GENDER TECHNICAL ASSESSMENT OF OPPORTUNITIES TO IMPROVE IMPLEMENTATION OF PLASTICS AND WASTE MANAGEMENT IN A UGANDAN MUNICIPALITY

CIF CLIMATE INVESTMENT FUNDS

AFRICAN DEVELOPMENT BANK GROUP

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THE REPUBLIC OF UGANDA

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EXECUTIVE SUMMARY

The gender gap in Kampala in the Waste Management and Plastics Recycling sectors represents a major issue to be resolved if the country is to achieve and improve the efficiency of the Strategic Program for Climate Resilience (SPCR)[1] projects and therefore enhance the achievement of Uganda´s Sustainable Development Goals. This analysis found that the most important drivers of Waste Management (WM) and Plastics Recycling (PR) sectors´ problems in Kampala are exacerbated by gender inequalities. Likewise, employment and education figures underline gender disparities between women and men and the same inequality can be observed in the realms of property and in political representation.

In the area of waste management and plastics recycling, gender issues manifest themselves most tellingly in Kampala, and have a particular impact on from lower socioeconomic tiers. Consequently, there is an urgent need for stakeholders to collaboratively identify and address the institutional, economic, socio-cultural and political determinants of women's higher vulnerability in WM and PR sectors. Uganda faces a particular significant increase in volumes of garbage generated. Solid waste collection is currently one of the most critical services in the city and is underfinanced, with poor quality and coverage causing serious public outcry in Kampala. Existing gender dynamics not only determine men and women's ability to interact with waste and recycling products but also underlines structural inequalities were issues have a disproportionate negative impact on women in Kampala.

This study allows a better understand of the gender issues within the WM and PR sectors, and ease improved project integration of gender activities in future, with the objective of account for gender differences in women's and men's specific roles, incentives and constraints within WM activities and processes, get a deeper understanding of the gender stakeholder mapping of WM in Kampala, identify potential stakeholders' team to work toward gender aware projects, identify and document community challenges and opportunities from local and design recommendations for improving gender equality within WM and PR sector, including to provide strong technical opportunities for the most vulnerable women.

An assessment of the gender and technical baseline has been performed to determine the current situation in Kampala and provide findings and recommendations in the form of technical proposals in waste management and plastic recycling that can be implemented and developed from a gender perspective in Kampala and even be scaled more globally in Uganda. The proposed Integrated Solid Waste Management (ISWM) activities assessed in this report are waste source reduction, waste separation, recycling (plastic recycling and organic fraction composting), energy from waste biological conversion and landfill gas capture and energy generation. Due the current practice, technological requirements, financial, social and gender assessment performed in this report, between the different

[1] Prepared under the Pilot Program for Climate Resilience (PPCR). The PPCR was the first program developed and operational under the Strategic Climate Fund (SCF), which is one of two funds within the design of the Climate Investment Funds (CIF)

waste management measures previously commented, waste separation and plastic recycling (including plastic bricks manufacturing for houses) is highly recommended, locally in Kampala and at national level in Uganda as well, accompanied by organic fraction composting.

These waste management options are simple processes with a high potential to be implemented with success in Kampala and waste collection and separation required in the first stage to proceed with the plastic recycling can be used to obtain an organic fraction, free of inert waste like plastic or metals. Furthermore, 80% of the waste pickers in Kampala are women and would be benefited by best work conditions, training and free time due to a better infrastructure and organization, further professionalizing the activity they are already carrying out. In a second stage, we recommend to implement landfill gas capture and energy generation projects in the landfills where this activity is technical and economically feasible due to the electricity production and the reduction of risk of explosions, odors, vectors and other health risks associated with the landfills or dump sites where the landfill gas is not controlled.

Additionally, the production of plastic bricks for houses manufacturing helps to provide access to a house for the population with less means and enables to mitigate the high increase in population that Uganda is experiencing, increasing the level of adaptation and resilience against the effects of the climate change.

01

INTRODUCTION AND STUDY CONTEXT

Uganda faces a particular significant increase in volumes of garbage generated. Specifically, according to the World Bank report published in 2012, the waste generation rate in Uganda is estimated at the range of 0.4 - 0.6 kg/person/day. About 28,000 tons of municipal waste from Kampala was disposed of in the landfill every month. This waste consisted on average (by weight) of 92.1% organic material, 1.8% hard plastic, 0.1% metals, 1.3% papers, 3.0% soft plastic, 0.6% glass, 0.5% textile and leather, and 0.6% others

The rate of waste generation in Kampala increased from 0.26 to 0.47 kg/capita/day over the seven years of the World Bank study, with an average annual increase of 0.03 kg/capita/day. Consequently, the total annual waste volumes generated in the city also increased significantly from 407,890 to 785,214 tons in seven years representing a 48% increase. This increase in the waste quantities corresponded to a 53.5% population increase within the same period. Solid waste collection is currently one of the most critical services in the capital city with poor quality and coverage causing serious public outcry in Kampala. The legal entity responsible for the Waste Management (WM) operations of the capital city of Kampala in Uganda: The Kampala Capital City Authority (KCCA) acknowledges that the amount of solid waste generated overwhelms the capacity of the Authority to collect and dispose it, under its current public budgetary capacity. The Government of Uganda recognizes the drivers and impacts of climate change and the need to address them within the national and international strategic frameworks.

Pilot Program for Climate Resilience (PPCR) Strategic Program for Climate Resilience (SPCR)

The SPCR is designed to demonstrate ways that developing countries can make climate risk and resilience part of their core development planning. It helps countries build on their National Adaptation Programs of Action and helps fund public and private sector investments identified in climate resilient development plans.

The SPCR is a framework for addressing the challenges of climate change that impact on the national economy including development of resilience by vulnerable communities, where it is necessary to pay special attention to women as agents of change.

The SPCR will build on and catalyzes existing efforts in climate resilience-building Programs in Uganda, and will address key identified barriers and constraints, in order to accelerate the transformative change, and garnering of benefits of climate resilience and sustainable socio-economic development in the targeted sectors and areas.

The strategy presents strong "business cases" for individual investment projects and is intended to be leveraged to attract significant financial resources from the Green Climate Fund (GCF), national resources, as well as other financing avenues. The SPCR has been elaborated under the guidance of the Ministry of Finance, Planning and Economic Development, via an extensive participatory process following Climate Investment Funds (CIF) requirements.

Gender rationale

The Intergovernmental Panel on Climate Change has highlighted the differences in vulnerability and exposure that stem from non-climatic factors and multidimensional inequalities such as discrimination on the basis of gender.

Gender is the collective social differences between males and females, as determined by culture. It is one of many components of vulnerability to climatic change. Fluctuations in the climate affect genders differently, magnifying existing gender inequality. Both women and men are affected by and vulnerable to climate change and global warming, but women often bear more of the burden. This higher vulnerability is mostly not due to biological or physical differences, but is formed by the social, institutional and legal context. Subsequently, vulnerability is less an intrinsic feature of women and girls but rather a product of their marginalization.

In the context of adaptation, gender is perceived by how the socio-political relations between men and women affect the planning and implementation of adaptation actions, access to resources (including material resources and capacity-building), the ways in which climate change impacts and adaptation measures differentially affect men and women, and the ways in which men and women contribute differently to adaptation actions. Of particular significance in this regard are the differences that exist between the access, control and opportunities of men and women on issues such as land, resources, work opportunities and wages, time spent in both productive and household roles, and leadership and participation in decision-making processes.

Women can be important agents of change. The unique adaptation-relevant knowledge women hold is crucial to ensuring that adaptation responses to climate change impacts are effective and sustainable; therefore, the full and effective participation and contributions of women are essential to any climate change adaptation plan.

According to the Gender and Environment Resource Center, governments around the world have committed to action on climate change—and they have committed to advancing gender equality and realizing women's and men's equal human rights as well. Climate Change Gender Action Plans (ccGAPs) help governments and stakeholders unite these goals, turning commitments to action.

Climate Change Gender Action Plans (ccGAPs) build on a country's national climate change policy, plan or strategy, delving into gender-specific issues by prioritizing sectors and creating innovative action plans to enhance mitigation, adaptation and resilience-building efforts for women and men in every community. A unique participatory, multi-stakeholder and cross-sectoral methodology builds the capacities of individual women and women's organizations together with government representatives and other key stakeholders—championing the value of gender equality and women's innovative activities and solutions.

As example in Africa, in Mozambique, the ccGAP was the catalyst for the inclusion of gender equality measures in the development of the country's Strategic Program for Climate Resilience under the Climate Investment Funds. In Jordan, the ccGAP inspired the government to declare gender equality as a national priority in the country's response to climate change and pledged to make gender a primary consideration in the country's third National Communication to the Intergovernmental Panel on Climate Change (UNFCCC), as well as created a permanent seat for women groups at the national climate change decision body; at the regional level, the League of Arab States and the Central America Integration System (SICA) have incorporated a gender approach in their climate change planning for the first time.

Existing gender dynamics not only determine men and women's ability to interact with waste and recycling products but also underlines structural inequalities were issues have a disproportionate negative impact on women. This is particularly the case in the topic areas of waste management sorting and recycling in Kampala which remain pressing challenges. Indeed, waste management and plastics recycling activities are undertaken by the most vulnerable population groups, with an estimative percentage of 80% of these workers being women in the Ugandan context (KCCA interview), compared to an average participation rate already disproportionate of 70% globally by women in this sector. Women are thus at the forefront of the challenges resulting from waste management and plastics recycling in Uganda. This work is largely undertaken in the unorganized, informal sector, with few labor protections.

However, while women are the majority of informal waste pickers and scavengers in both legal and illegal dumpsites in Kampala, women face several factors that hamper improving their socioeconomic status. These are largely gender constraints related to gendered roles and responsibilities, norms and customs such as "insecure land and tenure rights, obstructed access to natural resource assets, limited participation in decision making, limited access to basic education, and lack of access to markets, capital, training and technologies" (UNEP, 2015).

Such constraints hamper women's full potential to become agents of change, and to participate in policy and decision making for more effective action on environmental challenges by both women and men.

Study Approach

To better understand gender issues within the WM and PR sectors, and ease improved project integration of gender activities in future, the study aimed to:

- Account for gender differences in women's and men's specific roles, incentives and constraints within WM activities and processes.
- Get a deeper understanding of the gender stakeholder mapping of WM in Kampala.
- Identify potential stakeholders' interest to work toward gender aware projects providing opportunities to the most vulnerable women in the field.
- Identify and document community challenges and opportunities from local female leaders' point of view and general understanding of life in the settlement.
- Design recommendations for improving gender equality within WM in projects, including to provide technical opportunities for the most vulnerable women.

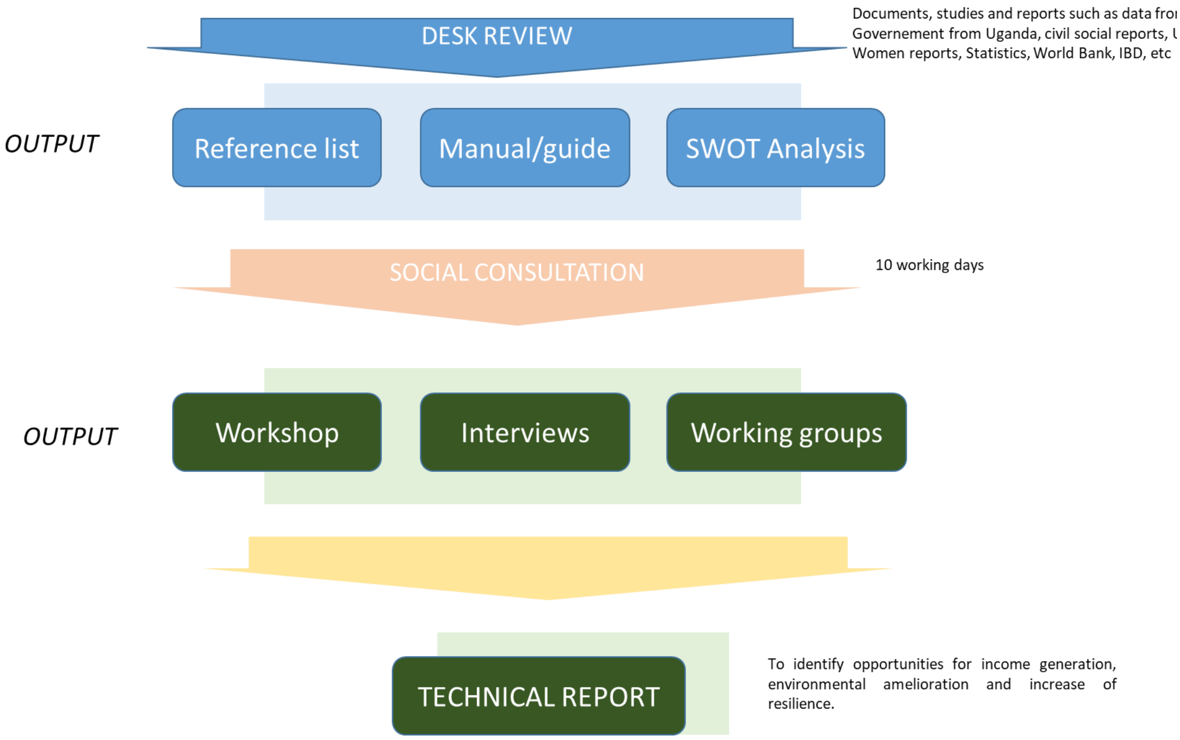
To design and integrate gender equality strategy and activities under the Strategic Program for Climate Resilience (SPCR) for Uganda, the ALLCOT[2] team developed a conceptual framework centered around desk review, social consultation and technical report activities and deliverables (See Figure 1).

[2] ALLCOT is a project developer offering knowledge, expertise and management to initiatives that reduce greenhouse gas (GHG) emissions to actively combat the climate crisis under Article 6 of the Paris Agreement being aligned with the 2030 Agenda and its 17 Sustainable Development Goals (SDGs).

ALLCOT works very actively in the waste management sector, developing emission mitigation projects in all phases of waste management. Currently, ALLCOT is developing about 20 projects in sector around the world, focused in sustainable waste management in landfill sites through biogas recovery and use for energy generation under the most important Greenhouse Gasses (GHG) mitigation standards as the Clean Development Mechanism under the United Nations Framework Convention on Climate Change (UNFCCC CDM) or Gold Standard for the Global Goals and new methodologies and technologies in plastic recovery and recycling.

One important example of ALLCOT work in the waste management sector in Africa is the development of the Sustainable Waste Management Programme in Senegal trough a Mitigation Activity for the generation of ITMOs (International Transfer Mitigation Units to meet the commitments contained in their NDCs or Nationally Determined Contributions), through the financing of KLIK (Foundation for Climate Protection and Carbon Offset KliK, Switzerland). The objective of the Mitigation Activity is to reduce greenhouse gases emissions generated by the Waste Sector in Senegal through the capacity building and technology transference.

Figure 1: *Conceptual framework for the technical assessment.*



Source: Authors.

Qualitative methodology

Under an overall qualitative study design, ALLCOT conducted in the first phase (from November 2019 to January 2020), a desk research review of existing data sources that included:

- Existing reports from Kampala Capital City Authority (KCCA) and research institutes working in the field of waste management and gender.
- Collection of raw data from public utilities including Uganda Bureau of Statistics (UBOS), Uganda National House Survey (UNHS), United Nations (UN), World Bank (WB), African Development Bank, among others.
- On-going PhD and MSc. research through review of students' publications.

In the second phase (from 9th to 16th February 2020), the team designed and implemented a social visit in site to Kampala where they organized:

- Key Informant Interviews (KIIs) with female CBO leaders, female and male informal waste pickers in Kampala as well as registered waste pickers at Kiteezi landfill.
- Informal meetings and discussions with technical officers from both public and private entities at local and national levels, working in WM and PR sectors.
- A Gender and WM one-day Workshop "Gender and Waste Management: rethinking the social and technical system" delivered during 13th February 2020 to public and private WM and PR stakeholders in order to presenting and illustrating the

relationship of gender and waste management sector as well as present technical tools to Kampala specialties.

During the social consultation visit in Uganda, ALLCOT team members organized meetings, interviews and a workshop with different stakeholders' groups and institutions mapped in the desk review.

Members of ALLCOT technical team and recyclers

Participants attending the workshop

ALLCOT team during social consultation process in Kiteezi landfill.

Public entities such as the Ministry of Water and Environment, the National Environmental Management Authority (NEMA) and the Kampala Capital City Authority (KCCA), as well as private organizations such as the waste collection concessionaires of the capital city: e.g., Nabugabo Updeal Joint Venture and Homeklin (U) Limited, took part in the social consultative phase.

Additionally, site visits to plastics recycling plants were undertaken in Mukono area and a full day visit to Kiteezi landfill was organized. Meetings with the landfill authorities, as well as with waste Pickers Community Based Organizations (CBO) leaders and ALLCOT were also arranged. Individual interviews were also arranged with aleatory waste pickers (men 20% and women 80%) who were sorting plastics and other materials in different legal and illegal landfills in Kampala city.

02

GENDER BASELINE ASSESSMENT

This second section reports on findings of the Baseline Assessment conducted from both a sector and gender perspective, on the Waste Management (WM) and Plastics Recycling (PR) sectors in Uganda.

The gender gap in Kampala in the Waste Management and Plastics Recycling sectors represents a major issue to be resolved if the country is to achieve and improve the efficiency of SPCR projects and therefore enhance the achievement of Uganda´s Sustainable Development Goals.

This analysis found that the most important drivers of Waste Management (WM) and Plastics Recycling (PR) sectors´ problems in Uganda are exacerbated by gender inequalities. Therefore, conceptualizing, measuring, understanding, and counterbalancing the roots of gender gaps is essential to transform them into economic opportunities for women. This will help the overall management of the sector, and positively impact quality of life for the most vulnerable while improving the urban environment.

As United Nation Environment Program (UNEP) stated that “[W]aste sector reforms will only be effective and sustainable if they adopt a gender perspective and are committed to ensuring gender equality” (UNEP, 2019). Implementing policies to bring about such gender reforms within the waste sector will not only aid achievement of Sustainable Development Goal (SDG) 5 on “Gender Equality” and SDG 12 on “Sustainable Consumption and Production”, but will additionally improve Uganda´s situation towards all SDGs.

In this regard, it is essential to frame the context and multidimensional nature of gender issues in the country.

Gender framework and variables in the Uganda context

During the last few decades, the Government of Uganda has enacted different international commitments and policies aimed at promoting gender equality at the national level. These include commitments to gender equality in the 1995 Constitution, Vision 2040, the National Development Plan, the Equal Opportunities Commission Act (2007) and the National Youth Policy, to name but a few. Uganda has also ratified international instruments such as the Convention on the Elimination of all forms of Discrimination against Women (CEDAW), the Maputo Declaration on Gender Mainstreaming (2003), the African Youth Charter (2006), and the aforementioned Sustainable Development Goals, among others.

These commitments are perceived nationally and internationally as progress in women's rights and representation in decision-making positions. However, the benefits of these policies have not yet been fully realized on the ground.

Education statistics from the 2016/2017 Uganda National Household Survey (UNHS) illustrate women educational attainment is still lower than that of their male counterparts, with gaps increasing at higher education levels.

Likewise, employment figures underline gender disparities between women and men. Statistics show the population aged from 14 to 64 years had an overall Unemployment Rate (UR) of 9.4% with women experiencing higher unemployment rate (11%) than males (8%). Only 22.4 % of women have opportunities in modern wage employment compared to 36.6% of men. Women spend more than twice (30 hours a week) the amount of time spent by men (12 hours a week) on unpaid domestic and are work. Additionally, women average median monthly wage is UGX[3] 110.000, half that of men´s median monthly wage at UGX 220.000 (UBOS, 2017).

Finally, according to the Uganda National Household Survey (2013), there were more women engaged in self-employment activities (48%) compared to men (38%) and men tend to engage more in paid employment (51%) compared to women (35%) (UNHS, 2016/17).

In relation to women's ownership of assets, it was found that in all relevant ownership typologies women were in a lower asset holding position than their male counterparts. Men are own houses (38%) and land (33%) in their own names, compared to women, whose ownership of both houses as well as land stands at 8% each (UBOS, 2018). Additionally, women's control over earnings is still low, with men having more influence and decision making over women's assets. A qualitative review found that women interviewed confirmed the persistent difficulties in obtaining ownership rights and their use. This suggest more support is needed by government and public entities to strengthen the implementation of gender related laws, policies, projects and programs to effectively reach the most vulnerable women, particularly in the area of asset holdings.

With regard to leadership, the number of women has increased in Parliament in Uganda since year 2006 from 23.9% in 2005 to 34.8% in 2019 (IPU, 2019). The rise in the number of women at the parliamentary level can be attributed in large part to constitutional provisions and the 2006 Electoral

[3] Ugandan shilling

Law establishing quotas for women at the national level (OECD, 2014). However, few women are appointed to the highest positions in the districts: only 11 chief administrative officers out of the 112 are women, and only 2 chairpersons out of the 112 districts are women (OECD, 2015). At both national and subnational levels, women's formal participation remains less than that of men's.

The above gender gaps in human development outcomes, employment and labor, asset development, and governance reveal that gender inequalities are not unique to one sector nor exclusive to a specific region but are fully interrelated, geographically widespread and sector generalized across the country.

The importance of gender equality approach in WM and PR sectors in Kampala

In the area of waste management and plastics recycling, gender issues manifest themselves most tellingly and have a particular impact from lower socioeconomic tiers. Consequently, there is an urgent need for stakeholders to collaboratively identify and address the economic and sociocultural determinants of women's higher vulnerability in WM an PR sectors.

Indeed, stakeholders must understand the drivers of women vulnerabilities and develop specific interventions that effectively address gender gaps and identify appropriate pathways for implementation of these solutions. With rapid population expansion and constant economic development in Uganda, waste generation both in residential as well as commercial/industrial areas continues to grow rapidly, putting pressure on society's ability to process and dispose of this material posing a significant risk to health and environmental concerns. Improper waste handling in conjunction with uncontrolled waste dumping can cause a broad range of problems, including polluting water, attracting rodents and insects, as well as increasing floods due to blockage in drains. It could also bring about safety hazards from explosions and fires. Improper solid waste management can also increase greenhouse gas (GHG) emissions, thus contributing to climate change.

Having a comprehensive waste management system for efficient waste collection, transportation, and systematic waste disposal that takes into account women current position and barriers, together with activities to reduce: waste generation and increase waste recycling while counterbalancing gender gaps through positive discrimination actions such as creating specific projects run by women social associations of the sector, will significantly have better impact in reducing sector structural problems and also providing women with tools to overcome socioeconomic disparities that are at the base of overall poverty in the society as well as the feminization of the poverty. A gender-mainstreamed approach provides the opportunity to create a suitable combination of existing waste management practices to manage waste most efficiently while also taking into account women barriers and opportunities to be built.

According Kareem Buyana (Urban Action Lab of Makerere University Uganda, 2015), gender relations differentiate the ways in which women as compared to men manage urban waste, and urban waste management impacts the underlying inequalities and relations between women and men. By adopting a gender perspective, it is possible to set a starting point for understanding how neighborhood-level innovation around the re-use and recycling of wastes can be re-framed to promote equal participation in sustainable urban resource management and contribute to gender inclusive socio-economic transformation in cities of Africa, like Kampala.

Also, the empirical observations performed by Kareem Buyana in 2015, explain how home to home vendors were usually male youth (aged between 18-30 years) and boys (aged between 10-16 years); they were frequently associated with illegal waste dumping. These vendors walk long distances between the upland and low-lying areas of Kampala city in search for the desired volumes of waste materials and they have no designated distribution points like wholesale dealers and regular waste vendors do. Gender relations as an urban phenomenon that socially defines individual roles, needs, and expectations within a network of human interactions shape socio-economic routines in the urban waste economy from a number of fronts.

