relationship between the product quantity and break-even point. The unit cost of compost production decreases with the quantities produced, thereby lowering the break-even point.



Compost	quantité produite en 2025 T/an	seuil de rentabilité €/T
Bujumbura	74 394	18.5
Risizi	37 465	22
Uvira	23 702	23
Kigoma	16 861	28.5
Mpulungu	1133	133

The examples presented above show that for the 4 cities of Bujumbura, Kigoma, Rusizi and Uvira, the compost quantities that can be produced are large enough to allow the emergence of a sustainable compost market.