First, waste is a heterogeneous material and difficult to describe or classify. This is because the definition of waste can be very subjective: what represents waste to one person may represent a valuable resource to another. For example, oily milk packages may be used as fuel; leftover food may be fed to pigs and goats; discarded cardboard may serve as walls and roofs of houses. The classification of discarded materials may be influenced by the gender of the person making the judgment. What looks like 'scrap' to women may be motorcycle parts to men; what looks like 'dirt' to men may be compost or fertilizer to women; there are myriad examples of different sexes "seeing" things differently (Buyana, K. 2015). This means that waste needs to have a strict gender sensitive legal definition to comply with the law; such strict definitions have financial and legal implications for private businesses, local authorities, communities, and central governments.

Second, experiences from the local Kampala communities have shown that as men and women participate (or not) in managing waste within the household, their relationship to discarded materials may depend on who they are, as much or more than on what they do. In particular, the frequently subordinate status of women may affect their general access to and control of resources, so that the "waste" materials or waste related activities may be the only ones which are available to them. This implies that new schemes for managing waste materials, which are blind to women compared to men's activities, may destroy fragile livelihoods.

Third, the household/social arrangement surrounding the use of waste reduction/recycling technologies must be innovated for proper waste management options. Reduction involves good practice, input material changes, and technological changes for environmental cost savings arising from producing less waste, which include savings in energy costs, waste storage space, transport costs, and lower emissions into the air, the water, and on land (Buyana, K. 2015).

Technology for sanitation in public places—that is, waste collection and recycling machinery—has gender related questions that are critical for success in the targeted communities. For example, can women-owned enterprises as well as men-owned enterprises afford the investment? Are women-owned enterprises able to generate a higher work volume to pay for such investments, to the same extent as men-owned or mixed enterprises? Do women as well as men have equal access to the necessary training? Can women as well as men continue with related income earning activities, such as sorting the waste? How does new technology affect the health of women compared to men? Does it create equal risks or offer equal protection against health risks? Leaving such issues to the existing forces of competition and inequality in society may reinforce, or even increase, women's social-economic disadvantage.

This gendered understanding of the urban waste economy is advantageous to interventions that seek to achieve a balance between urban economic development, long-term ecological sustainability and social justice through the following ways (Buyana, K. 2015):

- **Studies** – disaggregating waste management modes and preferences by sex, and undertaking environmental health impact assessments by comparing vulnerability using gender-based variables such as what roles women play compared to men in collecting, sorting, disposing, storing, reuse and recycling of waste at multiple scales (household to community to city levels).

- **Capacity development** – training opportunities on sustainable urban waste management are offered to an equal number of female and male change agents/ambassadors to promote practices that not only safeguard communities against waste-related hazards but also offer economic opportunities through re-use and recycling. This can be vital to the empowerment of communities, especially when participants acknowledge and acquire the ability to transform the household/neighborhood waste activities into credible and environmentally sound businesses, and are capable of negotiating for enabling standards, regulations, and partnerships with formal institutions, mainly the private sector and local government authorities.

- **Incubation centers for cleaner technologies** – gendered innovations as the process of integrating gender analysis around women's and men's roles, and research into technology development for commercial and non-commercial management of urban waste, can enhance the quality of outcomes. This research can be completed through interdisciplinary collaborations between gender experts, natural scientists, urban economists, and engineers working together to reform research agendas and institutions.

Gender specific findings in the WM and PR sectors

During the desk review and the social consultation process, the ALLCOT consulting team focused on understanding sociocultural, institutional and environmental experiences, dynamics and ideas surrounding waste management, plastics recycling, and gender equality in WM and PR in Kampala, with a specific focus on adding voices and perspectives of women in the field.

The ALLCOT team focused in identifying similar projects in neighboring countries, in order to compare and analyze the success factors and the gender specific lessons learnt.

Specifically, four gender WM and PR mainstreamed projects based in South Africa ("All Women Recycling"), Kenya ("Ecopost"), Ivory Coast ("Conceptos Plásticos") and Gambia ("Gambian Community Project") were selected for comparative study due to the similarities with socioeconomic challenges found in Uganda.

The desk review comparative analysis identified four key gender project insights:

(1) Teaching, training and mentorship

In all projects, mentorship and training process were found to aid successful gender outcomes. For example, the Gambian Community Project was created in 2015 as the first recycling training center to teach women to use rubbish as a means of economic empowerment by creating a recycling training center in order to teach women to use rubbish as a means of economic empowerment. Through this project, women learn about waste reprocessing techniques at the Recycling Innovation Centre and are also trained in income-generating, leadership and decision-making skills.

This case highlights the importance of gender variable analysis in affirmative actions that goes beyond gender parity and equal opportunity in order to specifically encourage and support women's formal employment participation in the sector in the form of capacity building tools. This is in contrast to the educational barriers that typically hinder women in Africa from reaching such remunerative and safe employment.

(2) Women specific employment offers

The second success factor found among the comparative cases was the approach of directing employment offers specifically to women and female youth. This second success factor also correlates with the first one and has a positive multiplier effect on women formal participation's in the sector with higher quality jobs. Indeed, most private and public sector employers' interviewed stated while describing jobs to which they steer women, that they direct women to jobs related to 'care and sensitive duties' such as sorting and washing, while 'technical and hard work such as freight, stock, and material movers, as well as trucks drivers is steered towards men. Consequently, the opening of specifically directed jobs for recruitment of female workers in "technical and hard work" was found to be a success factor to increase women's participation in the legal labor force of the projects and helps to empower women and change social norms regarding participation in previously male-typed positions.

(3) Work formalization

The third employment success factor found was the importance given to the objective of bringing women work from informal to formalized recycling markets. In fact, these projects set academic incentives to mobilize women to move up in the organization by actively working in the leverage of their skill sets as well as making more flexible work hours by acknowledging and meeting women's gendered care and household responsibilities in relation to child and elder care.

(4) Female head of household involvement

The fourth variable found was the direct involvement of the community and specifically women heads of household from both urban and rural areas. For instance, these gender-mainstreamed projects organized teaching sessions and workshops to explain to women about how to separate garbage in their homes, how to recognize which plastics can be recycled and how to manage money effectively. This strategy added another actor to the project by involving the overall community through women household heads who are in sociocultural terms the main players in waste management household decisions due to gendered status of women as head of household chores.

The main conclusions from this comparative study were the need to actively consider women's gendered needs and interests in relation to employment, training, and job flexibility. The cases showed the importance of ensuring that teams diagnose, formulate, implement and evaluate women's specific situation in each stage of the project process and actively work on creating affirmative actions for their participation and involvement in order to create a successful gender mainstreamed project in the WM and PR sectors.

In addition, during the social consultation process in Kampala, the ALLCOT team identified seven key gender insights

(1) Conceptual misunderstanding of gender terminology across the institutional sector.

The consultation found that stakeholders considered "gender issues", "gender projects" or "gender interests" as solely relating to women, and never as a technical matter involving both genders where women are generally found to be at a disadvantage compared to men.

Stakeholders viewed gender issues as topics where women might potentially hold back the project, program or strategy effectiveness and impact. The relational aspect of gender dynamics was not considered by stakeholders, and many thought the issue could be overcome just by adding one or two women to the project coordination team.

(2) Sociocultural and economic characterization of women working in WM and PR activities.

Most of the women involved in the WM and PR sectors were found to have similar socioeconomic characteristics. Interviews and discussions with women working in the WM and PR sector illustrate economic and social variables of women working on the sector are characterized by social exclusion, extreme poverty[4], lack of education, early marriage, early motherhood, and de facto female household head status.

Indeed, women in the sector were mostly participating in the lowest part of the value chain. They were mostly found to be waste pickers in dumpsites, i.e., working in an activity that has negative social implications for the people performing it. In fact, most women working in the Kiteezi landfill reported to suffer from social exclusion even in their closest family and friend circles. They prefer not to share with their relatives anything about their work activities because of the shame related to this activity. The main economic drivers for women working in the sector were the need to support daily needs and education of their children. This employment was chosen as a last resort, and indeed most women interviewed by the team said that they did not feel they had any other option for surviving, other than working as waste pickers.

Most of the women interviewed did not finish their elementary education, as they came from poor families, and were generally already wives and mothers before age 18. Finally, women tend to be heads of their households, whether due to their widow status, abandonment by their husband, or being in a polygamous marriage with insufficient support from their husband.

(3) Gender roles in Ugandan society had a direct influence in the gender gap in relation to women's contribution to and benefit from the WM and PR sectors in Kampala.

Gender constraints were confirmed to be key factors limiting women's improved benefits from participation in the WM and PR sectors in the city.

[4] Women interviewed in both illegal and legal dumpsites reported an average income of 6.000 USh ($1.5) per day for work of 11 hours per day.

- Waste Management within the household: Gendered duty in the head of women

Women's gender roles in household reproduction and care at the community level dictate their responsibilities in waste management. They are the main actors within each household sorting the waste at source and then disposing it. Also, most of women are not paid to handle waste as it is seen and understood to be a household chore in charge of women. However, due to cultural and religious reasons, some women cannot leave their homes, and will therefore find difficult to deliver waste to a neighbourhood collection point.

Most women interviewed, likely due to their resource management roles at household level, had a holistic view of what waste is, which meant that before disposing of any item, women would analyze whether the material, substance or by-product should be eliminated or discarded as waste or could be used in any other activity by any other member of the household. Men did not take such careful account of resource use, in the study area.

Women spent an average of one hour per day working on waste activities within the household. However, they have not been targeted by WM activities and capacity-building of public entities and related bodies. It was observed during different meetings with public entities, government, and local organizations leading waste and environment sectors and activities that they had not put in place a broad policy directed to guide and educate households in relation to waste management. This situation leaves women in charge of waste duties with insufficient information about good WM practices. or even the potential economic and environment opportunities in this sector.

- Gender typing of WM and PR sector jobs

In analyzing the hierarchical job organization of public and private institutions involved in WM and PR sectors, the team found employers engaged in gender stereotypes and "streaming" into particular gendered positions. For example, women were hired for detail-oriented tasks that require great care and accuracy, such as plastic sorting, plastics cleaning, and waste weight inventory, while being excluded from technical and managerial positions. This task and occupational sex segregation relegated them to the lowest-paid and most easily replaced positions (e.g., during a technological automation process) – and this was the case in both the formal and informal sector jobs. Around 80% of the people interviewed working in the municipality as waste pickers and scavengers in both legal and illegal dumpsites were women.

(4) Gender gap in relation to leadership positions in the WM and PR sectors, with men holding more senior and technical positions in both sectors.

This situation was evident in most of meetings but was even more palpable during the workshop with the different stakeholders involved where around 75% of the participants were male, despite the specific interest and commitment for inviting women leaders as well as women senior and technical players of the sector.

Women's formal leadership is also not found in CBOs in the sector. The hierarchical organization of the largest CBO of informal waste pickers in Kiteezi landfill (i.e., comprising nearly 1000 members) showed that despite women are making up a majority of the membership, the three top officers were male. Women were not invited by this male leadership to the project presentation given to the study team by the CBO leaders.

(5) Lack of implementation of gender projects within the WM and PR sectors.

Despite the high number of international agreements that the government has committed to in the last years, gender mainstreaming in environmental programs in the country has not advanced significantly.

The study team found no successful gender-focused projects within the project review that could be considered as background to the current proposal. Some projects led by the Ministry of Water and Environment did seek to improve women's participation in consultations for projects by inviting them to meetings, however, gender issues were not significantly identified or mainstreaming in the resulting projects.

(6) WM and PR business model affects women economic opportunities.

Even though, most of the women working as waste pickers did not choose to work in this field but were pushed by necessity into it, they have acquired experience and expertise in the sector.

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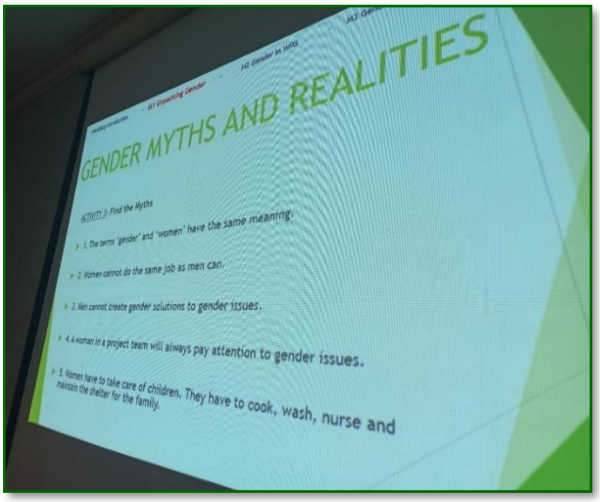
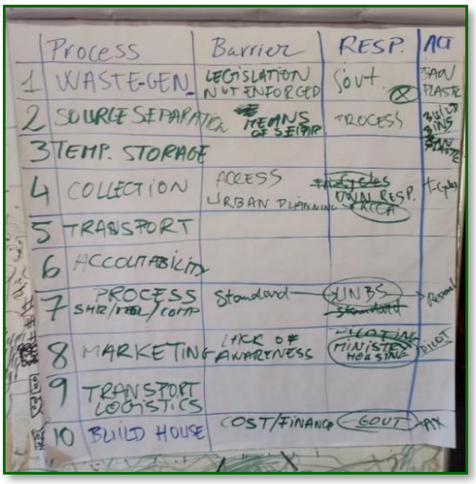


During the social consultation, ALLCOT team found interest from women in improving their position in the WM and PR value chain.

However, WM and PR business model is based in an "only buy in bulk" restricting possibilities for individual women working in the field. Hence, the middlemen business structure is at the heart of women waste pickers lack of negotiation and business influence.



Women were aware of their low position in the value chain of the business model stating they were dependent on middlemen to transport and intermediate between the plastic sorting they do and the eventual plastic recycling sale to separate companies. Despite this awareness, few women had a sense of business models or basic enterprise development approaches that could be taken to improve their economic status.

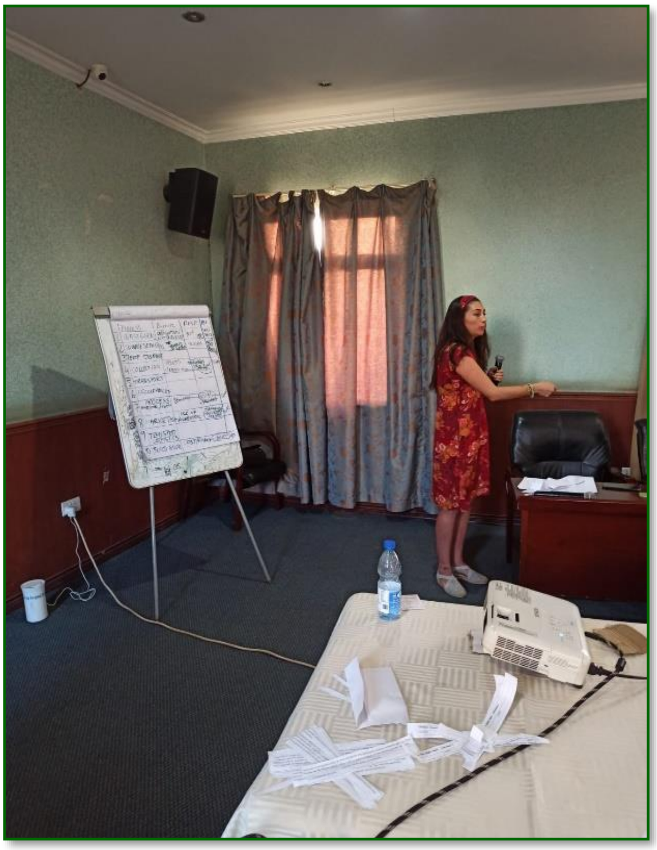
There are potential opportunities for projects and policy makers to work in building gender responsive proposals that improve women's position in the WM and PR value chains.

(7) Facilitating women's effective participation and leadership in WM and PR sector governance and value chain development.

Even though ALLCOT team focus its work in reaching women involved in leadership, management, technical and informal positions of WM and PR sector, the reality showed women are not proportionally represented in the sector value chain. On the contrary, in every position and in every stage of the value chain of the sector women voices were usually not present. Then, when they were present, they were not commonly raised and when they were raised, they did not mention or explicitly talk about gender gaps or gender discrimination in a critical way. This is directly related to be also caused or related by the first social finding “General conceptual misunderstanding of gender terminology within the entire institutional sector”.

As noted above, women were found to predominate at the lowest levels of the value chain but not be present in governance of the sector, or decision-making around it. Positive discrimination actions and activities to encourage women’s presence and leadership could be taken going forward, with due attention to facilitating meeting times and approaches in line with women’s other care responsibilities and preferred modes of communicating and analyzing. For example, the study team held separate interviews with women recyclers and waste pickers with the only presence of women translators when needed due to language barriers as projected in the risk management proposal of the social consultation manual guide build previously to the visit. These interviews were organized in separate, private spaces in order to facilitate women to speak openly.

These findings emphasize the specific needs for a WM and PR project to be gender inclusive and gender transformative. If specific actions are not undergone to promote equality between women and men, any public and private strategy, project or program will tend to reproduce the hierarchical order of gender that has historically locate women at the baseline of unequal opportunities and unfair treatments.



Gender expert during the workshop on 13th February 2020

03

TECHNICAL BASELINE ANALYSIS

This third section is centered in the creation of a Baseline Analysis from a technical perspective of the Waste Management (WM) and Plastics Recycling (PR) sectors in Uganda.

Overview of Current Waste Management System in Uganda

During the desk review and the social consultation process, the consulting team also focused on the assessment of the current solid waste management system and plastics recycling during the entire life-cycle of waste in Uganda with a specific focus in Kampala.

(1) Waste streams

The provision of reliable solid waste services, particularly to an increasing urban population, requires an accurate and up to date database, which is consistently maintained. Knowledge of the composition and quantity of municipal waste streams has direct implications on planning the collection, recovery and disposal activities and will enable municipal authorities and those engaged in solid waste management to effectively address these issues. Data stored can help policy makers and city planners to reduce disposal site waste, set up recycling programs, and save money and resources. Waste characterization plays an important part in any treatment of wastes.

A successful waste management system hinges on accurate and reliable data so that waste managers, planners and policy makers can make informed decisions. Data on waste is sparse in Uganda and this makes calculating the true cost to manage waste difficult. Even more so, a comprehensive waste management strategy is difficult to be formulated without reliable data on all types of wastes, hence data gathered in previous studies has been used in the current assessment. Solid waste is broadly defined as non-hazardous, industrial, commercial and domestic refuse, including household organic trash, street sweepings, hospital and institutional garbage, and construction wastes.

In Uganda, residential wastes take a portion of 52-80% of the weight of wastes produced, followed by markets, commercial sectors, industrial sectors and others. The major wastes produced are the food wastes while minor portion of the wastes produced are comprised of paper, plastics and ceramics.

Kampala has five divisions: Central (central business district), Makindye, Nakawa, Kawempe and Rubaga. The mean composition of Kampala's municipal waste by percentage weight and total waste collected from the five different divisions of Kampala city (mean ± Coefficient of Variation) is the following:

Table 1: Mean composition of municipal waste from Kampala by percentage weight and total waste collected from the five different divisions of Kampala city

Division	Organic	Hard plastics	Metals	Papers	Soft plastics	Glass	Textiles and leather	Other	Total/ yr (Gg)
Nakawa	91.0±0.0	2.0±0.9	0.1±0.7	1.2±1.2	3.9±0.4	0.5±0.9	0.6±0.9	0.6±0.8	45.5
Makindye	95.0±0.0	1.1±0.6	0.1±0.9	0.7±0.9	2.0±0.5	0.3±0.6	0.3±0.9	0.6±0.8	32.6
Kawempe	92.9±0.0	1.6±0.8	0.1±0.9	0.7±0.9	3.2±0.5	0.7±1.1	0.3±0.8	0.5±0.8	39.0
Central	91.9±0.0	1.7±0.7	0.2±0.7	2.1±0.9	2.4±0.5	0.7±0.7	0.4±0.9	0.7±0.9	69.4
Rubaga	89.8±0.0	2.4±0.8	0.2±0.7	1.9±0.8	3.6±0.6	0.6±0.9	0.7±1.0	0.7±1.0	40.3

Source: Allan J. Komakech et.al.; "Characterization of municipal waste in Kampala, Uganda", 2014.

The study performed by Allan J. Komakech et.al. (2014), established that on average, about 28,000 tons of municipal waste from Kampala was disposed of in the landfill every month. This waste consisted on average (by weight) of 92.1% organic material, 1.8% hard plastic, 0.1% metals, 1.3% papers, 3.0% soft plastic, 0.6% glass, 0.5% textile and leather and 0.6% others.

According Shamim Aryampa et.al. (2019), the rate of waste generation in Kampala increased from 0.26 to 0.47 kg/capita/day between 2011 and 2017, with an average annual increase of 0.03 kg/capita/day. Consequently, the total annual waste volumes generated in the city also increased significantly from 407,890 to 785,214 tons during the period 2011-2017, representing a 48% increase. This increase in the waste quantities corresponded to a 53.5% population increase within the same period. Per capita gross domestic product (GDP) was positively correlated with per capita waste generation for the 2011 to 2014 period. However, from 2015, the per capita waste generation continued to increase despite the fluctuations in the GDP.

The projected waste generation rates of Kampala city are 0.709 kg/cap/day in 2025 and 0.843 kg/cap/day in 2030.

The correlation between the 48% increase in waste quantity and 53.5% population increase in Kampala indicates that for every percentage increase in population, there was an almost equal increase (0.9%) in waste generated. This close relation between waste and population shows that population growth was probably the most important influencer of waste generation in Kampala.

(2) Collection and transportation

The city of Kampala is administered on behalf of the Central Government by the Kampala Capital City Authority (KCCA), a legal corporate entity established by the Ugandan Parliament. KCCA is responsible for the collection, transportation, treatment and safe disposal of the waste generated within the city as mandated by the Public Health Act Cap 281 and the Local Governments Act. In conducting its duties, KCCA is mandated by the Kampala City Council Solid Waste Management Ordinance of 2000 to ensure that solid waste is collected and conveyed to treatment installations in a manner that satisfies both public health and environmental conservation requirements.

In Kampala, most waste is collected in two phases. The first phase is where waste is stored at the household and then, when the need arises, it is transported to the collection point, normally the temporary storage. The second phase is when waste is collected from temporary storage points and then transported to the final disposal site. (Kinobe J., 2015).

Final disposal site – Kampala- *Source: Own elaboration*

The waste generated in the city is not segregated. Furthermore, only about 64 % of the waste collected

is transported to the landfill (Aryampa et.al., 2019). The uncollected waste is dumped in open spaces, on streets, in markets, and in drainage and storm water channels. These uncollected wastes create health risks, while the heaped garbage on the streets becomes an impediment to traffic and an aesthetic nuisance in the city streets (Kinobe J., 2015).
According the study performed by Kinobe J., 2015, there are 4 models of waste collection system used in Kampala:

- **Model 1 - poor areas/households:**

In this model, the households are located in informal areas inhabited by low income earners characterized by poor accessibility and living conditions. Waste is stored in buckets and old plastic sacks until it accumulates to about 30-50 kg. The waste is then transported to an unofficial collection site, normally located along the main road or street next to drainage channels for secondary collection by the waste management authority or its contractors.

- **Model 2 - upscale residential areas and institutions:**

This model is associated with upscale residential areas and institutions inhabited by more affluent people. Waste generated is initially temporarily stored in a legal demarcated place in polyethylene bags and collected regularly to a timetabled schedule. The main operators in these areas are private operators because the inhabitants can afford to pay for the services of waste collection.

- **Model 3 - city center and business areas:**

In this model, waste collection is targeted at the central business center and commercial area of Kampala. Both KCCA and private operators carry out the activities where the central business areas are operated by private companies where the beneficiaries pay a monthly bill of 10,000 – 100,000 Ugandan shillings (depending on the size) per shop located in a particular building. Plastic bags and bins of different colors according to a particular private company are provided and given to the waste generators. These are then collected by each private company referring to the color they provided while leaving the colors that are not for their company.

- **Model 4 - market areas, public park areas, street sweepings and drainage channel de-silting:**

The main actor in this model is KCCA which collects waste in the major markets of the city. All activities involving street sweepings, drainage channel de-silting or generating waste within the city are taken care of by this model.

(3) Transfer stations

A transfer station is a building or processing site for the temporary deposition of waste. Transfer stations are often used as places where local waste collection vehicles will deposit their waste cargo before loading it into larger vehicles. Transfer stations are convenient hubs for the deposit of waste, which is then consolidated and transferred to large, long-distance trucks for delivery to disposal facilities. Transfer stations are sometimes collocated with material recovery facilities and with localized mechanical biological treatment systems to remove recyclable items from the waste stream.
To date no transfer stations have been established due, in part, to inadequate funding.

(4) Treatment

- **Reduction of waste**

Waste reduction is said to be a logical starting point for sustainable solid waste management, by reducing the amounts of waste that must be managed, collected and disposed.

In developing countries, such as Uganda, waste reduction strategies are less familiar but have the potential to resolve the current solid waste issues. The current household solid waste management practices, such as disposal by burning and indiscriminate dumping resulting from the inadequate collection, can negatively impact public and environmental health. According to Shamim Aryampa et.al (2019), the best practice for sustainability of waste management in Africa would be the reduction of waste that is eventually disposed of. However, since there are no official transfer stations for waste in most African countries, huge amounts of recyclable waste are taken directly to the disposal sites. Nevertheless, it is paramount that the maximum possible efforts start being made towards achieving more recycling and reducing the quantities of waste that are disposed of. This could start with well-coordinated and managed efforts to increase the separation of wastes at the source, which would reduce the disposal of recyclable and reusable materials. Effective waste separation necessitates treating waste as a resource and hence designing circular economies for resource efficiency, which in turn calls for policies that permit a shift from conventional waste management to integrated and comprehensive resource management.

- **Reuse**

Waste prevention and minimization at household level will reduce its generation and reduce the associated impacts. There should be precedence with proper storage of household wastes, waste separation and placement of household containers. Waste minimization is mainly driven by individual habits that value environmental protection and resource conservation. These social values take time to develop and change, however they are essential to environmentally sustainable and cost-effective services. The process of reusing starts with the assumption that the used materials that flow through people´s lives can be a resource rather than refuse (Kinobe J., 2015).

- **Recycle**

Through their informal recycling activities, waste pickers broaden their sources of income. They contribute to national industrial competitiveness and benefit the environment. Maximum benefits will be gained when the authority recognizes the importance of the informal sector responsibilities in solid waste management and strengthen their activities in reverse logistics. Government intervention including the reverse logistics chain in waste management should be developed and passed. Another way is to come up with programs that can join up the reverse chain distribution network of waste pickers, street children and scavengers. These people work in extremely poor conditions, so with the support of the programs formed they can be registered, then work jointly, hence leading to efficiency. Much of the waste stream can be recycled, making this an important component of integrated solid waste management. Each recyclable product (hard plastics, paper, metals and polyethylene) has a market-based monetary value (Kinobe J., 2015).

Plastic storage point. *Source: own elaboration*

- **Composting and energy recovery from waste**

According Kinobe J., 2015, the available technologies for treating biodegradable waste components are composting, anaerobic digestion, landfilling with methane capture for power generation, and incineration. However, some of these technologies cannot be applied in Uganda:

- Incineration is not generally considered economically viable for developing countries, because their wastes are too wet and too low in combustibles to burn without supplementary fuel. Where incineration is implemented in a developing country, air pollution control measures that address standards comparable to those required in high-income countries should be implemented. Incineration produces toxic emissions.

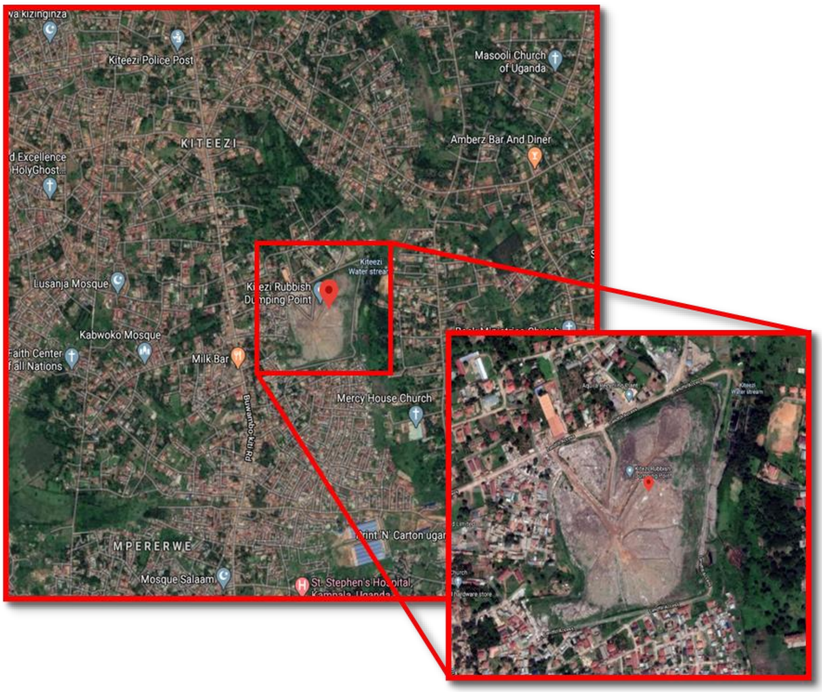
- Composting may be the best alternative because a large percentage of waste generated comprises biodegradable matter. The compost will later be used as manure and soil enrichers.

- Related to the methane capture for power generation, there is a project currently registered under the Clean Development Mechanism (CDM) of the UNFCCC, called "Mpererwe Landfill Gas Project" and located in Kiteezi landfill. This is the unique CDM project of this technology currently registered in Uganda and consists of the landfill gas extraction and flaring, controlling gas both in terms of risk from the explosion and for reducing harmful emissions of greenhouse gases (methane). This technology would be new in Uganda and would contribute to improving the situation of the waste sector in the Sustainable Development Goals (SDGs). However as related previously, special focus should be put on each one of the project stages for analyzing women positions in relation to the access of the resources needed as well as in the sex disaggregated study of the beneficiaries in order to actively engage in transforming and counterbalancing unequal starting positions of land tenancy, educational skills or work abilities in order to fully engage women access, participation and benefits from the project. While projecting in generating new employment opportunities, restoring the site after its use and training local staff to become experts relating to the monitoring, operation and maintenance of the project, the coordinators and every part of the team involved has the technical and socioeconomic duty to go further on analyzing the specific impacts on women economic and sociopolitical involvement of any potential design, implementation, monitoring and evaluation in order to equally involve women from the basis of unequal starting point of rights and obligations owned by and demanded to women.

- **Disposal method**

Kiteezi landfill is the only sanitary landfill in Uganda and is currently managed by KCCA. The landfill is located in the peri-urban Kiteezi, 13 km from Kampala city center at latitude: 0º25`0``and longitude: 32º34`00``. Waste from Kampala city and the nearby peri-urban areas in the Wakiso district is disposed of at the landfill free of charge.

The landfill location receives two seasons of rainfall (March to May and September to November) and has two dry seasons (December to February and June to August).



Kiteezi landfill location. Source: Own elaboration

According to Shamim Aryampa et.al. (2019), waste collection efficiency in Kampala increased from 30% in 2010 to a rate of 64% in 2019 and the total annual waste increased from 227,916 tons in 2011 to 481,081 tons in 2017 as can be seen in the table presented below:

Table 2: Total and mean waste delivered to Kiteezi landfill in seven years.

				95% Confidence Interval	
	Total Waste		Mean	Lower Bound	Upper Bound
Year	2011	227,916	12,662	11,956	13,368
	2012	327,998	13,667	13,055	14,278
	2013	344,593	14,358	13,747	14,969
	2014	380,900	15,871	15,259	16,482
	2015	371,273	15,470	14,858	16,081
	2016	430,067	17,919	17,308	18,531
	2017	481,081	20,045	19,434	20,656
Collector	KCCA	1,637,077	20,075	19,741	20,410
	Private collectors	926,751	11,351	11,017	11,686

Source: Shamim Aryampa et.al, 2019.

According the discussion in the study of Shamim Aryampa et.al (2019), the trend of ever-increasing waste quantities for disposal in Kampala city creates an ever-growing need for more land to dispose of the waste. Consequently, due to limited land availability coupled with limited institutional capacity to establish new disposal sites as required, there is continued use of existing sites beyond their capacities creating a major sustainability dilemma. Kiteezi landfill continues to be used beyond its capacity ending up with conditions similar to an open dump although it was constructed as a sanitary landfill.

The continued use of more land for waste disposal creates a growing threat to all land resources particularly soil and water and consequently affects negatively human health of the most vulnerable and exposed, namely women representing more than 70% of informal waste pickers. Additionally, the negative impacts women are being thread of are multiplied because of the current disposal trend that is creating a situation where the most vulnerable and poor who are mainly women have to compete with waste for settlement and productive agricultural land as well as for safe water. This has resulted in more poor households, usually head by single women rapidly occupying areas adjacent to landfills without due attention to the impact that the landfills may have on their health and wellbeing. This situation, coupled with the expanding disposal areas, continuously puts the health of vulnerable women at risk.

- **Leachate management and treatment**

Leachate is produced when rainwater percolates with liquids created from decomposing waste in an anaerobic environment. It has the potential to travel through the soil layers to the water table, ultimately contaminating groundwater resources which, in turn, contribute to land-based sources of pollution to the marine environment. Leachate consists of aromatic hydrocarbons (benzene and toluene), chlorinated benzenes, volatile halocarbons, phenols, and various carboxylic acids. These contaminants may cause major public health risks to exposed populations who are statistically represented by more informal women waste pickers.

According Kinobe J., 2015, the most common disposal method for solid waste in Africa is open landfills, with no environmental control. Many of these landfills have reached their capacities and, in most cases, the environmental conditions are very poor. This has caused considerable land degradation and contamination of underground water sources through leachate pollution.

- **Disposal sites GHG gas emissions**

As garbage in disposal sites undergoes microbial decay and other chemical reactions, methane gas is produced. Depending on the waste composition and the structure of the disposal site, this gas builds up pressure under the surface, thereby creating a high incidence of fires and release of toxic fumes. The gas, called landfill gas (LFG) also has traces of nitrogen, oxygen, water vapour, sulphur and other contaminants.

Gases are extremely mobile once there is nothing to constrain their movement from an area of high concentration to an area of low concentration. Disposal site gas may therefore migrate to areas in proximity to disposal site areas, thereby creating potential health hazards such as respiratory diseases, or even explosive conditions. Moreover, disposal site gases are a significant contributor to greenhouse gas emissions with related implications for their contribution to global climate change.

As explained above, Kiteezi landfill is currently registered as a CDM project to promote the collection and destruction of the landfill gas, however, without CDM project backing, the scheme will not progress as at present. There are no regulatory drivers in Uganda pushing this type of project forward and there are other far greater priorities for any funds that may be available within the country. Without the scheme, uncombusted raw methane, which typically makes up to 50% of the landfill gas mixture and is a 21 times more powerful greenhouse gas than carbon dioxide, will continue to be untreated, uncontrolled and will continue to disperse directly to atmosphere.

- **Groundwater and surface water pollution**

According Kinobe J., 2015, Kiteezi is an open and unlined landfill with no groundwater protection and limited leachate recovery. The landfill is an ecologically sensitive area where groundwater supplies are threatened because it is located on a wetland. There is susceptibility to both surface and groundwater pollution. As mentioned in the study of Shamim Aryampa et.al (2019), with more land being used for disposal particularly beyond its carrying capacity, the risk of soil and water resources being exposed to direct contact with waste and subsequent leachates reduces the sustainability of waste disposal sites.

- **Post-closure practices**

The KCCA has no plans for proper closure of the disposal sites and it does not have the resources to prevent and manage the illegal dumping that takes place.

04

GENDER AND TECHNICAL RECOMMENDATIONS

General recommendations

Based on our technical assessment, the study team recommends that any waste management and plastic recycling project integrate gender through the following actions that cut across the institutional, economic and social dimensions of the intervention.

The following gender general recommendations specifically apply to WM and PR sectors in the context of climate adaptation, mitigation, or both intervention areas in Uganda capital city.

- **For both Adaptation and Mitigation projects**

- Ensure disaggregation of qualitative and quantitative data by sex, in all assessments and stocktaking.
- Develop and apply gender-sensitive criteria and indicators for progress monitoring and evaluation of results.

With the general findings of both the social consultation and the desk review, ALLCOT team has built a matrix summarizing the main issues and recommendations encountered and proposed in relation to – Waste Management and Plastics Recycling technical variables and -Gender Equality in the specificities of the sectors.

These issues and recommendations are grouped by sociocultural, economic and institutional factors in order to better elucidate the roots of the barriers and challenges, and better work upon the opportunities and solutions.

It is important for every country to propose specific criteria and indicators (both qualitative and quantitative as they are both important and needed to measure progress towards achieving gender transformation), and then develop the monitoring and evaluation strategy. Qualitative and quantitative indicators informed by sex- and age-disaggregated data will be an important aspect of how gender considerations are integrated into any adaptation and mitigation project in Uganda.

They can be qualitative, in the form of experiences, stories, or perceptions, or more quantitative, in the form of facts, percentages or numbers. Ultimately, they signify progress or changes in specific conditions. A qualitative indicator could also be the perceived level of empowerment women have to adapt to climate change or convince their communities to implement adaptation measures. This is also related to another possible indicator, which would be the amount of change in relations between men and women or relative changes in the level of poverty or participation in particular Kampala`s communities.

The technical gender oriented recommendations matrix below provides guidance to on sector gendered issues, recommendations and potential gender indicators, WM and PR projects in Kampala context will need to take into account in order to demonstrate their commitment and close alignment to gender indicators:

Figure 2: *Technical gender oriented recommendations matrix*

Technical Gender Analysis Matrix

	ISSUES	RECOMENDATIONS	INDICATORS
INSTITUTIONAL	Kampala faces a constant shortage of Waste collection trucks units within the KCCA's fleet and additionally has one of the most rapid urbanization rate around the world with an average over 5% .	Recover and Reuse the materials from waste stream can provide jobs and income sources for low-income communities and specifically for women who are usually in the most vulnerable position of this value chain. The activities proposed to counterbalance this situation are: 1) Identification and documentation of every CBO working on Waste Management in the different parishes of the District. 2) Supporting with trainings and educational programs the current CBOs identifyied in the first step and stimulate either with trainings or economical subsidies the creation of more CBO from the existing women social organizations to work on WM and PR. 3) Promote private partnerships between the existing Plastics recycling companies (PRI, MUKONO Plastics) with women CBOs working on WM and PR. 4) Creation of recovery reuse project for creating building blocks (Bloqueplas example), which will be used in the construction of houses to create affordable housing for women head of households. This could be a program to be implemented in Kampala with the association and involvement of CBOs or entities such as the Uganda Housing Cooperative Union.	Recycling and reutilization rate (%) KGs of Waste treated by CBOs
	Limited overall Governmental budget.	•Finance public sector waste management through a mixture of levies, taxes and fees •The polluter pays principle applies. Regulators and operators are to implement cost recovery measures as a component of service delivery: - for regulators - regulatory fees and fines, - for operators - revenue to cover operational costs (at least) and possibly make a profit to keep the entity viable •Review existing arrangements for financing municipal solid waste management services through property taxes and modify or develop a new model so that revenue collected can pay for the services An IWMS will generate revenues— for example, the fees for the collection services, implementation of recycling schemes, energy recovery from controlled landfill sites, and interaction plans. The clean development mechanism might be a source of revenue.	Fees for collection services against waste produced Revenues

INSTITUTIONAL	Misunderstanding of "Gender" conceptualization within the public and private institutional WM and PR landscape.	Design and Implement Gender focused capacity building activities within the WM and PR officers in charge of budget allocations, policies design and projects implementation. Public entities might ask employees and officers to undergo for instance free Gender courses from United Nations Women like " I know gender 1,2,3 ".	Number of WM and PR officers who did or were present in Gender focus Workshops or have certificates of Gender Courses.
	Gender related activities headed by public and private entities are few and most of the time are replicating and reinforcing gender stereotypes positioning women in the most vulnerable situations by reinforcing women biased gender assumptions of physical, mental and professional (in)capacities in comparison to men in most of (paid) productive roles. In fact, in most projects and structures analyzed in the different entities and organization of WM and PR sectors, it was found the constant reinforcement of gender labour division		Gender gap indicator in relation to the number of women and men present in each level of activity undergone by the entities. This indicator will elucidate " How is the work division in gender terms?" Namely, is the project taking into account actions for not having neither promoting gender related work division which usually locates women work (salary, power and impact) in the lowest positions of the value chain.
	Lack of gender aware projects in the sectors. Projects being part of the SPCR program do not take into account the potential barriers for women participation in relation to their triple role within societies (reproductive, productive and community) which tends to seclude their participation and limit their benefits from the project development.	For projects, programs and activities to be fully inclusive, public and private entities have to add to their design, implementation, monitoring and evaluation gender perspective in every step of it. Therefore, taking into account barriers in specific areas of mobility, family and household duties, children care and women empowerment were found to be essential for women in the WM and PR sectors.	Gender gap measuring women economic benefit vs men economic benefit acquired from SPCR projects implementation.
		Partner with International Organization specifically working towards advancement in SDG 5 and 12 in the country in order to develop solutions for waste management and plastics recycling projects mainstreamed by gender.	Number of affirmative actions put in place to counterbalance and improve women mobility problems, household duties and women empowerment.

Technical Gender Analysis Matrix			
	ISSUES	RECOMENDATIONS	INDICATORS
ECONOMIC	PR sector is very susceptible to external shocks. Growing restrictions on importation of recyclables to China and India had a huge negative impact in the sector.	One of the benefits of a waste management policy is the reconciliation and accommodation of competing economic interests. That these interests can be reconciled demonstrates that they are neither fundamentally nor necessarily in competition. Many of the best strategies for waste reduction, i.e. reuse, recovery, recycling and composting, produce benefits resulting in a quadruple bottom line. These strategies require less capital investment, create more jobs and sustain more livelihoods, protect public health and provide raw material to production processes: - The economic contribution of waste pickers to waste valorisation should not be overlooked. Informal recycling sector in Kampala could have a bigger impact in reducing the volume of waste, thereby saving on collection and disposal costs, and extending the life of landfills. KCCA and public entities should support instead of neglect and reject the informal sector which is composed mainly by the poorest women. Strategies to insert, integrate and connect waste pickers activities into wider waste management systems through national programs that provide legal and technical assistance are highly recommended. This integration should promote and facilitate (in a similar way, it has been done with Kiteezi Landfill) the establishment of waste pickers organizations, which would improve their organization, agency and therefore command greater respect from the society as well as encourage self development and the ability to negotiate direct source-collection contracts (or informal agreements) with businesses, industries and neighbourhood associations.	Number of waste pickers organizations Number of persons (disagregated by sex) working in the informal sector Reduction of environmental impacts
	Tendency towards a more technological and engineering based sector that will displaced and affect strongly the women working in the informallity and are also working in the most operationalized activities such as cleaning and sorting.	Reinforce women educational capacities to be directed to operate machines in the sector.	Gender gap in the number of women and men machines operators. Gender gap in the number of job replaced by machines. Gender gap in relation to the number of women vs men hired to manage or work with new machines and new techologies.
	Dependency on women economic development from middlemen activities and lack of gender specific financial support to support women bussiness ideas.	Encourage and accelerate women entrepreneurship ideas with women seed capital specific lines in WM and PR sectors	Number of women playing the role of "middlemen" person in the chain of plastics recycling sector.

Technical Gender Analysis Matrix			
	ISSUES	RECOMENDATIONS	INDICATORS
SOCIAL	Insufficient community engagement and social awarness in relationship to Waste Management Social acceptation of dumping of garbage at illegal sites. Resilience from the society to waste management policies enforcement because of -the mobility that characterize the unhabitants of Nakawa Municipality and -the percentage of informal settlements. Women overcharge duties in relation to waste management in the household level.	Create waste prevention behavioural change programs/trainings in partnership with schools to create activities specifically directed for children, both girls and boys (disrupting the social role/task/responsability imposed to women and girls in relation to WM and emphasyzing in a shared responsability of it from both genders) to learn about recycling and how to avoid the generation of solid waste. Create waste prevention communication strategies. Strategy should be directed to overall community focused on emphasizing both genders responsability over the reuse and recycling of waste (gender transformative approach to counterbalance the social responsabilities imposed to women over the household and community care). Support with Mass media communication for a sociocultural transition into a "circular" recycling economy through educative gender mainstreamed programs that will position waste and plastics to be an economic resource , rather than just a mounting problem in the household and community. .	Number of persons (disagregated by sex) attending to workshops and educational activities about waste management, plastic recovery and recycling. Number of mass media/communication strategies
	Difficulties and barriers to self-load waste.	Women should be able to access environmentally sound waste facilities. That includes access to deposit containers and a drop-off recycling centers. The structure, location and access to those has to be analysed through a gender study that takes into account women and girls social barriers and physical differences (higher levels of insecurity in public, dark and lonely spaces for women and girls, strenght to lift up waste to deposit it in containers, mobility limits to women because of traditional clothes) and address them to facilitate women access and use.	Percentage of uncontrolled disposal vs percentage of controlled disposal Average distance between the households and the drop-off centers.
	Social stigma of women waste pickers based on the social perception of the typology of the work in the sector and the characteristics of activities performed., which usually leads to exclusion from community and family network and access to public services (healthcare, electricity, water and sanitation)	Strategies to manage solid waste need to be cognizant of the important role scavengers play in waste management and that their livelihoods are dependent on waste: Develop occupational health and safety standards for the informal waste sector supported with specific attention to special women health needs in relation to menstruation. Ensure safety training for informal workers in the waste management sector that takes into account women participation barriers caused by the household duties they are socially responsible for (children and elders care, cooking and cleaning) and therefore acts upon the creation of flexible training agenda and positive discrimination activities in relation to transportation and location of the trainings in order to facilitate women participation. In order to have real affirmative action, organizers have to take into account also the persons women are in charge of. For instance, if women are in charge of their children and elders care, subsidies for someone to take care of them while they are assiting to trainings has to be an action to offer them.	Reduction of health impacts among the informal waste workers disaggregated by sex

Source: Authors.

- Mainstreaming gender within National Adaptation Plans (NAPs) and National Adaptation Programmes of Action (NAPAs) considering gender as a cross-cutting issue

Considering the reports of the Intergovernmental Panel on Climate Change (UNFCCC), the Least Developed Countries (LDCs) have embarked on the process to formulate and implement NAPs. The NAPs constitute comprehensive adaptation plans that integrate and synergize with existing adaptation efforts in the countries. In this way a comprehensive approach to adaptation planning is taken, which is country-driven and fully consistent with national priorities.

Given the need for a "gender-sensitive approach" in NAPs, LDCs may need to consider how to effectively integrate gender considerations within the steps of the process to formulate and implement NAPs, and to communicate how gender is being addressed. Integrating gender considerations entails a logical, interconnected, coherent and comprehensive inclusion of gender perspectives, and there is no single best formula for identifying the entities to be created to guide and implement the planning process. Each country needs to set up structures best suited to their particular situation. However, there are some specific aspects to consider when integrating gender in the process to formulate and implement NAPs. Some of them are presented below:

- Gender as a cross-cutting issue to be considered throughout the process to formulate and implement national adaptation plans

The process to formulate and implement NAPs build on the four main elements of the initial guidelines adopted by Parties to the UNFCCC. These four elements are: (1) laying the groundwork and addressing gaps; (2) preparatory elements; (3) implementation strategies; and (4) reporting, monitoring and review. The guidelines provide the following general guidance on how to consider gender issues in the process to formulate and implement NAPs across the four elements:

- Assess what information is available regarding particularly vulnerable groups including women, and carry out further research on this topic in the country;
- Harness the potential of women as agents of change within their communities, and invest in this potential as part of the process to formulate and implement NAPs;
- Tailor and implement NAP activities based on an understanding of gender dynamics and the potentially disproportionate impacts of climate change on women;
- Ensure the participation of the most vulnerable groups, including women, in the process to formulate and implement NAPs. This includes integrating the perspectives of women and drawing on their unique adaptation knowledge and local coping strategies when formulating the NAP;
- Undertake outreach to ensure that different stakeholders understand the gender dynamics of climate change;
- Use sex-disaggregated data in vulnerability and adaptation assessments;
- Monitor and report on the integration of gender considerations into the process to formulate and implement NAPs;
- Evaluate the integration of gender considerations into adaptation and make improvements if necessary.

- Key recommendations for integrating gender considerations in the process to formulate and implement national adaptation plans.

There is a need for a concerted process that focuses on creating an enabling environment for gender by creating gender-sensitive policies, strengthening women's networks and generating political will, capacity and knowledge. These pillars need to be considered in all the stages of the formulation and implementation of NAPs. This can help to ensure that a foundation is established upon which the appropriate technical support, financial resources, and political support can be built. Furthermore, Uganda can undertake a number of strategies to create a gender-sensitive NAP and enhance understanding of gender. Several recommendations pertaining to the process to formulate and implement NAPs were made at the meeting on the application of gender-sensitive approaches and tools for adaptation. They include:

- Inclusion of gender considerations and analysis in all stages of the process to formulate and implement NAPs;
- Acknowledgement of national and international laws and policies in relation to gender equality and the empowerment of women in NAPs;
- Attachment of greater priority to and provision of resources for gender consideration in risk analysis and national budgeting by national institutions;
- Establishment of national-level partnerships for learning and exchanging good practices;
- Prioritization by national governments of efforts to build the capacity of women and gender-focused organizations at the national level, including through dedicated training;
- Allocation of funding earmarked for integrating gender consideration into adaptation programmes by the government.

According to UNFCCC[5], Uganda is awaiting GEF approval of its NAPA programme to make further progress in the project implementation phase. The update of its NAPA in the near future is not planned at this stage.

- Integrating gender into adaptation and low carbon development plans, strategies and policies

There are many approaches and tools available and recognized by the UNFCCC for integrating gender into adaptation planning and implementation. Some of these available tools are presented below:

- International Union for Conservation of Nature Climate Change and Gender Action Plans (ccGAP)

The ccGAP[6] is a long-term placeholder for the moment in time when policy and planning opportunities emerge. This tool connects multiple sectors because gender is a cross-cutting issue that is pertinent to diverse sectors. It orients the steps to be taken by government and donors for optimal impact and targeted actions by defining the objectives, action-steps and indicators of success across sectors

[5] https://unfccc.int/topics/resilience/workstreams/national-adaptation-programmes-of-action/ldc-portal/country-experiences-with-napa-process/uganda

[6] Experiences from LDCs like Haiti, Liberia, Mozambique, Nepal and the United Republic of Tanzania showed that process of ccGAPs align with national climate change priorities, other national policies, NAPs, NAPAs, national communications, etc., to uncover and address gender considerations.

considered as priority by countries by ensuring gender equality in different policies, project or activity formulation.

As example, in Liberia, the objective was to ensure that gender equality is mainstreamed into Liberia's climate change policies, programs, and interventions so that both men and women have equal opportunities to implement and benefit from mitigation and adaptation initiatives in combating climate change and positively impact on the outcome of "Liberia Rising 2030". Agriculture, Coast, Forestry, Health, Water and sanitation, and Energy were the covered sectors.

Other example is in Mozambique, where the ccGAP led to the inclusion of gender in the country's Strategic Programme for Climate Resilience.

- World Health Organization (WHO) on assessing different types of gender responsiveness of policies and programmes.

The Gender Responsive Assessment Scale, which was developed by the World Health Organization (WHO) includes five levels, two of which hinder the achievement of gender equality and health equity. The third level, gender sensitivity, is the turning-point when policies or programmes recognize the important health effects of gender norms, roles and relations. Only when a policy or programme is gender-sensitive can it be either gender-specific (level 4) or gender-transformative (level 5), and thus have a real impact:

- Level 1: Gender-unequal: perpetuates gender inequality by reinforcing unbalanced norms, roles and relations; privileges men over women (or vice versa); will often lead to one sex enjoying more rights or opportunities than the other;
- Level 2: Gender-blind: ignores gender norms, roles and relations; by ignoring gender aspects, gender-blind programming will often reinforce gender-based discrimination;
- Level 3: Gender-sensitive: considers gender norms, roles and relations; does not address inequality generated by unequal norms, roles or relations; indicates gender awareness, although often no remedial action is developed;
- Level 4: Gender-specific: considers gender norms, roles and relations for women and men and how they affect access to and control over resources; considers women and men's specific needs and might intentionally target and benefit specific groups of women or men to achieve certain policy or programme goals or meet certain needs;
- Level 5: Gender-transformative: considers gender norms, roles and relations for women and men and how they affect access to and control over resources; considers women and men's specific needs; addresses the causes of gender-based health inequities; includes ways to transform harmful gender norms, roles and relations; includes strategies to foster progressive changes in power relationships between women and men.

In Uganda, there is a dearth of information and statistics to illustrate the effects of climate change on gender and yet climate change and increased weather variability has significant gender implications due to the different roles, needs, capacities and positioning of men and women in society. As a consequence, women and men are exposed to different risks and vulnerabilities. The SPCR is based on the premise that climate change affects everybody and it is not gender neutral. Responses to effects of climate change and variability cannot be effective without taking into consideration the different needs of women and men, the inequalities that compound the impacts of climate change for women and the specific knowledge they can contribute to the solutions. The SPCR will support the implementation of diverse integrated strategies to enable women and men that live in highland and lowland regions of Uganda to cope and adapt to the effects of climate change. The strategies will include climate smart agricultural practices such as agroforestry, mixed farming, soil conservation, food storage and engaging in various alternative sources of income generation, including waste management and plastic recycling activities.

The SPCR suggest the inclusion of promoting the use of wastes more productively specifically making waste management a commercial activity in urban areas and address issues of attitude change for waste management both in rural and urban areas that it is a great opportunity to consider gender gaps in this sector.

Additionally, the National Environment (Waste Management) Regulations S.I. No. of 2020 intends in its National Waste Management Plan to include and regulate health, safety, social and environmental safeguards, operating procedures for waste handling and the equipment available for waste management, an environmental management and monitoring plan where applicable, developed in accordance with the National Environment (Environmental and Social Assessment) Regulations (2020), an environmental management and monitoring plan where applicable, developed in accordance with the National Environment (Environmental and Social Assessment) Regulations (2020), training of personnel and an effective information, education and communication strategy, among other measures. The integration of a gender perspective in this waste management plan is needed in both national and regional level.

- Foster global Gender, WM and PR alliances.

The Global Gender and Climate Alliance (GGCA) was launched in 2007 by the United Nations Development Programme (UNDP), the International Union for Conservation of Nature (IUCN as per its Spanish acronym), the United Nations Environment Programme (UNEP) and the Women's Environment and Development Organization (WEDO). The GGCA works to ensure that climate change policies, decision-making and initiatives at the global, regional, and national levels are gender-responsive. The GGCA has grown to include nearly 40 United Nations and civil society organizations and has been recognized as a unique and effective partnership that is bringing a human face to climate change decision-making and initiatives. Below are specific examples of support provided to countries under the program which could be applied in Uganda:

- **Niger**: In collaboration with the International Institute for Sustainable Development (IISD), the UNDP Bureau for Crisis Prevention (BCPR) and Africa Adaptation Programme (AAP) Niger, gender dimensions have been integrated into the Climate Risk Management Technical Assistance Project (CRM/ TASP) through an integrated study on climate risks in the Pond of Tabalak (one of the 12 RAMSAR sites in Niger and situated in the border of the Sahel and the Sahara);
- **Nigeria:** The African Adaptation Programme in Nigeria, in collaboration with UN Women, has reviewed the Nigeria Adaptation Strategy and Plan of Action (NASPA) to identify all gender gaps and appropriately redressed these within both the NASPA and the low emission climate resilient development strategy. A new and transformative gender intervention approach, "Transformative Adaptation- Prioritizing the Adaptation Needs of Women in the African Adaptation Programme (AAP) in Nigeria", has been developed by UN Women to deal with climate change adaptation;
- **Senegal:** A gendered vulnerability and adaptation case study of Guinean migrant women in the district of Joal in sea resources management has been documented to inform policy and decision makers about the need to consider climate change adaptation policies and programs

in important, but always missing dimensions, gender and migration. AAP Senegal has documented best practices of women's leadership roles in mangrove restoration, disaster risk management (especially flooding) and in agriculture and food security;

- **Burkina Faso:** Local stakeholders (elected officials, government officials, civil society organizations, and women's groups) have been trained on how to mainstream gender and climate change into the drafting and implementation of local development plans. The local stakeholders have developed an integrated advocacy strategy and commit to mainstreaming gender and climate change in the decentralization reform processes initiated by the government at the communal and regional levels;
- **Kenya:** The AAP has initiated a process to mainstream gender into Kenya's climate change response strategy. Interventions that empower women to positively adapt to the adverse impacts of climate change have been designed. National guidelines for mainstreaming gender in adaptation programs have been developed as a pilot project that will be adopted for use with the other AAP countries.

- Practice regular audit and independent evaluation of the gender impacts of funding allocations.

To ensure balance between mitigation and adaptation activities and gender responsive delivery, its needed to perform regular external audits to verify through a third party the progress of the project against the different gender requirements.

An example of this verification process would be the revision which Gold Standard for the Global Goals (GS4GG) performs during the registration and verification of climate change mitigation projects. This standard requires that all the projects to be registered under its protocol must comply with a number of mandatory Gender-Sensitive Requirements and establish the process to follow during the design of the stakeholder consultation to guarantee that the gender equality is respected.

- **Mitigation**

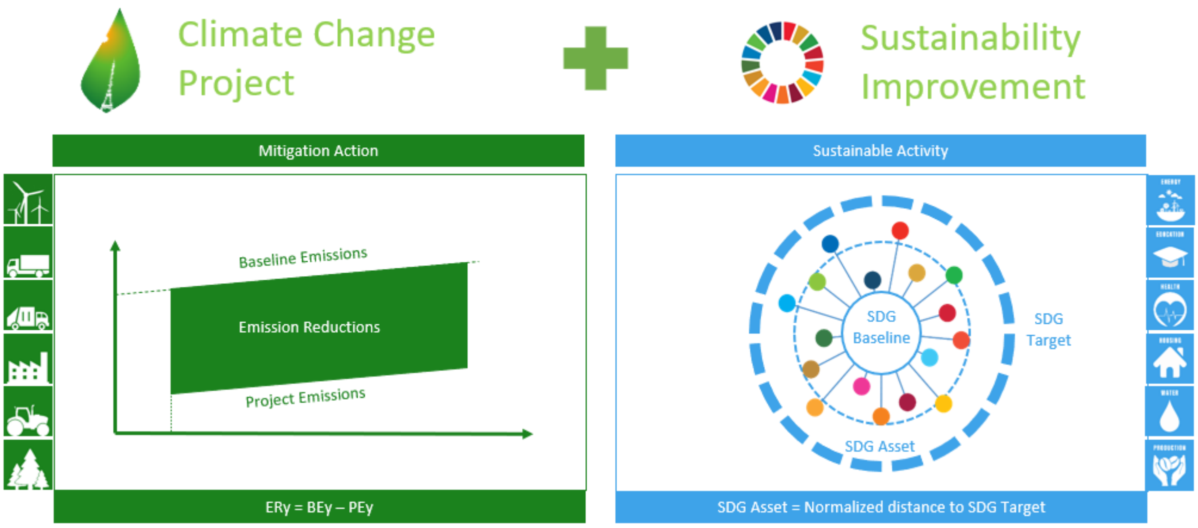
- Use of Clean Development Mechanism (CDM) projects considering gender equality and women's empowerment as a catalytic principle for achieving SDGs

In total, there are 253 CDM projects currently working in Africa, 222 already registered, reducing 280,327 ktCO2 during the period 2013 – 2020.

Currently, 19 CDM Projects currently registered and operating in Uganda, with an expected accumulated amount of 10,236 ktCO_2 until 2020. The average issuance success of these projects is about 74%. 3 of these projects belong to the waste management sector: Mpererwe Landfill Gas Project, Anaerobic digestion and heat generation at Sugar Corporation of Uganda Limited and Nakivubo Wastewater Treatment Plant Methane Capture and Utilization Project.

Actually, a CDM Project or any other Climate Change Mitigation Project needs to take action and obtain certification in the following two scopes: GHG emissions reduction and Sustainability Improvement, aligned with the National NDCs, the United Nations SDGs and the National 2030 Agenda:

Figure 3: Alignment between climate change projects and SDGs



Source: Own elaboration

For example, Mpererwe Landfill Gas Project, the unique CDM project registered in Uganda, is located 13 kilometers north of Kampala city center and promotes the Landfill gas extraction and flaring, controlling gas both in terms of risk from explosion and for reducing harmful emissions of greenhouse gases. The benefits which this project provides, aligned with the SDGs are the following:

Table 3: Mpererwe Landfill Gas Project, the unique CDM. SDGs mapping

13 Climate Action	Reduction on GHG emissions
9 Industry, Innovation and Infrastructure	Introduction of new landfill gas management technology into Uganda
15 Life on Land	Restoration of the site to a beneficial after-use
4 Quality Education	Training of local staff to become experts in the monitoring and control of landfill gas
8 Decent Work and Economic Growth	Provision of a number of employment opportunities relating to the operation and maintenance of equipment.

The SDG 5 "Gender equality" is not among the SDGs of this projects, however, this SDG and others can be integrated in during the validation of CDM, Gold Standard for the Global Goals or Verified Carbon Standard projects. These climate change mitigation standards already have tools and methodologies to monitor and verify the progress and contributions of the project activities to the different SDGs.

Additionally, to these general recommendations, the ALLCOT team built a desired and detailed Integrated Solid Waste Management (ISWM) as a gender equality approach proposal for Kampala specificities based on the principle that avoiding waste is the preferred option and the least preferred is disposal. Thus, waste management systems should be designed in this way to be sustainable.

Prevention and minimization require changes in policies´ development, consumption and lifestyle patterns.

A specific gender mainstreamed Integrated Solid Waste Management proposal

As Uganda's socio-demographic, economic and environmental factors change coupled with the drive to attain developed country status, it is important that policy makers embrace a thinking of converting waste into resources. Ultimately, the goal should be to have a waste free society within a practical timeframe. Achieving this status will require a culture shift and a comprehensive package of strategies gender mainstreamed by community involvement of women voices, waste management business structure and prevention schemes that take into account women central and educational position for waste management within households as well as reduction, and resource recovery strategies actively inviting women to be part of the ISWM.

ISWM represents a contemporary and systematic approach to solid waste management. The U.S. Environmental Protection Agency (EPA) defines ISWM as a complete waste reduction, collection, composting, recycling, and disposal system. Furthermore, it is peremptory to add to this definition that an efficient and effective ISWM system has to consider how to reduce, reuse, recycle, and manage waste to protect human health and the natural environment by having gender perspective lenses and therefore by adding gender mainstreaming strategies to all core aspects of the diagnose, design, implementation, monitoring and evaluation stages.

It involves evaluating local conditions and needs disaggregated by sex. Then, choosing, mixing and applying the most suitable solid waste management activities according to the specific technical and cultural conditions.

(1) Functional Elements of Integrated Solid Waste Management

The main components or functional elements of ISWM include source reduction, recycling and composting, energy production, waste transportation and landfilling. These waste management activities should be undertaken hierarchically. Brief discussions of each of these functional elements of ISWM are described below:

a. Waste Source Reduction

Source reduction, also known as waste prevention, aims to reduce unnecessary waste generation. A significant component to successful waste reduction programs is public participation therefore, recognizing and understanding the factors that influence in specific women participation is important in the effort to identify and promote an integrated sustainable solid waste management solution. Within the realm of household solid waste management, even if individuals are considered the primary waste generators and primary users of the waste management system, it will be peremptory to disaggregate women and men interactions with waste in relation to generation and use. Adding gender specific perspective as well gender specific activities that will take into account women central role in household decisions over waste as well as women sociocultural and economic participation barriers have to be properly involved in waste management solutions for the ultimate goal of developing strategies that will enable long-term commitment and participation. Consumers have a role to play, e.g. by refusing to choose or use products that carry waste implications and in this role to play, women in their mothers and educators role can be the most express mean of communication as well as the actors with the biggest influence in community and families patterns over waste reduction.

Additionally, waste source reduction requires that the range, composition and design of products change in order to reduce waste through reduced resource demand and/or improved quality, i.e. improved manageability or reduced use of hazardous materials. These changes are at the heart of the waste management challenge and constitute the starting point for sound waste management policy. Improving knowledge and understanding of waste prevention and related concepts is the first step to study. In addition, for doing this, any project aiming at waste source reduction has to take into account how do women live and experience the sector differently from men due to the socialization of specific tasks in the head of women who are culturally set to be responsible for household duties.

Source reduction strategies may include a variety of approaches, such as:

- Products that are designed for recycling, durable, sustainable products or in concentrated form.
- Educational programs directed to the community with specific activities directed to women involvement and active participation such as taking into account women household duties agenda, women sociocultural participation barriers and working upon those in order to effectively have women voices in relation to the design and enforcement of this sociocultural mind-set change for improving the creation of reusable goods, including reusable packaging, as reuse increasingly becomes an important component of the culture and therefore of the circular economy.
- Programs run by women associations or organizations directly aimed at the refurbishing of goods to prolong their useful life with specific training activities that will enhance women capabilities and social transformation mind set of gendered labour division.
- Redesign of goods and utilize less or no packaging.
- Transformative educational programs directed to teach and equilibrate the responsibilities of reduction of food spoilage and waste through better attention of food processing and storage in the head of both women and men in each household.
- Avoidance of goods that does not last long and cannot be reused or recycled, such as Halloween decorations.
- Waste source reduction helps us to lessen waste handling, transportation, and disposal costs and eventually reduces methane generation.

b. Waste Separation

Source separation, meaning that goods and materials are separated out from the waste stream at source, is paramount for successful re-use, recycling, composting and anaerobic digestion.
In Uganda, there is negligible separation of solid waste which often has recyclable and re-useable (valuable) materials mixed with other types of garbage. The crushing together of garbage in this manner has the potential for hazardous materials to get dispersed through thousands of tons of garbage at the disposal site.

Separation at source has two main benefits: it enables the value of re-usable goods and recyclable materials to be recovered efficiently; and the composition is less mixed and therefore less in need of sorting, reducing the problems of dealing with waste downstream, where sorting is more difficult and expensive. Source separation is centrally important to the application of the waste hierarchy. To be effective, source separation requires the active cooperation of the entire population, which in turn requires considerable outreach, engagement and specific attention to public education directed to counterbalance women and girls' particular barriers and gaps as well as breaking up with the gender hierarchy that dismisses soft labour or soft activities. Indeed, these non-technological and non-infrastructural elements, too often are neglected and disregarded because society qualifies them to be "soft" while they are in fact the key to successful waste management.

In general, as previously detailed, women are not paid to handle waste, while men only do so when they are to be paid. Due to their less mobility and access to public spaces, some women, who cannot leave their homes for cultural or religious reasons, will find it difficult to deliver waste to a neighbourhood collection point. Therefore, in orientating and directing policies, is important to consider the specific needs of women to ensure that they can have equitable and affordable access to facilities and services (T.T. Poswa, 2004). All these are issues that need to be addressed when planning waste management systems in terms of waste collection and separation.

A study performed in South Africa by T.T. Poswa (2004), from the Durban Institute of Technology (DIT), Department of Environmental Health researched about the significance of socio-economic and gender aspects of the community in the provision of domestic solid waste services. The research sample consisted of an initial sample size of 400 households from Fortgale (high income); Northcrest (middle income) and Ngangelizwe (low income). An important observation was that women in most homes in the middle and low socio-economic status suburbs in the study area were more active in the enquiry. This was interpreted as indicating their active role in family affairs including waste handling in their respective homes. The study found that women predominantly from the low socioeconomic suburb constituted 81% of the total unemployed respondents in the study area.

There were great differences between men and women on the choice of type of waste collection service system. Women preferred a door-to-door waste collection system unlike men whose choice was a drop off center. This difference can be attributed to the cultural traditions, which govern gender relations in the households. Women in most of least developed societies are responsible for the domestic work, which include many tasks including childcare, shopping, cooking and cleaning. This obviously affects their mobility and suggests a convenient waste disposal method. The understanding of the mobility of households is paramount for the design of waste collection points. A gender sensitive waste service program is the one that empowers and gives due importance to the knowledge on waste separation of women who cannot leave their homes to dispose of waste at a distant waste collection points. Added to the above is the need to design user-friendly and sustainable waste collection systems/containers that are accessible to all users. According T.T. Poswa (2004), one of the shortcomings of the current solid waste collection systems is their male bias regardless of the fact that women constitute the majority of the service recipients. Waste is not a neutral concept but should be understood within the cultural context realizing that within the same society, same household, men and women and children may have differing perceptions and views about what is regarded as waste. For this reason, it is essential to define what constitutes waste and could be put out for collection with the ultimate aim of final disposal and separation can be performed in a responsible manner.

c. Recycling

Recycling and composting are crucial phases in the entire ISWM process. Recycling is a series of activities that includes the collection of used, reused, or unused items that would otherwise be considered waste; sorting and processing the recyclable products into raw materials; and remanufacturing the recycled raw materials into new products. Consumers provide the last link in recycling by purchasing products made from recycled content. Recycling also can include composting of food scraps, yard trimmings, and other organic materials. Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for the future of children, and reduces the need for new landfills and combustors.

According Buyana (2015), the re-use of waste involves using a product or package more than once or re-using it in another application. Examples of re-use include re-using supermarket consumer bags, glass milk and water bottles, re-trading partly won tires or selling car scrap to merchants. Reusing extends the life of the material used and therefore reduces the waste quantity requiring treatment and disposal. However, waste re-use can be affected by consumer preferences that may be different in the case of women compared to men. Men and women value waste materials differently and see their usefulness for different purposes, such as domestic utility, saving on household expenditure, earning money or other purposes. Such issues are at stake in the field of gender and urban natural/social resources important in local livelihoods. Who uses which resources? Who controls decisions about how resources are used? Who is helping to sustain local resources and who benefits from this? How is the situation changing?

For example, in East Africa urban centres, wastes of value such as plastics, cardboards and scrap metals separated stating at source, at transfer points, on transit and at disposal sites. Some of the separated wastes are sold to artisans and women groups who convert them into goods such as hats, bags, necklaces, baskets, door rugs, mats and seedling cups that are sold to the community as crafts (James Okot-Okumu, 2012).

Recycled wastes, from the left to the right: bags; necklaces; tree seedling in plastic cups, hats and baskets, all from plastic wastes and bicycle carrier from scrap metals. Source: James Okot-Okumu, "Solid Waste Management in African Cities – East Africa". Department of Environmental Management; School of Forestry Environmental and Geographical Sciences; College of Agricultural and Environmental Sciences; Makerere. University Kampala, Uganda (2012).

Some creative and modern examples of plastic recovery, recycling and reutilization activities that were introduced during the social consultation phase to the different actors of the WM and PR sectors had special interest from public and private organizations and received specific attentiveness from the Uganda Housing Cooperative Union, an NGO that is already supporting projects such as "Charcoal Briquette" run by a women social enterprise that works with local communities from whom they buy charcoal produced from banana leaves and peelings using drum kilns. This NGO was particularly interested in possible partnerships, institutional or human development support to implement the exposed projects in the country. These projects are:

- **Plastic Bank:** has the objective to create a positive social and environmental impact in areas with high levels of poverty and plastic pollution. IBM provide an Information Technology (IT) environment system on LinuxONE based on Blockchain that monetizes plastic waste recovered and records transactions at the micro-level. They form the credits that waste collectors use to earn useful goods that could help them to transcend poverty.

  Recycling infrastructure in many countries like Africa is part of the informal economy. Any women who work in the informal economy lack financial security due to the absence of labor laws and health benefits. Plastic Bank is bringing formality to an informal sector by providing the opportunity for plastic collectors – 45% of which are women – to exchange plastic waste for everyday necessities, as well as school tuition and health insurance. This business strategy is revealing the value in plastic, enabling collectors to build better futures for their families and communities.

- **Ecobuild**: plastic Bricks for Sustainable Housing. The aim of this organization is to recycle plastic waste and processes it into bricks to build sustainable houses. The technology uses the extrusion process by mixing different waste plastic creating bricks and other construction materials.

  This provides a solution incentivizing proper collection and disposal of certain types of plastic waste and offering an affordable product to the underserved gap housing market. An application example of this technology would be the affordable housing sector in Africa, due to the fact that low income houses demand is increasing across Africa giving the rapid urbanization.

  This project aims to integrate waste recycling economies and the informal housing industry into a decentralized circular economy system. Its main characteristics are:

  - Recycling plastic with a low technological procedure to be achieved by fairly simple machines.
  - Knowledge, tools and machinery drawings and techniques.
  - Market-based solution being used at scale and replicated.

  This business would provide the opportunity in Uganda to give an alternative outlet to recycled plastic, formalizing informal plastic collectors in a new market and industry.

- **Bloqueplas**: plastic recycling project for city halls. It consists in the construction made from beams, blocks and columns obtained with the plastic extrusion process. These materials have thermo-acoustic properties, earthquake resistance and high durability. Its main features are:

  - 30% cheaper construction system with a more accessible raw material.
  - Simple mounting system with high strength.
  - Reduces plastic waste in landfills, and with it, water, energy and CO_2 emissions.
  - This technology can be used for households, roads or highways and anti-vandalism luminaires.

Building a house using Bloqueplas material. Source: Own elaboration

The project is aligned with the 2030 Agenda. The project contributes to increasing the resilience of the country to the climate change, and because of that, will obtain a number of benefits aligned with other SDGs: no poverty, good health or gender equality, among others:

- SDG 1 – No Poverty: Collectors of waste will receive a fair and stable source of income for the plastic they collect.
- SDG 2 – Zero Hunger: By unclogging the water basins, agriculture can be benefitted by reducing elevated food prices. By removing plastic waste from the river, the available (uncontaminated) flooded area for rice fields and the water quality for other food collection activities in the river will increase, such as the collection of oysters.
- SDG 3 – Good Health & Well-Being: By removing plastic from water supplies and reducing the amount of incinerated material helps to create cleaner living environments.
- SDG 4 – Quality Education: A training programme for collectors (and any community identified and involved in the project) will be implemented as part of the project in the matter of circular economy, new livelihoods and wealth creation in rural areas that will increase the education of the local communities in the area. The project will create direct employment of the local communities involved in the project and all the training necessary shall be done. The project will promote a working family model where both men and women can actively participate in the project, improving the empowerment of the women. Organization of associations in different activities related to the wastes recycling will be made, and can imply an extra income to the communities.
- SDG 5 – Gender equality. Promoting a working family model where both men and women can actively participate in the project, improving the empowerment of the women.
- SDG 6 – Clean Water and Sanitation: The removal of plastic from waterways reduces the toxicity of local water supplies and increase the awareness of the local communities about the importance of the protection of the rivers and water courses.
- SDG 8 – Decent work and economic growth. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all through the generation of the employment. Successful green development requires entrepreneurs because economic transformation and green growth depend on implementing new ideas, creating new business models, and promoting innovation, so, this new business will contribute to the economic growth of all the municipalities involved in the present project, and hence, at national level.
- SDG 9 - Industry Innovation and Infrastructure: In Colombia there is not an integrated waste disposal infrastructure, so the projects implemented in different municipalities

will connect local transporters, plastic processors, freighters, and other industry members to create a circular recycling industry. From an innovation perspective, the project can use blockchain-based technologies like Smart Contracts to create an infinitely scalable, decentralized, and autonomous banking system.

- SDG 10 - Reduced Inequalities: Using the blockchain-based platform, waste collectors will be able to open a secure digital banking account without fear of corruption or theft. This level of financial inclusion is key to bridging the gap between the developed world and the impoverished.
- SDG 11 - Sustainable cities and communities. The importance of solid waste management for sustainable, healthy and inclusive cities and communities taking into consideration that global annual waste generation will increase from 2.01 billion tonnes in 2016 to 3.5 billion tonnes in 2050. The project will introduce sustainable, circular economies to replace the linear, wasteful models currently in place in developing regions.
- SDG 12 – Responsible consumption and production. The project will ensure sustainable consumption and production patterns. The marketing campaign and the awareness training programme with ensure that the local communities have the information needed to ensure a higher sustainable consumption. The project can be incorporated into the supply chains of companies to reduce the demand for virgin plastic and alleviate the environmental effects related to plastic production. Consumers can identify the project on product packaging to help guide their responsible consumption choices.
- SDG 13 – Climate action. The project is taking immediate action to combat climate change and its impacts. Recycling saves energy and prevents extraction of raw materials, helping to combat climate change as mitigation action reducing waste, and therefore pollution. Recycling reduces environmental impact as a whole, contributing to a "green" mentality and more sustainable lifestyles overall, and creating a reception center and the manufacturing of the bricks will generate a source of material to adapt to climate change and to increase resilience.
- SDG 17 – Partnership for the goals. The creation of an alliance between different countries (Uganda, Ghana, Colombia and Spain) and private and public companies working together to build an adaptation project in a Least Developed Country.

These strategies in plastic recycling are important opportunities for women empowerment through a new industry using discarded plastic, mainly from Polyethylene terephthalate (PET) bottles from sources like dumpsites, community centers and schools. By recruiting and training women that have been unemployed or have been plastic collectors in the informal sector, these projects can help to address the plastic waste pollution problem in Kampala but also provide a formal employment to one of the most vulnerable groups of the Ugandan society.

In social terms, while many of the women of these groups have a low education at the outset, plastic recycling and household construction provide extensive training that helps them develop a wide range of transferable skills, which enable women to move on to further education or other employment. Moreover, with the stable income they could earn through these projects, the women could better support their families.

From the economic point of view, plastic recycling and household construction can develop a new value chain in the waste management sector. The model should link waste collectors (women and men considering a gender equality approach) from dumpsite, community members from waste collection associations and women producers and managers directly with international retailers. By increasing the income of all those involved along the value chain, these plastic recycling projects can increase the purchase power of people in the poorest areas of Kampala, especially women. In addition, each bottle that is recycled saves municipal costs on waste management (Heuër, A. 2016).

Finally, the main environmental objective is to reduce plastic waste pollution by cutting the number of PET bottles ending up in landfills or being illegally dumped in the environment. At the same time, these plastic recycling and reutilization projects raise awareness on environmental issues and entrepreneurship. They can organize information days in schools and through campaigns with the waste collectors, community centers, and the poorest communities would be informed about waste management and recycling opportunities (Heuër, A. 2016), always from a gender perspective.

d. Waste transportation

Waste Transportation is another waste management activity that must be integrated systematically with other waste management activities to ensure smooth and efficient waste management and also a stage that has to be analysed through gender lenses due to the unequal situation of women discrimination in this activity. Transportation typically includes the collection of waste from curbside and businesses, as well as from transfer stations where waste may be concentrated and reloaded onto other vehicles for delivery to the landfill and most of these activities are socially only allowed for men to perform while considering women not capable of executing.

As the quantities of the Municipal Solid Waste (MSW) grow and the travel distances to their management facilities increase, the cost of direct transportation by the collection vehicles becomes increasingly expensive. From a point onward, the transportation becomes more affordable though the use of transfer stations that will also improve women geographical access by diminishing the distance length they have to do. The latter receive the waste of collection vehicles and transfer it to large trucks, tractor-trailers, semi-trailers, railroad cars and/or barges for economic long-distance transportation. Transfer stations without waste compression are the simplest to construct and require limited investment. However, most modern transfer stations provide waste compression, as this reduces the transportation costs enabling the howl vehicles to transport heavier net pay loads. The latter are usually of the order of 19.5 t, but this depends on the applicable gross weight limits of the roads and on the vehicle design and configuration.
The security in this waste transfer stations and along waste transportation routes becomes more important from a gender equality point of view. Women face particular risks. Street waste collection and transportation often takes place at night or the early morning, and working in the dark leaves them

vulnerable to harassment or abuse. They often lack access to toilets while they are working, and have not place to rest for a break. This can be even more difficult during menstruation or pregnancy when they may continue to have to deal with heavy workloads. These poor working conditions and inequalities for women remain overlooked. This is partly because women have low bargaining power as they participate and engage less in policy, planning, programming and decision-making by national departments, municipalities, recycling companies or other employers (Uttam Kumar Saha, 2019).

Working with the existing informal sector, both women and men, is needed to help them to establish themselves as entrepreneurs, and have a formal space to engage with municipalities. Supporting them to improve their relationships with larger recycling companies is also important given the WM and PR business structures. And it should be done through performance-based service-level agreements between waste co-operatives and municipalities.

e. Composting of organic fraction

Composting a component of organics recycling, involves the accumulation of organic waste and converting it into soil additives. For example, according to Allan J. Komakech et.al around 90% of the waste generated in Kampala is organic waste and comes from household units and markets where women are socially the head of both places and activities. Therefore, working on composting which is a relatively simple process has to be directed for actively involving women and therefore effectively and efficiently help nature to take its natural course. The optimization efforts increase the rate of decomposition (thereby reducing costs), minimize nuisance potential, and promote a clean and readily marketable product.

Composting is highly compatible with other types of recycling. Diverting organic material helps to increase the recovery rate of recyclable materials, while at the same time, recycling programs for glass and plastics, which are common MSW compost contaminants, improve the quality of the finished compost. Household source separation of recyclable paper, metal and glass is already common in many developing countries.

Many cities in developing countries are plagued with poor waste collection systems and structures. While a few, more influential residents may get daily waste collection, others may never have such services. Daily waste collection in wealthy neighbourhoods is usually too frequent and contributes to the lack of collection in poorer areas. In more affluent areas of a city, the use of containers and diversion of organic waste for composting is a good way to quickly improve the city’s overall waste collection service. Many cities have switched from unreliable daily collection to bi-weekly organic waste collection and weekly non-organic waste collection. Variations of this schedule are easily tailored to each area’s individual characteristics specifically adding women care and household sociocultural responsibilities’. Introducing waste diversion for composting programs provides a city with a unique opportunity to improve its overall waste collection service.

f. Energy from waste

Due to the high moisture content and low caloric value of organic waste, incineration will not be an economical option in Uganda. Thus, the treatment of MSW to generate energy can be achieved alternatively by Anaerobic Digestion (AD) and Landfill with Gas Capture for Energy Generation. An example of this type of technology is the Landfill with Gas Capture and Energy generation, broadly applied by the CDM projects activities registered under the UNFCCC in the waste management sector.

Landfills are a significant source of greenhouse gas emissions, and methane in particular can be captured and utilised as an energy source. Organic materials that decompose in landfills produce a gas comprised of roughly 50% methane and 50% carbon dioxide, called landfill gas (LFG). Methane is a potent greenhouse gas with a global warming potential that is 25 times greater than CO_2. Capturing methane emissions from landfills is not only beneficial for the environment as it helps mitigate climate change, but also for the energy sector and the community. Applications for LFG include direct use in boilers, thermal uses in kilns (cement, pottery, bricks), sludge dryers, infrared heaters, blacksmithing forges, leachate evaporation and electricity generation, to name a few. LFG is increasingly being used for heating of processes that create fuels such as biodiesel or ethanol, or directly applied as feedstock for alternative fuels such as compressed natural gas, liquefied natural gas or methanol.

g. Waste disposal in sanitary landfills

Waste disposal, in particular through the use of sanitary landfills, at the bottom of the hierarchy, is the management option proposed for the remaining fraction of waste when all forms of diversion, recycling and valorization are exhausted.

It also has the important function of removing unwanted materials from the life-cycle for a final safe and secure storage. Disposal facilities and operations are not all the same: there is a hierarchy of sophistication and reliability of measures applied to protect the environment. At the top of the disposal hierarchy is the landfill, an engineered facility featuring various controls installed to prevent releases of pollutants to soil, water and air. A controlled disposal site (or controlled dumpsite), officially designated for the purpose, is next in the hierarchy. The site is fenced and access is controlled, with some form of control and registration of incoming waste, and basic operations management at the site. An uncontrolled dumpsite is third in the disposal hierarchy, below the level of acceptability but common in low and sometimes middle-income countries as in the case of Uganda.

It is important to phase out open-burning dumpsites and convert to controlled disposal facilities, even if they do not meet modern engineering standards. The internationally accepted approach in this regard is progressive rehabilitation to upgrade and phase out uncontrolled dumpsites.

(2) Contributions of an Integrated Solid Waste Management to sustainable development

Actively working on affirmative actions to add women voice and participation to prevent the generation of waste and waste management, illustrates waste management top hierarchy by positively impacting broader principles and concepts of sustainable development. Some examples illustrating how gender mainstreaming activities in waste management contributes and enhance sustainability as shown below:

- Gender mainstreamed waste management policy will have a wider potential to contribute to all three “pillars” of sustainable development (environmental, economic and social): by adding women labour force economic efficiency, especially in resource extraction and use (e.g. through waste prevention, reuse, recovery or recycling); by reducing the budget needed for solid waste collection services; by creating educative programs that take into account women specific needs and barriers for reducing or eliminating adverse impacts on health and the local and general environment; by delivering more attractive and pleasant human settlements and social amenity that respond to women infrastructure needs; and by creating women specific sources of employment it will be translated into a route out of poverty for the most vulnerable members of the community.

- Waste management delivers benefits to subsequent generations, by providing them with a more diverse and robust economy with women participation that will translate into a fairer more inclusive society and a cleaner environment, thereby facilitating gender equity.

- Sustainable waste management can provide opportunities to the most vulnerable women by enabling informal women waste pickers to earn a sustainable income. Waste management activities can deliver significant economic and social benefits by improving individual autonomy and social recognition for the people concerned.

- Policies that are careful, balanced and integrated give effect to other principles of sustainable development, such as the precautionary principle.

(3) Commercial and implementation viability elements of the proposed ISWM

Based on the Integrated Solid Waste Management (ISWM) program proposed ALLCOT has conducted a high-level financial analysis of the solid waste collection (including waste source reduction, separation, recycling and transfer) and disposal (including composting and other means of treatment/resource recovery, including waste to energy systems as Landfill Gas to Energy and Anaerobic Digestion) systems.

This shall include a validation of capital requirements estimated by others (in unsolicited proposals), if any, for new transfer, disposal, and treatment facilities and incremental pre-collection, recycling, collection and transfer vehicles and equipment.

The main components or functional elements of ISWM include source reduction, recycling and composting, energy production, waste transportation and landfilling. These waste management activities should be undertaken hierarchically and its commercial viability have been discussed to include estimates of capital expenditure (CAPEX), the use of tariffs or viability gap funding, if applicable. Cost savings or affordability for the administration, including the measures to fund a viability gaps or to maintain any operating function have been demonstrated for each of the functional elements of the proposed ISWM:

a. Economics of Waste Source Reduction

A significant component to successful waste reduction programs is public participation, and recognizing and understanding the factors that influence participation is important in the effort to identify and promote an integrated sustainable solid waste management solution. Consumers, industrial and large commercial waste generators have a role to play by refusing to choose or use products that carry waste implications and the involvement of tipping fees, licence fees as well as an increase in taxes is crucial for waste source reduction.

- **Current waste collection system**

According a study performed by the Global Green Growth Institute (Uganda 2018), in June 2015, KCCA divided the city into 7 zones and awarded three private waste collection companies 5-year concessions that give exclusivity to the concessionaire to collect all waste in a well-defined geography within the city. According to the contract, private companies can charge households from 3,000UGX up to 30,000UGX ($0.80 – $8.30) per month for waste collection depending on quantity and frequency of collection. Some companies who did not participate in the bidding process have challenged the validity of the KCCA waste collection concessions and continued to collect waste in the gazetted areas. KCCA refers to these companies as “Errant companies” and they include some of the oldest names in waste collection such as BINit, NOREMA and newer ones such as Asante. When KCCA failed to enforce exclusivity, tensions between concessionaires and errant companies escalated into deadly violence.

KCCA is the largest collection company with capacity of 24 trucks. In 2017, KCCA spent 5.3BnUGX ($1.5mm) to collect 263k tons of waste or 55% of the total waste delivered to the landfill. In total, the private sector collected 45%. The three concessionaires accounted for 32% while errant companies accounted for 13%. Private sector participation has increased dramatically from 33% in 2016 and 30% in 2015 and is expected to continue to increase as the concessionaires slowly increase their capacity and improve efficiency. However, even with sufficient capacity, private sector players are faced with numerous challenges and KCCA will remain the largest collector if these persist.

Table 4: *Details about the main waste collectors in Kampala*

Collection Company	No. trucks	No. workers	No. female workers	Quantities Recovered in 2017 (tons)
KCCA	24	n.a	n.a	263,126
Nabugabo	26	360	90	65,846
Homeclean	40	400	200	58,691
Kasasiro	19	103	10	28,660
Errant companies	40	n.a	n.a	64,759
Total	**149**			**481,082**

Source: Kampala Municipal Solid Waste Value Chain Mapping. Global Green Growth Institute (Uganda 2018)

According to the Global Green Growth Institute, the key challenges faced in collection of MSW in Kampala are the following:

- Low willingness to pay: Low income households, mostly in semi-formal and slum areas, make up a significant portion of the households in Kampala. These households find the waste collection fees too high and moreover, KCCA has failed to enforce payment in these areas due to political pressure. Concessionaires are therefore more incentivized to collect waste in wealthier suburbs and from institutions that are willing to pay for the service, leaving KCCA to fill the gap

- Poor infrastructure: In many slum areas and informal settlements, there are no access roads. In such cases, collection trucks use the “bring to truck” model, where residents either take their own trash to the truck and pay 500UGX ($0.13) to a local porter to transport their trash on a wheelbarrow to the truck. This can end up being more expensive than paying a waste collection company depending on how many times they dispose of trash.
  Due to poor infrastructure, open dumpsites are commonplace in high population areas. In 2015, there were 59 illegal dump sites in Kampala, 133 unofficial temporary storage sites (these are acknowledged by KCCA but not formally designated for waste storage), and 35 official temporary waste storage locations (these are officially recognized by KCCA).

- Hostile political climate: In certain areas (especially the most impoverished ones), local politicians gain political favor by discouraging citizens from paying waste collection fees, claiming that it is the duty of KCCA to collect waste at no fee

- Citizens lack sensitization: Waste management is a relatively new concept in Kampala and many people still do not understand the value of organized waste management systems. It is common to see a driver/passenger throw an empty can out of the window on the highway and littering in the streets is quite acceptable. Furthermore, about 70% of Kampala residents are renters who shift houses frequently. It is therefore necessary to carry out sensitization campaigns several times a year in the same community, which waste collectors find too costly.

- Collectors have limited capacity: Concessionaires are still building their internal capacity in terms of number of trucks and workforce necessary to cover their zones. It is also clear from the volumes collected that their efficiency is still lower than that of KCCA.

- **Proposed source reduction strategies and "polluter pays" principle**

To solve these problems, the need for regulations under the 'polluter pays' principle is required in Kampala to fund solid waste activities to increase revenues and reduce waste generation. Other than economic strategies, source reduction strategies may include a variety of approaches, such as:

- products that are designed for recycling, durable, sustainable products or in concentrated form.
- reusable goods, including reusable packaging, as reuse and increasingly becomes an important component of the circular economy.
- refurbishing of goods to prolong product life, another important component of the circular economy model.
- redesign of goods and utilize less or no packaging.
- reduction of food spoilage and waste through better attention to food processing and storage.
- avoidance of goods that don't last long and can't be reused or recycled.
- waste source reduction helps us to lessen waste handling, transportation, and disposal costs and eventually reduces methane generation.

Waste source reduction requires that the range, composition and design of products is changed in order to reduce waste through reduced resource demand and/or improved quality, i.e. improved manageability or reduced use of hazardous materials. These changes are at the heart of the waste management challenge and constitute the starting point for sound waste management policy. Improving knowledge and understanding of waste prevention and related concepts is a first step, both within the waste management sector itself and more broadly with regard to the public.

Cost recovery measures for the KCCA as a regulator need to be determined together with the identification of effective and efficient mechanism to pay for solid waste management services to benefit the waste source reduction strategy.

The need for regulations for tipping fees and licence fees as well as an increase in taxes to fund solid waste activities would need to be implemented to increase revenues and reduce waste generation. Kampala needs to ensure that there is accountability and transparency in the implementation of SWM programmes: fees collected for solid waste management should be kept separate from funds of other services and should be used only for gender mainstreamed development strategies of the sector.

The definition of tariffs is not an easy task, and lack of information is an issue from determining the real SWM costs and from fixing the pay to be paid for collection and disposal services.

The 'polluter pays' principle is the basis on which the system should be operated so that the waste generator is always cognizant of the fact that a cost is associated with the management of waste and can start thinking on waste reduction principle to avoid paying more. Incentives, penalties and public education should complement these initiatives with a view to reducing waste generation and illegal dumping.

KCCA will earn revenue from fees to license solid waste management companies, collection vehicles, disposal sites and waste processing facilities. Additionally, revenue may be generated from the operation of recycling enterprises. At little or no cost, KCCA should adopt ‘polluter pays’ principle: The primary cost may be in the preparation and adoption of principle and subsequent monitoring of its outcomes. Monitoring costs can be minimized if proper reporting and evaluation requirements are included in the design and adoption of ‘polluter pays’ principle.

The KCCA could incentivize minimization at source using deposit or refund schemes, which involve legislation that requires the producers/importers of a particular package to include a deposit in the price of their product. They must then take back the empty container and refund the deposit to the consumer/retailer. This provides an incentive to bring containers back to collection points, reduces the cost of collection and recycling, and greatly reduces the amount of carelessly discarded waste. It will be peremptory to take into account women transportation barriers, violence and hours threads as well as sociocultural roles for the design and implementation of those collection points.

As example, the manufacturer of glass and plastic bottles should have a return on deposit system in place which rewards the returns of these products with cash. With the inclusion of plastic bottles, very little of these recyclable products will end up at disposal sites since individuals would have an incentive to return these forms of waste at designated collection points to reduce waste. Additionally, taking into account the potential negative impact of the decrease of plastics bottles for women waste pickers, private companies will should be encouraged to actively involve these women into the return system and create flexible strategies to bring these women to the proposed model.

Waste avoidance can also be increased through a change in consumption patterns and this could be encouraged as part of the healthy lifestyle campaign. Given the high organic content of domestic waste, home composting of such wastes could be linked to the composting waste management approach as an effective measure in waste prevention.

b. Economics of Waste Separation

Source separation, meaning that goods and materials are separated out from the waste stream at source, is paramount for successful re-use, recycling, composting and anaerobic digestion.

- **Current waste separation practices**

According the Global Green Growth Institute (Uganda, 2018) nearly all waste collected from households and institutions is mixed or unsorted waste. When a waste collection truck picks up waste, the collector's employees or "**Loaders**" quickly rummage through the waste and extract as much of the valuables as possible; most especially plastics (e.g. PET bottles, plastic containers, polyethylene bags or "kavera") and metal (e.g. aluminum, copper and steel). The loaders pack the valuables into separate bags and tie them atop the collection trucks and sell them to waste dealers located on the roadside in-route to Kiteezi landfill. Since sorting is not part of their official job description, the loaders' segregation efforts are minimal and haphazard which is why much of the valuable waste ends up in the landfill after all.

On the last stretch of road nearing Kiteezi landfill, there is a row of **scrap dealers** who weigh and buy the bags of mixed recyclables off the trucks at a fixed price of 200 UGX ($0.06) per kilogram. There are about 14 such businesses on the roadside, 10 of which are female owned. These businesses employ on average 4 workers each, who earn 6,000 UGX ($1.67) per day; more than half of the employees are women. These scrap dealers are organized under the Scrap Association and their take home profit in can be up to 1.3mm UGX ($360) in a month. Scrap dealers clean and further sort the waste for sell to recyclers or larger brokers.

Street pickers are itinerant waste pickers who roam around neighborhoods in the city collecting recyclable waste for sale to waste brokers or recyclers. This group of people is mostly comprised of unemployed women and youth and some have found modest success despite the stigma they face from participating in waste picking.

At Kiteezi landfill itself, there are 1,000+ waste pickers manually sorting through the waste and picking out the most valuable items for sale to waste brokers. Half of these pickers are organized under the **Landfill Waste Pickers Association**, which has around 500 registered members, 78% of whom are women. The clear majority live around the landfill and about 60% of them moved to Kiteezi mainly for the business of waste picking. About 300 members show up daily (the equivalent of full time), and 250 of them pay membership fees to the organization. Most of the waste pickers are independent workers but a fraction of them are employed directly by scrap dealers for a daily wage of 6,000 UGX ($1.67). The pickers sell the waste to specialized scrap dealers who are usually located near the landfill themselves, and are typically specialized in one sub-value chain e.g. cardboard or PET etc.

The **Community Based Organizations (CBO) model** is new to Kampala's MSW sector. It was introduced by Plastic Recycling Industries (PRI), the largest plastics recycling company in Uganda, structured as a partnership between PRI, KCCA and members of civil society, organized as a CBO. The goal of the partnership was to establish 10 plastic waste collection centers in different zones of the city by the end of 2018. KCCA provided the land on which the centers are constructed. PRI committed 175millionUGX ($49,000) in total construction costs for all ten centers. PRI also serves as a reliable market for all collected plastics and has pledged to buy them at market prices. CBOs are made up of community members, mostly women and youth, and it are responsible for operating the collection centers i.e. collecting, cleaning and packing plastics and finally selling them to PRI.

These centers are aimed at increasing collection and recycling of plastics and some shown positive results. Rubaga center, for example, was supplying PRI with 10 tons of plastics per month during its sixth month in operation, and Makindye, during its fourth month in operation, was supplying 3 tons of plastics per month. In 2018, the Rubaga CBO, was expected to generate 60million UGX ($17,000) in 12-month revenue.

As the CBOs improve their capacity and efficiency, their revenue is expected to increase significantly. Rubaga is eventually expected to supply 4-6 tons of plastic per week, which translates to 120mmUGX ($33k) in annual revenue. The positive performance of these collection centers is highly encouraging given that currently, PRI's largest suppliers deliver no more than 8 tons of plastic per month. This success, though too early to gauge full results, serves as a case study to demonstrate the possibilities that lie in working with large corporates to create value through corporate social responsibility (CSR) projects that benefit both the corporation and society.

- **Proposed separation strategies at source**

Separation at source has two main benefits: it enables the value of re-usable goods and recyclable materials to be recovered efficiently; and the composition is less mixed and therefore less in need of sorting, reducing the problems of dealing with waste downstream, where sorting is more difficult and expensive. Source separation is centrally important to the application of the waste hierarchy. To be effective, source separation requires the active cooperation of the entire population, which in turn requires considerable outreach, engagement and public education. These non-technological and non-infrastructural elements, too often neglected and disregarded as "soft", are nevertheless key to successful waste management.

In addition, waste separation at source is the key to improve recycling and composting options, eventually reducing the amount of municipal solid waste to be disposed of at landfill, composting or anaerobic digestion.

Municipal solid waste can be collected in several ways:

- House-to-House: Waste collectors visit each individual house to collect garbage. The user generally pays a fee for this service.
- Community Bins: Users bring their garbage to community bins that are placed at fixed points in a neighborhood or locality. MSW is picked up by the municipality, or its designate, according to a set schedule.
- Curbside Pick-Up: Users leave their garbage directly outside their homes according to a garbage pick-up schedule set with the local authorities (secondary house-to-house collectors not typical).
- Self-Delivered: Generators deliver the waste directly to disposal sites, transfer stations or hire third-party operators (or the municipality).
- Contracted or Delegated Service: Businesses hire firms (or municipality with municipal facilities) who arrange collection schedules and charges with customers. Municipalities often

license private operators and may designate collection areas to encourage collection efficiencies.

Collected MSW can be separated or mixed, depending on local regulations. Generators can be required to separate their waste at source, e.g., into “wet” (food waste, organic matter) and “dry” (recyclables), and possibly a third stream of “waste,” or residue. Waste that is un-segregated could be separated into organic and recycling streams at a sorting facility. The degree of separation can vary over time and by city. ‘Separation’ can be a misnomer as waste is not actually separated but rather is placed out for collection in separate containers without first being ‘mixed’ together.

The degree of source separation impacts the total amount of material recycled and the quality of secondary materials that can be supplied. Recyclables recovered from mixed waste, for example, tend to be contaminated, reducing marketing possibilities. However, source separation and separate collection can add costs to the waste collection process.

The percent of MSW collected varies by national income and by region. Higher income countries tend to have higher collection efficiency although less of the solid waste management budget goes towards collection. In low-income countries, collection services make up the bulk of a municipality’s SWM budget (as high as 80 to 90% in many cases), yet collection rates tend to be much lower, leading to lower collection frequency and efficiency. In high-income countries, although collection costs can represent less than 10% of a municipality’s budget, collection rates are generally higher than 90% on average and collection methods tend to be mechanized, efficient, and frequent. While total collection budgets are higher, they are proportionally lower as other budget items increase.

Containerization is an important aspect for waste collection, particularly from residential generators, however, special attention has to be paid in relation to its location in relation to lightening and vision for them not to turn into dangerous places for gender violence. Additionally, if waste is not set out for collection in closed containers it can be disturbed by vermin such as dogs and rats, and it can become water-logged, or set afire.

Frequency of collection is an important aspect readily under a municipality’s control. From a health perspective, no more than weekly collection is needed. However, in some cities, largely because of culture and habituation, three-times per day residential collection is offered. Good waste collection programming requires an ongoing iterative approach and communication channel between collection crews and generators (usually women head of households). Therefore, specific campaigns should be put in place directed to men and women to be aware of the true costs of collection as a first step before starting a direct charge fee.

c. Economics of Recycling

Recycling is a series of activities that includes the collection of used, reused, or unused items that would otherwise be considered waste; sorting and processing the recyclable products into raw materials; and remanufacturing the recycled raw materials into new products. Consumers provide the last link in recycling by purchasing products made from recycled content. Recycling also can include composting of food scraps, yard trimmings, and other organic materials. Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for the future of children, and reduces the need for new landfills, composting or anaerobic digestion.

- **Current waste recycling practices and proposed strategies**

The Global Green Growth Institute (Uganda, 2018) estimates that only 10% of the total waste generated in Kampala is recycled. Typical of many informal systems, materials recovery is highly uneven, opportunistic and determined by potential value derived. The most common recyclables are the ferrous and non-ferrous metals such as aluminum, copper and brass, cardboards, office paper, high density and low-density plastics and PET bottles while only a fraction of organic waste is utilized (typically as animal feed).

Incorporating waste pickers into waste management and recycling programs in Kampala and generally in Uganda can be socially desirable, economically viable, and environmentally sound. To do so, however, decision makers need to recognize that waste pickers can be an asset, and municipalities need to engage with them as potential partners. Waste pickers have already started to organize themselves using different business models (for example, through the Community Based Organizations: CBO). In some country's governments some programs have been launched to support this formalization. Similarly, international donors are increasingly integrating waste pickers into programs to foster urban development, promote a cleaner environment, and increase recycling activities.

A growing number of experiences in Latin America demonstrate that formalization of women scavenging can promote women empowerment through grassroots development, women poverty reduction, as well as enhancement on the protection of the environment and improvement of the industrial competitiveness with women labor inclusion. The most common models are:

- Scavenger cooperatives – By getting organized, women waste pickers become empowered. They can strengthen their bargaining position with industry and government, become relevant actors in the development process, and overcome women highest poverty ratio through grassroots and capacity building development. Through team together, women can gain stability, receive higher incomes, and legalize their activities. Therefore, women will be able to sign contracts with industry or apply for grants with donors. In fact, in South America, studies have shown the higher interest of women scavengers to be part of cooperative with a ratio of 58% of women in overall scavengers' cooperatives.

- Micro-enterprises – around the world some women scavengers have also create their own micro-enterprises to perform waste collection, recycling, and various manufacturing activities that use waste as raw materials. This model could fit Kampala´s scenario in relation to the findings of the social consultation where most women scavengers actively talked about economic ideas they already have in relation to the PR business. None less, this model will require active public and private support due to the lack of economic options they currently have for starting their micro enterprises.

- Gender mainstreamed public-private partnerships – This model of Public and Private Associations can combine the experience, creativity and low-operating costs of CBOs´ organization as well as NGOs such as the Uganda Housing Cooperative Union with Public partnerships for collecting, recycling and reusing plastic waste. This typology of public private partnerships has been put in place with very positive outcomes in Colombian cities. There, the model is set for the municipality to provide the infrastructure and the equipment while the waste pickers provide the labor. In Bogotá, for instance, a partnership has been formed to operate a recycling plant, managed by the Bogotá Association of Waste Pickers, to which the municipality takes recyclables separated at source.

In addition to its impact on reducing women poverty, that has proven to have a direct and higher correlation with overall poverty reduction, scavenging renders environmental benefits. Recycling has a lower environmental impact compared to the use of virgin resources, and extends the life of disposal facilities, which saves municipalities' money. Recycling can result in a more competitive economy and a cleaner environment, and can contribute to a more sustainable development.

Scavenging activities can reduce emissions of greenhouse gases by recycling inorganic and organic materials. The recycling of inorganic materials by scavengers saves energy. Power generation is one of the largest sources of greenhouse gases. Assuming that everything else remains the same, recycling reduces the emissions of greenhouse gases. When organic waste –mostly food leftovers, kitchen waste, and garden waste– is sent to open dumps and landfills it gets buried under layers of waste. Eventually, all oxygen is consumed and organic matter decomposes in anaerobic conditions. Anaerobic decomposition generates methane, a greenhouse gas that is 20 times more potent than CO_2 in trapping the sun's heat. Garbage dumps and landfills generate about 11 per cent of anthropogenic emissions of greenhouse gases. Diverting organic waste from dumps and landfills can prevent the generation of methane and reduce greenhouse emissions.

But there are several important issues that need to be addressed. Women scavengers with their children account for most of the scavenger population and face multiple health hazards and socioeconomic problems. Due to their daily contact with garbage, women scavengers are usually associated with dirt, disease, squalor, and perceived as a nuisance, a symbol of backwardness, and even as criminals. They survive in a hostile physical and social environment. They also face serious risks to their health that result in high morbidity rates and shorter life expectancy than the rest of society. But a growing number of experiences demonstrate that once scavengers are organized and public policy systems are put in place to support them, these problems can be greatly diminished or be eliminated.

Further, the existence of middlemen allows the possibility of exploitation and/or political control of women scavengers. Because industry demands large volumes of materials that are processed – sorted, baled, crushed, or granulated – it does not buy directly from individual waste pickers. Instead, middlemen who as their noun say are mostly men are the ones in the power position to purchase recyclables recovered by waste pickers by setting very low prices and gaining most of the profit of the value chain of plastics recycling. This exploitation accounts for women scavengers' very low incomes.
However, when women scavengers are supported it can constitute a perfect example of sustainable development: jobs are created, poverty is reduced, industry is supplied with inexpensive raw materials, natural resources are conserved, and the environment can be protected.
Women scavenger cooperatives, micro-enterprises, and public-private partnerships can be successful models that formalize and incorporate women scavengers into domestic and global supply chains. However, external support is peremptory in order to counterbalance socioeconomic and cultural barriers women have historically had. Therefore, in order to unlock the development of women scavenging and to recognize its contribution in the climate change challenge, national governments, multilateral, bilateral, and international organizations as well as non-governmental agencies that work in international development and environmental protection have to enforce gender mainstreaming strategies in all phases of projects, programs and policies.

- **Current recycling practices and proposed recycling strategies for plastic and organic fraction**

i. Plastic

- **Current plastic recycling practices**

The table below, obtained from the Global Green Growth Institute (Uganda, 2018), shows the various types of plastics that exist in the waste stream of Kampala. It also shows their level of availability on the market and whether they are recycled in Uganda:

Table 5: *Plastics' typology in the waste stream of Kampala*

Symbol	Acronym	Full name	Common uses	Availability /Recycled	Common uses of recycled resin
	PET	Polyethylene terephthalate	Mineral water and soda bottles	High/Yes	Clothing, vehicle upholstery

	HDPE	High density polyethylene	Jerrycans, basins, plastic cups, toiletry bottles	High/Yes	Plastic bottles, jugs, outdoor furniture
	PVC	Polyvinyl chloride	Rigid packaging, pipes, flooring	Low/No	Pipes, floor tiles, mats, hotel key cards, credit cards
	LDPE	Low density polyethylene	Grocery bags, cling wrap, bread and trash bags, hospital drip bottles	Medium/yes	Compost bins, trash cans, floor tiles
	PP	Polypropylene	Yoghurt + margarine containers, bottle caps, 85% of total plastic packaging	High/Yes	Storage bins, missing bowls, car battery cases
	PS	Polystyrene	Foam meat and fish trays, egg cartons, plates, cups	Low/No	Egg cartons, picture frames, home décor, foam packaging
	Other	Any other plastics	Any other plastics	Low	Depends on resin

Source: Kampala Municipal Solid Waste Value Chain Mapping. Global Green Growth Institute (Uganda 2018)

According to the data provided by Global Green Growth Institute (Uganda, 2018) there is increased awareness about the value of collecting plastics for recycling and there are many people in the informal sector who are involved in the segregation of plastic waste in Kampala.

As mentioned above, collection company employees or loaders who are specifically women are usually the first point of segregation. They extract plastics and other recyclable materials from each bag of waste and pack them in separate bags, which are then tied atop the collection truck. The process is very hurried and thus inefficient because the activity of segregation is for their own private benefit and not for the collection company that employs them. They then sell the bags of recyclable waste to landfill brokers along the road to Kiteezi.
Landfill brokers then clean and do a more thorough segregation of the waste and sell the final product (clean plastic material) to recyclers.

Street pickers, who are either independent or contracted by large waste brokers walk around neighborhoods in search of discarded plastics, which they pack and sell to specialized brokers who usually have storage facilities where they aggregate volumes provided by street pickers and after they aggregate large volumes, then pay for a truck to transport the material to their client, usually a plastic recycling plant such as PRI. The recycler weighs and sorts through the material to determine if it is in good condition and typically pays the broker in cash within 2-3 days of delivery.

Finally, landfill pickers at Kiteezi extract any plastics from the landfill and sell them to landfill brokers. time the waste gets to Kiteezi landfill, most of the plastic has been extracted as much of the segregation of plastic happens upstream. There are over 30 companies registered as plastic recycling companies in Uganda. Most of these are engaged in recycling of PET, Polyethylene (both HDPE and LDPE) and Polypropylene (PP).

PET from bottles is the most recycled plastic in Uganda. Four major companies are involved in turning PET into PET flake for export to China and India mainly for use in making polyester fabric. The four companies export ~582MT in total per month, worth $250k. The largest recycler of PET is PRI, an offshoot of Coca-Cola with 45% market share of PET exports operating at 50% capacity.

As an important event in the recycling sector, in July 2018, filing with the World Trade Organization (WTO), China's Ministry of Environmental Protection announced that it will ban the importation of 24 categories of recyclables and solid waste by end of 2017. The ban, which is part of a campaign against yang laji or "foreign garbage" applies to textiles, mixed paper and plastic, which includes recycled PET, PE, PVC, PS and other plastics. The impact is far reaching as China has been the dominant market for recycled plastic, taking 51% of the world's recycled plastic. Alternative markets include India and South Korea. In Uganda, the effects are already being felt by the four major exporters of recycled plastic. The four are PRI, Standard Plastics, Aquilla and a Chinese recycling company. Altogether, these recyclers have been exporting a total of about 582 Metric Tons of recycled PET flake to China. At a price of $430 per metric ton, the total annual revenue of the industry is $250k.
According to a statement from China Scrap Plastic Association said in November 2017, the Chinese government may allow importation of some grades of clean material if they can be used directly in manufacturing. Such materials may include hot washed PET flake, which fetched even more than unwashed flake.

Recyclers are finding modest success in entering new markets mainly in India but the prices in India are about 28% lower than prices in China (about $430/MT in China against $310/MT for India). Larger ones such as PRI are considering value addition and other manufacturing options as an alternative to exporting PET flake.

About the **HDPE**, according the data from the Global Green Growth Institute (Uganda, 2018), most plastic recyclers also recycle used jerrycans, plastic plates etc. used in making new products. 22% of PRI's recycling material is HDPE (its second largest product). HDPE is not easily available, and its scarcity is reflected in its price of 850 UGX to 1,050 UGX ($0.24 - $0.29) per kg. This may be due to the long-lasting nature of the products e.g. jerrycans, plastic plates etc. The recycled resin is sold locally to manufacturers such as Victoria Nile (for jerrycans), Mukwano (for bottle caps), and even local plastic floor tile manufacturers.

In reference to another important plastic source, the **LDPE** (Kavera), this is the most commonly used plastic shopping bag in Uganda. In 2009, the government of Uganda, through the National Environment Management Authority (NEMA), banned the importation, manufacture and use of polythene bag of gauge 30 microns and below, popularly known as “kavera”. The issues cited as reasons for the ban included clogging of water channels and impeding smooth water filtration and percolation into the soil. However, NEMA has since failed to enforce the ban due to a strong lobby group from recyclers and manufacturers of Kavera. The lobby group, Uganda Plastic Manufacturers and Recyclers Association (UPMRA) is made up of 45 members and claims to have the support of Uganda’s Ministry of Trade as well as KCCA.

UPMRA claims that there are currently 30+ kavera recycling plants in Uganda who have invested over $45mm in machinery and provide direct employment to 3,000 people and indirectly to 10,000+ others. The machinery used to make kavera is not fungible and therefore these plants cannot easily switch from manufacturing kavera to manufacturing other products. The recyclers buy the raw material from street pickers and landfill waste brokers, and per UPMRA, produce a total of 2,500+ tons of recycled material per year.
It is important to note that a kavera ban has been successful in neighboring countries namely Kenya and Rwanda. While it took Kenya three attempts over ten years, it finally passed the ban in Q3 2017. In Rwanda, plastic bags have been banned since 2008. In Uganda, the manufacture of kavera is still ongoing despite the ban, albeit much uncertainty.

Given that prices are derived from byproducts of petroleum; the final price of recyclable plastic is positively correlated with the price of oil; prices today are 75% lower than they were during the oil price peak in 2011:

Table 6: *Price of a kg of unsorted waste*

Actor	PET ($/kg)		HDPE (blow) ($/kg)		HDPE (injection) ($/kg)		LDPE ($/kg)		PP ($/kg)	
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
Street waste pickers	0	0.108	0	0.216	0	0.2295	0	0.135	0	0.216
Collection truck loaders	0	0.054	0	0.054	0	0.054	0	0.054	0	0.054
Landfill waste loaders	0	0.081	0	0.216	0	0.216	0	0.135	0	0.081
Scrap dealers	0.054	0.108	0.216	0.2835	0.216	0.2295	0.135	0.135	0.081	0.216
Recycling plants	0.108	0.41796	0.2835	0.486	0.2295	0.432	0.135	0.324	0.216	n.a

Source: Conversion from UGX to $ from Kampala Municipal Solid Waste Value Chain Mapping. Global Green Growth Institute (Uganda 2018).

- **Proposed plastics recycling strategies**

Plastic materials can be recycled in a variety of ways and the ease of recycling varies among polymer type, package design and product type. For example, rigid containers consisting of a single polymer are simpler and more economic to recycle than multi-layer and multi-component packages.
Thermoplastics, including PET, PE and PP all have high potential to be mechanically recycled. Thermosetting polymers such as unsaturated polyester or epoxy resin cannot be mechanically recycled, except to be potentially re-used as filler materials once they have been size-reduced or pulverized to fine particles or powders. This is because thermoset plastics are permanently cross-linked in manufacture, and therefore cannot be re-melted and re-formed. Recycling of cross-linked rubber from car tyres back to rubber crumb for re-manufacture into other products does occur and this is expected to grow owing to the EU Directive on Landfill of Waste (1999/31/EC), which bans the landfill of tyres and tyre waste.

A major challenge for producing recycled resins from plastic wastes is that most different plastic types are not compatible with each other because of inherent immiscibility at the molecular level, and differences in processing requirements at a macro-scale. For example, a small amount of PVC contaminant present in a PET recycle stream will degrade the recycled PET resin owing to evolution of hydrochloric acid gas from the PVC at a higher temperature required to melt and reprocess PET. Conversely, PET in a PVC recycle stream will form solid lumps of undispersed crystalline PET, which significantly reduces the value of the recycled material.

Hence, it is often not technically feasible to add recovered plastic to virgin polymer without decreasing at least some quality attributes of the virgin plastic such as colour, clarity or mechanical properties such as impact strength. Most uses of recycled resin either blend the recycled resin with virgin resin—often done with polyolefin films for non-critical applications such as refuse bags, and non-pressure-rated irrigation or drainage pipes, or for use in multi-layer applications, where the recycled resin is sandwiched between surface layers of virgin resin.

The ability to substitute recycled plastic for virgin polymer generally depends on the purity of the recovered plastic feed and the property requirements of the plastic product to be made. This has led to current recycling schemes for post-consumer waste that concentrate on the most easily separated packages, such as PET soft-drink and water bottles and HDPE milk bottles, which can be positively identified and sorted out of a co-mingled waste stream. Conversely, there is limited recycling of multi-layer/multi-component articles because these result in contamination between polymer types. Post-consumer recycling therefore comprises of several key steps: collection, sorting, cleaning, size reduction and separation, and/or compatibilization to reduce contamination by incompatible polymers.

Two key economic drivers influence the viability of thermoplastics recycling. These are the price of the recycled polymer compared with virgin polymer and the cost of recycling compared with alternative forms of acceptable disposal. There are additional issues associated with variations in the quantity and

quality of supply compared with virgin plastics. Lack of information about the availability of recycled plastics, its quality and suitability for specific applications, can also act as a disincentive to use recycled material.
Collection of used plastics from households is more economical in suburbs where the population density is sufficiently high to achieve economies of scale. The most efficient collection scheme can vary with locality, type of dwellings (houses or large multi-apartment buildings) and the type of sorting facilities available. In rural areas 'bring schemes' where the public deliver their own waste for recycling, for example when they visit a nearby town, are considered more cost-effective than kerbside collection. Many local authorities and some supermarkets in the UK operate 'bring banks', or even reverse-vending machines. These latter methods can be a good source of relatively pure recyclables, but are ineffective in providing high collection rates of post-consumer waste.

The price of virgin plastic is influenced by the price of oil, which is the principle feedstock for plastic production. As the quality of recovered plastic is typically lower than that of virgin plastics, the price of virgin plastic sets the ceiling for prices of recovered plastic.

Technological advances in recycling can improve the economics in two main ways—by decreasing the cost of recycling (productivity/efficiency improvements) and by closing the gap between the value of recycled resin and virgin resin. The latter point is particularly enhanced by technologies for turning recovered plastic into food grade polymer by removing contamination—supporting closed-loop recycling. So, while over a decade ago recycling of plastics without subsidies was mostly only viable from post-industrial waste, or in locations where the cost of alternative forms of disposal were high, it is increasingly now viable on a much broader geographic scale, and for post-consumer waste.

In summary, recycling is one strategy for end-of-life waste management of plastic products. It makes increasing sense economically as well as environmentally and recent trends demonstrate a substantial increase in the rate of recovery and recycling of plastic wastes. These trends are likely to continue, but some significant challenges still exist from both technological factors and from economic or social behaviour issues relating to the collection of recyclable wastes, and substitution for virgin material. The manufacturer of glass and plastic bottles should have a return on deposit system in place which rewards the returns of these products with cash. With the inclusion of plastic bottles, very little of these recyclable products will end up at disposal sites since individuals would have an incentive to return these forms of waste at designated collection points.

The **Bloqueplas Construction System** is an example of innovative plastic recycling project with a high potential of success through its implementation in Uganda. This strategy proposes adapting building construction to the effects of climate change by the use of plastic bricks created through recycled plastic. The objectives of this project are the following:

- To recycle plastic waste into durable building & construction materials such as pavement bricks and building blocks which are cheaper than the traditional ones.

- To support women employment, directly and indirectly across Uganda.
- To improve sanitation through plastic waste collection and use.
- Involve women as main actors for leading the adaptation of new and appropriate technologies on economic and non-economic livelihoods and create awareness on circular economy, climate change and adaptation strategies.

The financing of this activity is achieved through the following:

- Purchasing the products (bricks, pavement modules, houses, etc.).
- Mitigation carbon credits (CERs or Certified Emission Reductions from CDM, VCUs or Verified Carbon Units from Verified Carbon Standard, VERs or Verified Emission Reductions from Gold Standard for the Global Goals, etc.).
- Monetizing plastic trash through the Social Plastic® ecosystem.
- Exchange of plastic for money, items or Blockchain secured digital tokens.

The direct beneficiaries of the project are:

- Women: This project is designed to create work for women in local communities, as collectors, aggregators, trained brick layers, sales persons, administrative workers in the offices and leaders of the project.
- Children: collecting plastic waste and recycling them into useful products will give children the opportunity to play and explore their communities/environment without risking their health and safety. Additionally, by improving women opportunities, positive impact will directly benefit their children who are as they stated in social consultation their main reason for working in the WM system as only source of income for providing economic support for them.
- Local communities: environment free of plastic waste implies reduction in malaria, cholera, cost of disaster management after heavy rainfall, and improved aquatic life, etc

The general benefits for the community are as follows:

- 50,000 women employments created within 5 years.
- Integrating the role of scavengers in a dynamic model of production.
- The project is focused on women through the employment, educational and capacity building programs.
- Reduction of the plastic waste contamination leading to better health for the people, and thereby saving the people and government money spent on health and disaster management.

House build with recycled plastic bricks. Source: Own elaboration

Following we include the financial analysis with the estimated net cash flow considering the implementation and assembly of the plastic bricks households' production plant and 1 year of operation. The implementation and assembly stage of the plant is estimated to take 6 months until the production plant is economically self-sufficient and the investment return starts. This model consider that the partner contributions will be made during the first 3 months of implementation of the production plant.

Table 7: *Projected cash flow for 1 year of operation ($)*

PROJECTED CASH FLOW FOR 1 YEAR OF OPERATIONS	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	TOTAL
1. Opening cash balance	0	119,941	205,822	364,726	343,185	359,360	1,182,728	430,643	277,824	195,050	272,189	421,907	**4,173,374**
REVENUES													
Revenues from sales	0	16,250	59,800	157,690	258,960	343,200	395,200	517,400	689,000	791,440	824,200	830,960	**4,884,100**
2. Total revenue	0	16,250	59,800	157,690	258,960	343,200	395,200	517,400	689,000	791,440	824,200	830,960	**4,884,100**
OPERATIVE EXPENSES													
ASSEMBLY COST AND START-UP	188,620	179,690	178,190	0	0	0	0	0	0	0	0	0	**546,500**
RAW MATERIAL COST	0	18,545	53,410	133,525	178,033	222,542	237,378	356,067	453,985	468,821	474,756	474,756	**3,071,817**
LEASE	5,101	5,101	5,101	5,101	5,101	5,101	5,101	5,101	5,101	5,101	5,101	5,101	**61,211**
Administration and production expenses	16,526	30,460	17,826	40,605	41,605	42,727	42,727	42,727	64,507	64,507	64,507	64,507	**533,234**
Partner participation	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Tax payment	0	0	0	0	18,045	24,698	37,314	41,559	73,417	101,107	105,354	107,090	**508,584**
OTHERS	10235												**10,235**
3. Total Expenses	220,482	233,796	254,527	179,231	242,785	295,068	322,520	445,454	597,010	639,536	649,718	651,454	**4,731,580**
4. NET OPERATING CASH FLOW (2 + 3)	-220,482	-217,546	-194,727	-21,541	16,175	48,132	72,680	71,946	91,990	151,904	174,482	179,506	**152,520**
Net operatin cash flow / total revenue					6%	14%	18%	14%	13%	19%	21%	22%	
FINANCIAL CASH FLOW													
Debt amortization expenses	0	0	0	0	0	24,765	24,765	24,765	24,765	24,765	24,765	24,765	**173,352**
Disbursement of new credits	0	0	0	0	0	1,000,000	0	0	0	0	0	0	**1,000,000**
Partner contributions	340,423	303,427	353,631	0	0	0	0	0	0	0	0	0	**997,481**
5. Net Financial Cash Flow	340,423	303,427	353,631	0	0	975,235	-24,765	-24,765	-24,765	-24,765	-24,765	-24,765	**1,824,129**
OTHER CASH FLOWS													
Investment expenses	0	0	0	0	0	200,000	800,000	200,000	150,000	50,000	0	0	**1,400,000**
Other flows													
6. OTHER CASH FLOWS SUB-TOTAL	0	0	0	0	0	-200,000	-800,000	-200,000	-150,000	-50,000	0	0	**-1,400,000**
7. NET TOTAL CASH FLOW (4 + 5 +6)	119,941	85,881	158,904	-21,541	16,175	823,367	-752,085	-152,818	-82,774	77,139	149,718	154,742	**576,649**
8. Final Cash Blance (1 + 7)	**119,941**	**205,822**	**364,726**	**343,185**	**359,360**	**1,182,728**	**430,643**	**277,824**	**195,050**	**272,189**	**421,907**	**576,649**	**4,750,023**

Source: Ecoplasso- Bloqueplas

This economic model considers the construction and sale of 700 households during the first year with a unitary price of $6,500 and the recycled plastic raw material is determined according to the average weigh of the house (6.13 tons) and the price of each ton of raw material is $605.

ii. Organic fraction

- **Current recycling organics practices**

According to the study of the Global Green Growth Institute (Uganda, 2018), organic waste is the least valorized waste stream and most of it ends up in Kiteezi landfill, apart from green banana peels also known as "Bikuuta". Matooke (green banana) is the main staple food of Uganda and as such, matooke peels make up a large chunk of the organic waste in Kampala. Small restaurants and hotels are major generators of matooke peels, especially in high population neighborhoods e.g. markets and slums.
Itinerant brokers buy the waste from small restaurants and sell it to organized groups of roadside brokers, such as the Bikuuta group featured in the case study below. These groups sell their inventory to farmers to use as animal feed or convert it into compost or mulch to improve the quality of soil.

These groups are usually located strategically along major highways that lead out of Kampala to various up-country farming regions. Most of the roadside brokers do not have permanent locations and are sometimes evicted from the premises by KCCA. Other challenges include lack of storage, high costs of transportation, and lack of technology and know-how to add value to the waste.
Organic fertilizers can be made from organic waste but the market for organic fertilizers in Uganda is insignificant because most farmers believe that Uganda's soils are fertile as is and therefore, do not need fertilizer. In addition, when they do need fertilizer, most farmers will choose a synthetic fertilizer because imported synthetic fertilizers are well marketed. The price of organic fertilizer is 10UGX per kg. A community initiative called "Kasanvu" was formed by a former employee of KCCA in the slum of Namuwongo but has failed to take off due to the low prices of compost.

Another project was funded by the World Bank and implemented by NEMA to support 12 municipalities/secondary cities in Uganda (Kampala was not included in this project) to develop composting capabilities. The project was registered as a CDM project and the cities went through one emissions reduction verification process and received a $215k payout for 15,425 metric tons during the period 2010 – 2012. The World Bank was the buyer for this first tranche.
Other case study of organic recycling in Kampala reported by the Global Green Growth Institute (Uganda, 2018) is the Bikuuta group (organic waste brokers). The Bikuuta group was formed in the year 2000 by Nalongo, a female broker, to focus on trading in banana peels in Mulago, along the Masindi highway just outside the city. The group had in 2018 17 members (12 women). They buy sacks of banana peels from a network of itinerant dealers who source the peels from local restaurants around large markets. Members pool their resources to pay for inventory and transportation and remain wary of the high interest loans offered by micro finance groups. Their client base is mostly made up of farmers who own farms on the outskirts of Kampala and along Masindi highway. The group's highway location is advantageous because farmers often make a stop to buy peels in route from the city to their upcountry farms.

Their main challenges include lack of a permanent location as the location they occupy now is on public land and KCCA has evicted them in the past. Another issue is the high transportation costs. The group believes that owning a truck would increase sales and allow them to distribute to their clients across the farming regions. Also, the group has limited knowledge of sales and marketing and their marketing efforts are limited to their children interning as sales agents during school vacations. In their spare time, the members cut up the banana peels into small pieces, which they sell as chicken feed. This process is labour intensive but almost 6x value to the peels. The group sells 200-500 bags per day depending on the season - high season is in January-February. Assuming all members work 30 days in a month (which is typical), sell all their inventory, and split costs and profits evenly, each member would take home $257 in the low season and $643 in the high season:

Table 8: *Organic recycling products. Sale prices*

	Low season ($)	High season ($)
Price of peels / bag	1.35	1.35
Price of a sack (packaging)	0.08	0.08
Transportation cost / bag	0.27	0.27
Working capital / bag	1.70	1.70
Selling price / bag	2.43	2.43
Sales per day (# bags)	0.05	0.14
Group Revenue / day	486.00	1,215.00
Working capital / day	340.20	850.50
Profit / day	145.80	364.50
Group Monthly profit	4,374.00	10,935.00
Number of members	0.00	0.00
Member Profit / day	8.58	21.44
Member Monthly profit	257.29	643.24

Source: Conversion from UGX to $ from Kampala Municipal Solid Waste Value Chain Mapping. Global Green Growth Institute (Uganda 2018).

- Proposed recycling strategies for composting

Composting, a component of organics recycling, involves the accumulation of organic waste and converting it into soil additives.
Composting is a relatively simple process; the compost operator helps nature take its natural course. The optimization efforts increase the rate of decomposition (thereby reducing costs), minimize nuisance potential, and promote a clean and readily marketable finished product. Composting is highly compatible with other types of recycling. Diverting organic material helps to increase the recovery rate of recyclable materials, while at the same time, recycling programs for glass and plastics, which are common Municipal Solid Waste (MSW) compost contaminants, improve the quality of the finished compost. Household source separation of recyclable paper, metal and glass is already common in many developing countries.

Many cities in developing countries are plagued with poor waste collection. While a few, more influential residents may get daily waste collection, others may never have such services. Daily waste collection in wealthy neighborhoods is usually too frequent and contributes to the lack of collection in poorer areas. In more affluent areas of a city, the use of containers and diversion of organic waste for composting is a good way to quickly improve the city's overall waste collection service. Many cities have switched from unreliable daily collection to bi-weekly organic waste collection and weekly non-organic waste collection. Variations of this schedule are easily tailored to each area's individual characteristics. Introducing waste diversion for composting programs provides a city with a unique opportunity to improve its overall waste collection service.

The Carbon/Nitrogen (C/N) ratio of the biodegradable portion of MSW is another important determinant of the speed (and therefore the cost) of composting. The optimal C/N ratio of 25:1 is easily achieved by organic waste in Uganda. Lower C/N ratios can be achieved, although at a cost, by blending waste with sewage sludge or certain animal manures, such as chicken or cow, that have relatively low C/N ratios. But if the primary goal is to recover energy by anaerobic digestion of organic materials, too low a C/N ratio can lead to excessive generation of ammonia. A C/N ratio of less than 10:1 kills the anaerobic bacteria that generate methane.

The benefits of composting are detailed as follows:

- Increases overall waste diversion from final disposal, especially since as much as 80% of the waste stream in low- and middle- income countries like Uganda is compostable
- Enhances recycling and incineration operations by removing organic matter from the waste stream
- Produces a valuable soil amendment—integral to sustainable agriculture
- Promotes environmentally sound practices, such as the reduction of methane generation at landfills
- Enhances the effectiveness of fertilizer application
- Can reduce waste transportation requirements
- Flexible for implementation at different levels, from household efforts to large-scale centralized facilities
- Can be started with very little capital and operating costs
- The climate of many developing countries is optimum for composting
- Addresses significant health effects resulting from organic waste, such as reducing dengue fever
- Provides an excellent opportunity to improve a city's overall waste collection program
- Accommodates seasonal waste fluctuations, such as leaves and crop residue
- Can integrate existing informal sectors involved in the collection, separation and recycling of wastes

However, there are some constraints for the application of composting program:

- Inadequate attention to the biological process requirements
- Over-emphasis placed on mechanized processes rather than labor intensive operations
- Lack of vision and marketing plans for the final compost product
- Poor feed stock which yields poor quality finished compost, for example heavy metal

contamination

- Poor accounting practices which neglect that the economics of composting rely on externalities, such as reduced soil erosion, water contamination, climate change, and avoided disposal costs
- Difficulties in securing finances since the revenue generated from the sale of compost will rarely cover processing, transportation and application costs
- “subsidies” may be required to maintain programs; these reflect the benefits that accrue beyond
- Local governments, and avoided disposal costs are not adequately addressed
- Sensible preoccupation by municipal authorities to first concentrate on providing adequate waste collection
- Inadequate pathogen and weed seed suppression
- Nuisance potential, such as odors and rats
- Poor marketing experiences
- Poor integration with the agricultural community
- Perverse incentives such as fertilizer subsidies or over-emphasis on capital intensive projects
- Land requirements are often minimal, but can be a constraint

All organic matter will eventually decompose; however, some materials are more suitable for composting than others. The raw materials which are most appropriate for composting include: vegetable and fruit waste; farm waste such as coconut husks and sugar cane waste; crop residues such as banana skins, corn stalks and husks; yard waste such as leaves, grass and trimmings; sawdust; bark; household kitchen waste; human excreta and animal manure. All of these organic materials are readily found in municipal solid waste generated in developing countries. Animal waste, such as carcasses and fish scraps, can be used as well but they are more likely to attract unwanted vermin and generate odours. Other organic matter such as wood, bones, green coconut shells, paper and leather decompose very slowly and hinder the composting process.

Composting occurs whenever there is sufficient oxygen, water and ambient temperatures. Designing a composting system usually involves optimization between: transportation, land, labour, and capital costs, feedstock, and markets. There is never one “right answer” but rather several possible options. For example, combinations of community and large-scale composting facilities should be encouraged to reduce municipal costs.

In Upper Mid Income Countries, the cost of disposal in compost plants varies from 20 to 75 $/tone of waste composted. The following points would estimate the cost of composting the organic fraction of the waste stream which ended up during 2017 in Riverton landfill, Jamaica:

Composting without forced aeration

Composting without forced aeration (also known as aerated or turned windrow composting) is suited for large volumes such as that generated by entire communities and collected by local governments, and high volume food-processing businesses (e.g., restaurants, cafeterias, packing plants). It will yield significant amounts of compost, which might require assistance to market the end-product. Local governments may want to make the compost available to residents for a low or no cost.

This type of composting involves forming organic waste into rows of long piles called “windrows” and aerating them periodically by either manually or mechanically turning the piles. The ideal pile height is between four and eight feet with a width of 14 to 16 feet. This size pile is large enough to generate enough heat and maintain temperatures. It is small enough to allow oxygen flow to the windrow's core.

Large volumes of diverse wastes such as yard trimmings, grease, liquids, and animal by-products (such as fish and poultry wastes) can be composted through this method. The following issues should be taken into account when composting without forced aeration:

- Windrow composting often requires large tracts of land, sturdy equipment, a continual supply of labour to maintain and operate the facility, and patience to experiment with various materials mixtures and turning frequencies.
- In a warm, arid climate, windrows are sometimes covered or placed under a shelter to prevent water from evaporating.
- In rainy seasons, the shapes of the pile can be adjusted so that water runs off the top of the pile rather than being absorbed into the pile.
- Windrow composting can work in cold climates. Often the outside of the pile might freeze, but in its core, a windrow can reach 140° F.
- Leachate is liquid released during the composting process. This can contaminate local ground water and surface-water supplies. It should be collected and treated.
- Windrow composting is a large-scale operation and might be subject to regulatory enforcement, zoning, and siting requirements. Compost should be tested in a laboratory for bacterial and heavy metal content.
- Odours also need to be controlled. The public should be informed of the operation and have a method to address any complaints about animals or bad odours.

The cost of composting without forced aeration for the organic fraction of the waste stream which ended up in Riverton landfill (Jamaica) during the year 2017 was estimated using the OrganEcs tool, developed by the Environmental Protection Agency (USEPA). A Low and High Capital Investment case was evaluated resulting as follows:

- Low Capital Investment case of composting without forced aeration:

Key Outputs		
Compost Sale Price	$10.00	$/tonne
Gate Fee - Yard Waste	$25.00	$/tonne
Gate Fee - All Waste	$0.00	$/tonne

Composting Facility Assumptions		**Units**
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Total Incoming Yard Waste in YR 1	75,993	tonnes/year
Purchased Bulking Agent Requirements in YR 1	0	tonnes/year
Total Annual Waste Throughput in YR 1	75,993	tonnes/year
Daily Waste Throughput in YR 1	245	tonnes/day
Facility Design Capacity	76,753	tonnes/year
Design Capacity Daily Throughput	248	tonnes/day
Land Requirement	8	ha
Process Water Demand in YR 1	4,856	m3/year
Capital Cost Assumptions		**Units**
Infrastructure and Site Development Cost in Investment Year	$1,474,542	$
Equipment Cost in Investment Year	$2,996,564	$
VAT	$749,141	$
Land Purchase in Investment Year	$809,147	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$447,111	$
Capital Investment	**$6,481,504**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$6,481,504**	$
Financing Assumptions		**Units**
Total Debt in Investment Year	$3,240,752	$
Total Equity in Investment Year	$3,240,752	$
Short-term Debt in Investment Year	$1,498,282	$
Long-term Debt in Investment Year	$1,742,470	$
Finance New Equipment	Yes	
Inflated Composting Equipment Costs		
Replacement 1	$4,569,568	$
Financed Amount	$2,284,784	$
Replacement 2	$6,344,598	$
Financed Amount	$3,172,299	$
Replacement 3	$0	$
Financed Amount	$0	$

Source: own development

- High Capital Investment case of Composting without forced aeration:

Key Outputs		
Compost Sale Price	$10.00	$/tonne
Gate Fee - Yard Waste	$25.00	$/tonne
Gate Fee - All Waste	$0.00	$/tonne

Composting Facility Assumptions		**Units**
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Total Incoming Yard Waste in YR 1	75,993	tonnes/year
Purchased Bulking Agent Requirements in YR 1	0	tonnes/year
Total Annual Waste Throughput in YR 1	75,993	tonnes/year
Daily Waste Throughput in YR 1	245	tonnes/day
Facility Design Capacity	76,753	tonnes/year
Design Capacity Daily Throughput	248	tonnes/day
Land Requirement	8	ha
Process Water Demand in YR 1	4,856	m3/year
Capital Cost Assumptions		**Units**
Infrastructure and Site Development Cost in Investment Year	$1,916,914	$
Equipment Cost in Investment Year	$3,895,549	$
VAT	$973,887	$
Land Purchase in Investment Year	$809,147	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$581,246	$
Capital Investment	**$8,181,744**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$8,181,744**	$
Financing Assumptions		**Units**
Total Debt in Investment Year	$4,090,872	$
Total Equity in Investment Year	$4,090,872	$
Short-term Debt in Investment Year	$1,947,775	$
Long-term Debt in Investment Year	$2,143,097	$
Finance New Equipment	Yes	
Inflated Composting Equipment Costs		
Replacement 1	$5,940,462	$
Financed Amount	$2,970,231	$
Replacement 2	$8,248,011	$
Financed Amount	$4,124,005	$
Replacement 3	$0	$
Financed Amount	$0	$

Source: own development

- Composting without forced aeration. Financial Summary:

Composting W/O Forced Aeration	USD	
	Low	High
Initial Capital Investment ($)	$6,481,600	$8,181,800
Capex/tonne ($/TPY)	$86	$108
Total Annual Expenses in YR 1 Operations ($/year)	$1,316,800	$1,401,100
O&M/tonne in YR 1 Operations ($/tonne of waste processed)	$18	$19
Total Land Required (ha)	7.68	7.68
Total Yard Waste Available in YR 1 (tonnes/year)	75,993	75,993
Total Yard Waste to Composting in YR 1 (tonnes/year)	75,993	75,993
Total Bulking Agent Required in YR 1 (tonnes/year)	0	0
Total Waste Composted in YR 1 (tonnes/year)	75,993	75,993
Compost Produced in YR 1 (tonnes/year)	37,996	37,996
Waste Diverted from Landfill in YR 1 (tonnes/year)	74,473	74,473
Percent of Waste Diverted from Landfill (%)	98%	98%
Gate Fee - Yard Waste ($/tonne)	$25.00	$25.00
Gate Fee - All Waste ($/tonne)	$0.00	$0.00
Compost Sale Price ($/tonne)	$10.00	$10.00
Levered IRR (%)	36%	19%

Source: own development

As it can be observed in the previous table, for a gate fee of 25 $/ton of yard waste and a selling price of compost of 10 $/ton, the Levered Internal Rate of Return (IRR) of a Low and High Capital Investment case for Composting without forced aeration result in 36% and 19%, respectively, which is a case of commercial viability under Public-Private Partnership (PPP) arrangement of a concessions. The total incoming yard waste in the compost plant would start in 75,993 tons/year and was expected to have an increment of 1% each year.

Composting with forced aeration

Composting with forced aeration (also known as aerated static pile composting) produces compost relatively quickly (within three to six months). It is suitable for a relatively homogenous mix of organic waste and work well for larger quantity generators of yard trimmings and compostable municipal solid waste (e.g., food scraps, paper products), such as local governments, landscapers, or farms. This method, however, does not work well for composting animal byproducts or grease from food processing industries.

In aerated static pile composting, organic waste mixed in a large pile. To aerate the pile, layers of loosely piled bulking agents (e.g., wood chips, shredded newspaper) are added so that air can pass from the bottom to the top of the pile. The piles also can be placed over a network of pipes that deliver air into or draw air out of the pile. Air blowers might be activated by a timer or temperature sensors. The following issues should be taken into account when composting with forced aeration:

- In a warm, arid climate, it may be necessary to cover the pile or place it under a shelter to prevent water from evaporating.
- In the cold, the core of the pile will retain its warm temperature. Aeration might be more difficult because passive air flowing is used rather than active turning. Placing the aerated static piles indoors with proper ventilation is also sometimes an option.
- Since there is no physical turning, this method requires careful monitoring to ensure that the outside of the pile heats up as much as the core.
- Applying a thick layer of finished compost over the pile may help alleviate any odors. If the air blower draws air out of the pile, filtering the air through a biofilter made from finished compost will also reduce any of the odors.
- This method may require significant cost and technical assistance to purchase, install, and maintain equipment such as blowers, pipes, sensors, and fans.
- Having a controlled supply of air allows construction of large piles, which require less land than the windrow method.

The cost of composting with forced aeration for the organic fraction of the waste stream which ended up in Riverton landfill (Jamaica) during the year 2017 was estimated using the OrganEcs tool, developed by the USEPA. A Low and High Capital Investment case was evaluated resulting as follows:

- Low Capital Investment case of Composting with forced aeration:

Key Outputs		
Compost Sale Price	$10.00	$/tonne
Gate Fee - Yard Waste	$25.00	$/tonne
Gate Fee - Food Waste	$50.00	$/tonne
Gate Fee - Manure/Sludge Waste	$50.00	$/tonne
Gate Fee - Other Waste	$25.00	$/tonne
Gate Fee - All Waste	$0.00	$/tonne

Composting Facility Assumptions		**Units**
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Incoming Yard Waste in YR 1	75,993	tonnes/year
Incoming Food Waste in YR 1	303,971	tonnes/year
Incoming Manure/Sludge Waste in YR 1	20,000	tonnes/year
Incoming Other Waste in YR 1	114,759	tonnes/year
Purchased Bulking Agent in YR 1	0	tonnes/year
Total Annual Waste Throughput in YR 1	514,722	tonnes/year
Daily Waste Throughput in YR 1	1,660	tonnes/day
Facility Design Capacity	519,870	tonnes/year
Design Capacity Daily Throughput	1,677	tonnes/day
Land Requirement	42	ha
Process Water Demand in YR 1	21,951	m3/year
Capital Cost Assumptions		**Units**
Infrastructure and Site Development Cost in Investment Year	$22,039,045	$
Equipment Cost in Investment Year	$19,195,697	$
VAT	$4,798,924	$
Land Purchase in Investment Year	$4,384,486	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$4,123,474	$
Capital Investment	**$54,546,626**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$54,546,626**	$
Financing Assumptions		**Units**
Total Debt in Investment Year	$27,273,313	$
Total Equity in Investment Year	$27,273,313	$
Short-term Debt in Investment Year	$9,597,849	$
Long-term Debt in Investment Year	$17,675,464	$
Finance New Equipment	Yes	
Inflated Composting Equipment Costs		
Replacement 1	$29,272,205	$
Financed Amount	$14,636,103	$
Replacement 2	$40,642,875	$
Financed Amount	$20,321,437	$
Replacement 3	$0	$
Financed Amount	$0	$

Source: own development

- High Capital Investment case of Composting with forced aeration:

Key Outputs		
Compost Sale Price	$10.00	$/tonne
Gate Fee - Yard Waste	$25.00	$/tonne
Gate Fee - Food Waste	$50.00	$/tonne
Gate Fee - Manure/Sludge Waste	$50.00	$/tonne
Gate Fee - Other Waste	$25.00	$/tonne
Gate Fee - All Waste	$0.00	$/tonne

Composting Facility Assumptions		**Units**
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Incoming Yard Waste in YR 1	75,993	tonnes/year
Incoming Food Waste in YR 1	303,971	tonnes/year
Incoming Manure/Sludge Waste in YR 1	20,000	tonnes/year
Incoming Other Waste in YR 1	114,759	tonnes/year
Purchased Bulking Agent in YR 1	0	tonnes/year
Total Annual Waste Throughput in YR 1	514,722	tonnes/year
Daily Waste Throughput in YR 1	1,660	tonnes/day
Facility Design Capacity	519,870	tonnes/year
Design Capacity Daily Throughput	1,677	tonnes/day
Land Requirement	41	ha
Process Water Demand in YR 1	21,951	m3/year
Capital Cost Assumptions		**Units**
Infrastructure and Site Development Cost in Investment Year	$42,185,777	$
Equipment Cost in Investment Year	$36,741,668	$
VAT	$9,185,417	$
Land Purchase in Investment Year	$4,341,075	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$7,892,745	$
Capital Investment	**$100,351,682**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$100,351,682**	$
Financing Assumptions		**Units**
Total Debt in Investment Year	$50,175,841	$
Total Equity in Investment Year	$50,175,841	$
Short-term Debt in Investment Year	$18,370,834	$
Long-term Debt in Investment Year	$31,805,007	$
Finance New Equipment	Yes	
Inflated Composting Equipment Costs		
Replacement 1	$56,028,683	$
Financed Amount	$28,014,341	$
Replacement 2	$77,792,798	$
Financed Amount	$38,896,399	$
Replacement 3	$0	$
Financed Amount	$0	$

Source: own development

- Composting with forced aeration. Financial Summary:

Composting With Forced Aeration	USD	
	Low	High
Initial Capital Investment ($)	$54,546,700	$100,351,700
Capex/tonne ($/TPY)	$106	$195
Total Annual Expenses in YR 1 Operations ($/year)	$3,270,500	$5,230,300
O&M/tonne in YR 1 Operations ($/tonne of waste processed)	$7	$11
Total Land Required (ha)	41.59	41.18
Total Organic Waste Available in YR 1 (tonnes/year)	514,722	514,722
Total Yard Waste Available in YR 1 (tonnes/year)	75,993	75,993
Total Food, Manure/Sludge, and Other Organic Waste Available in YR 1 (tonnes/year)	438,730	438,730
Total Bulking Agent Required in YR 1 (tonnes/year)	0	0
Total Waste Composted in YR 1 (tonnes/year)	514,722	514,722
Compost Produced In YR 1 (tonnes/year)	257,361	257,361
Waste Diverted from Landfill in YR 1 (tonnes/year)	388,101	388,101
Percent of Waste Diverted from Landfill (%)	75%	75%
Gate Fee - Yard Waste ($/tonne)	$25.00	$25.00
Gate Fee - Food Waste ($/tonne)	$50.00	$50.00
Gate Fee - Manure/Sludge ($/tonne)	$50.00	$50.00
Gate Fee - All Waste ($/tonne)	$0.00	$0.00
Compost Sale Price ($/tonne)	$10.00	$10.00
Levered IRR (%)	76%	41%

Source: own development

As it can be observed in the previous table, for a gate fee in yard waste of 25 $/ton, food waste and manure/sludge of 50 $/tone and a selling price of compost of 10 $/ton, the Levered Internal Rate of Return (IRR) of a Low and High Capital Investment case for Composting with forced aeration result in 76% and 41%, respectively, which is another possible case of commercial viability under PPP arrangement of a concession. The total incoming waste in the compost plant would start in 514,722 tons/year and was expected to have an increment of 1% each year.

d. Economics of energy from waste by biological conversion

Biological conversion technologies utilize microbial processes to transform waste and are restricted to biodegradable waste such as food and yard waste. Accordingly, the wet matter from the MSW (the biogenic fraction) and agricultural waste are the most suitable feedstocks for biochemical conversion technologies. The economics of energy from waste by Biological conversion using Anaerobic Digestion (AD) and Landfill with Gas Capture and Energy Generation have been considered as follows:

- **Anaerobic Digestion (AD)**

Anaerobic Digestion (AD) is a process by which organic material is broken down by micro-organisms in the absence of oxygen, producing biogas, a methane-rich gas used as a fuel, and digestate, a source of nutrients used as fertilizer. The time of operation per cycle, meaning how long it takes for the organic waste to be processed by an AD plant, is usually 15 to 30 days. The biogas naturally created in sealed tanks is utilized to generate renewable energy in the form of electricity or heat with a combined heat and power unit (CHP). The bio-fertilizer is pasteurized to make it pathogen free and can be applied twice a year on farmland, successfully replacing the fertilizers derived from fossil fuels. The technology is widely used to treat wastewater and can also be effectively employed to treat organic wastes from domestic and commercial food waste, to manures and biofuel crops.

The choice of AD technology will depend on many factors such as type of feedstock, co/single digestion, space (e.g. plants will have to have a small footprint in urban areas), desired output (e.g. more biogas for energy production, waste mitigation, bedding, digestate), infrastructure and available grants/financing. It is very flexible as it can be designed in multiple ways, according to the context in which is intended to operate. The feedstock usually requires pre-treatment, depending on the kind available. For instance, waste food from supermarket will require removal of all packaging and screening for contaminants such as plastics and grit; while others such as manure or waste crops will need to be homogenized to reach the consistency desired for optimum fuel output. AD is a promising technology with multiple benefits for a wide range of stakeholders ranging from the local community, farmers to government. It is considered to be the optimum method for handling food waste in an environmentally safe way. While it is not a new technology, since it dates from as back as 1800s, and experienced continuous growth and technical development throughout the recent years, the market is rather small with huge room for expansion.

A main distinction between anaerobic digestion (AD) technologies for treatment of municipal and industrial biodegradable wastes is the operating process solids content. Wet AD systems operate at low total solids (<10–20% TS) and dry systems have high operating solids (20–>40% TS). The performance of wet and dry AD systems was quantified in relation to: technical operation (footprint, capacity, feedstock characteristics, pretreatment and post-treatment, retention time, water usage), energy balance (biogas productivity, parasitic energy, methane [CH4] content, utilization of biogas and produced energy), digestate management and economic performance (capital and operational costs, revenues, specific capital costs [per t of waste and per m3 biogas]). Wet AD plants had improved energy balance and economic performance compared to dry AD plants. However, dry AD plants offered several benefits, including greater flexibility in the type of feedstock accepted, shorter retention times, reduced water usage and more flexible management of, and opportunities for marketing, the end-product.

In Upper Mid Income Countries, the cost of disposal in anaerobic digestion plants varies from 50 to 100 $/tone of waste.

The cost of Dry Anaerobic Digestion for the organic fraction of the waste stream which ended up in Riverton landfill (Jamaica) during 2017 was estimated using the OrganEcs tool, developed by the USEPA.

A Low and High Capital Investment case has been evaluated resulting as follows:

- Low Capital Investment case of High Tech Dry Anaerobic Digestion:

AD Facility Assumptions		**Units**
Equipment Lifespan	20	years
Incoming Yard Waste in YR 1	75,993	tonnes/year
Incoming Yard Waste to AD in YR 1	75,993	tonnes/year
Incoming Food Waste in YR 1	303,971	tonnes/year
Incoming Manure/Sludge Waste in YR 1	20,000	tonnes/year
Incoming Other Waste in YR 1	114,759	tonnes/year
Total Annual Waste to AD in YR 1	514,722	tonnes/year
Daily Waste Throughput in YR 1	1,660	tonnes/day
AD Facility Design Capacity	519,870	tonnes/year
Design Capacity Daily Throughput	1,677	tonnes/day
Total AD Land Requirement	36	ha
Post Treatment Assumptions		**Units**
End Products from Digestate	Compost	
End Use Yard Waste	Compost Yard Waste	
Technology Used	Composting W/O Forced Aeration	
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Digestate to Composting in YR 1	471,486	tonnes/year
Yard Waste to Composting in YR 1	0	tonnes/year
Purchased Bulking Agent to Composting in YR 1	0	tonnes/year
Total Annual Waste to Composting in YR 1	471,486	tonnes/year
Daily Waste Throughput in YR 1	1,521	tonnes/day
Facility Design Capacity	476,201	tonnes/year
Design Capacity Daily Throughput	1,536	tonnes/day
Total Composting Land Requirement	48	ha
Capital Cost Assumptions		**Units**
Anaerobic Digestion		
Infrastructure and Site Development Cost in Investment Year	$14,941,257	$
AD Equipment Cost in Investment Year	$14,941,257	$
CHP Cost in Investment Year	$18,526,317	$
Dewatering Cost in Investment Year	$0	$
VAT	$8,366,893	$
Land Purchase in Investment Year	$3,836,425	$
Ancillary Costs	$100,000	$
Capital Cost Contingency	$4,840,883	$
AD Capital Investment	**$65,553,032**	$
Composting		
Infrastructure and Site Development Cost in Investment Year	$3,417,937	$
Equipment Cost in Investment Year	$6,945,933	$
VAT	$1,736,483	$
Land Purchase in Investment Year	$5,020,236	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$1,036,387	$
Composting Capital Investment	**$18,161,976**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$83,715,008**	$

Source: own development

- High Capital Investment case of High Tech Wet Anaerobic Digestion:

AD Facility Assumptions		**Units**
Equipment Lifespan	20	years
Incoming Yard Waste in Yr 1	75,993	tonnes/year
Incoming Yard Waste to AD in YR 1	75,993	tonnes/year
Incoming Food Waste in Yr 1	303,971	tonnes/year
Incoming Manure/Sludge Waste in Yr 1	20,000	tonnes/year
Incoming Other Waste in Yr 1	114,759	tonnes/year
Total Annual Waste to AD in Yr 1	514,722	tonnes/year
Daily Waste Throughput in Yr 1	1,660	tonnes/day
AD Facility Design Capacity	519,870	tonnes/year
Design Capacity Daily Throughput	1,677	tonnes/day
Total AD Land Requirement	36	ha
Post Treatment Assumptions		**Units**
End Products from Digestate	Compost	
End Use Yard Waste	Compost Yard Waste	
Technology Used	Composting W/O Forced Aeration	
Equipment Lifespan	7	years
Replacement 1	2027	year
Replacement 2	2034	year
Replacement 3	N/A	year
Digestate to Composting in Yr 1	471,486	tonnes/year
Yard Waste to Composting in Yr 1	0	tonnes/year
Purchased Bulking Agent to Composting in Yr 1	0	tonnes/year
Total Annual Waste to Composting in Yr 1	471,486	tonnes/year
Daily Waste Throughput in Yr 1	1,521	tonnes/day
Facility Design Capacity	476,201	tonnes/year
Design Capacity Daily Throughput	1,536	tonnes/day
Total Composting Land Requirement	48	ha
Capital Cost Assumptions		**Units**
Anaerobic Digestion		
Infrastructure and Site Development Cost in Investment Year	$27,540,646	$
AD Equipment Cost in Investment Year	$27,540,646	$
CHP Cost in Investment Year	$37,052,634	$
Dewatering Cost in Investment Year	$0	$
VAT	$16,148,320	$
Land Purchase in Investment Year	$3,836,425	$
Ancillary Costs	$100,000	$
Capital Cost Contingency	$9,213,393	$
AD Capital Investment	**$121,432,063**	$
Composting		
Infrastructure and Site Development Cost in Investment Year	$4,443,340	$
Equipment Cost in Investment Year	$9,029,750	$
VAT	$2,257,437	$
Land Purchase in Investment Year	$5,020,236	$
Ancillary Costs	$5,000	$
Capital Cost Contingency	$1,347,309	$
Composting Capital Investment	**$22,103,072**	$
Grant Funding	$0	$
TOTAL NET CAPEX IN INVESTMENT YEAR	**$143,535,136**	$

Source: own development

Anaerobic Digestion. Financial Summary:

High-Tech Dry Anaerobic Digestion	USD	
	Low	High
Initial Capital Investment - AD ($)	$65,553,100	$121,432,100
Capex/tonne ($/TPY)	$128	$236
Initial Capital Investment - Composting ($)	$18,162,000	$22,103,100
Capex/tonne ($/TPY)	$39	$47
Total Annual Expenses in YR 1 Operations ($/year)	$11,255,700	$13,482,800
O&M/tonne in YR 1 Operations ($/tonne of waste processed)	$22	$27
Total Land Required (ha)	84.01	84.01
Soil Product Produced		Com
Total Organic Waste Available in YR 1 (tonnes/year)	514,722	514,722
Total Waste to AD in YR 1 (tonnes/year)	514,722	514,722
Digestate Produced in YR 1 (tonnes/year)	471,486	471,486
Digestate to Composting in YR 1 (tonnes/year)	471,486	471,486
Yard Waste to Composting in YR 1 (tonnes/year)	0	0
Bulking Agent to Composting in YR 1 (tonnes/year)	0	0
Total Waste Composted in YR 1 (tonnes/year)	471,486	471,486
Total Compost Produced in YR 1 (tonnes/year)	306,466	306,466
Waste Diverted from Landfill in YR 1 (tonnes/year)	375,706	375,706
Percent of Waste Diverted from Landfill (%)	73%	73%
Net Electricity Produced by AD System in YR 1 (kWh/year)	75,176,834	75,176,834
Electricity Sold in YR 1 (kWh/year)	73,290,892	73,290,892
Gate Fee - Yard Waste ($/tonne)	$25.00	$25.00
Gate Fee - Food Waste ($/tonne)	$50.00	$50.00
Gate Fee - Manure/Sludge ($/tonne)	$50.00	$50.00
Gate Fee - All Waste ($/tonne)	$0.00	$0.00
Electricity Sale Price ($/kWh)	$0.23	$0.23
Levered IRR (%)	150%	47%

Source: own development

As it can be observed in the previous table, for a gate fee in yard waste of 25 $/ton, food waste and manure/sludge of 50 $/ton and a selling price of compost of 10 $/ton and energy sale price of 0.23 $/kWh, the Levered Internal Rate of Return (IRR) of a Low and High Capital Investment case for Dry Anaerobic Digestion result in 150% and 47%, respectively which is another possible case of commercial viability under PPP arrangement of a concession. The total incoming waste in the compost plant would start in 514,722 tons/year and was expected to have an increment of 1% each year.

e. Landfill with Gas Capture and Energy generation

- **Current final disposal practices**

According to the report of the Global Green Growth Institute (Uganda, 2018), the Kiteezi landfill in Wakiso district (15km from Kampala City center) currently collects around 1,400 tons of waste a day from Kampala and it is owned and managed by KCCA. All waste collection companies are mandated to dispose of their collected waste in the Kiteezi landfill, the only licensed waste disposal and treatment facility in the Kampala area. Near Kiteezi landfill, there are domestic residences, vacant land and plastic recycling workshops.

To address the capacity issues at Kiteezi landfill, Kampala City Council Authority (KCCA), with the International Finance Corporation (IFC) as its transaction advisor established together a Public Private Partnership (PPP) to close Kiteezi landfill and design, build, operate and maintain a new landfill at Ddundu. The project proposes remediation, closure and aftercare of the existing disposal site, construction and maintenance of a transfer station with an associated weigh bridge and treatment and or Pre-Treatment of the waste delivered to achieve KCCA diversion from landfill targets, if feasible at the existing Kiteezi landfill site. The PPP transaction was expected to cost between $30mm and $100mm to develop and run for 20 years, depending on the type of technology deployed. It proposed that waste be transported from Kiteezi to the new landfill site in Ddundu (30km distance) where the investor was expected to construct, operate and maintain an engineered sanitary landfill for disposal of treated and untreated municipal waste. The project strongly encourages proven methods of diverting waste away from the new landfill as much as possible.

At the investor conference celebrated in December 2017, the main problem identified was the 1,000+ landfill waste pickers who perform its economic activities through the Kiteezi landfill. These waste pickers are organized under the Landfill Waste Pickers Association, with over 500 registered members, 78% of whom are women. Most of them live around the landfill and about 60% of them moved to Kiteezi primarily for the business of waste picking. About 300 members of the organization are known to show up daily (the equivalent of permanent workers) while the rest work part time. Half of its registered members pay membership fees to the organization. Membership perks include group savings schemes and the group helps cover funeral expenses for its members and their families through voluntary member contributions.

When the IFC project commences, the landfill will be inaccessible to these waste pickers putting them out of work. It is expected that they will try to gain access to the landfill illegally but KCCA believes that it has the means to enforce the new policy by fencing off the landfill and restricting access. This however, poses various risks to the different stakeholders - operational risk for the investor, political risk for KCCA and reputational risk for IFC. At this point, IFC does not have a solution to the problem and is looking to local institutions.

- **Proposed final disposal strategies**

Waste disposal, in particular through the use of sanitary landfills, at the bottom of the hierarchy, is the management option proposed for the remaining fraction of waste when all forms of diversion, recycling and valorization are exhausted. It also has the important function of removing unwanted materials from the life-cycle for a final safe and secure storage. Disposal facilities and operations are not all the same: there is a hierarchy of sophistication and reliability of measures applied to protect the environment. At the top of the disposal hierarchy is the landfill, an engineered facility featuring various controls installed to prevent releases of pollutants to soil, water and air. A controlled disposal site (or controlled dumpsite), officially designated for the purpose, is next in the hierarchy. The site is fenced and access is controlled, with some form of control and registration of incoming waste, and basic operations management at the site. An uncontrolled dumpsite is third in the disposal hierarchy, below the level of acceptability but common in low and sometimes middle-income countries like Uganda. It is important to phase out open-burning dumpsites and convert to controlled disposal facilities, even if they do not meet modern engineering standards. The internationally accepted approach in this regard is progressive rehabilitation to upgrade and phase out uncontrolled dumpsites. Due to its simplicity and financial reason, solid waste disposal on sanitary landfill has been the common practice for many decades. However, reducing landfilling in favor of increasing recycle of energy and materials lead to a lower environmental impact, a lower consumption of energy resources and lower economic costs. Landfilling of energy rich waste should be avoided as far as possible, partly because of the negative environmental impacts from landfilling, and mainly because of its low recovery of resources. Furthermore, burying organic fraction of municipal solid waste together with other fractions implied extra cost for leachate treatment, low biogas quality and quantity, and high post closure care.

The most common way of managing these wastes is through sanitary landfills, which must be properly designed, well-constructed and systematically managed. In modern landfills the design comprises a low permeability liner to restrict leachates, a strong effluent, from percolating through the base of the landfill and a pipe system enabling collection of leachates for proper treatment and disposal. It comprises also a pipe system for collecting most of the biogas generated by the anaerobic decomposition of the organic materials so as to be flared or used for energy generation. In Upper Mid Income Countries, the cost of disposal in open dumps varies from 3 to 10 $/tone of waste, while the disposal in sanitary landfills varies from 25 to 62 $/ton.

Landfills are a significant source of greenhouse gas emissions, and methane in particular can be captured and utilized as an energy source. Organic materials that decompose in landfills produce a gas comprised of roughly 50% methane and 50% carbon dioxide, called landfill gas (LFG). Methane is a potent greenhouse gas with a global warming potential that is 25 times greater than CO2. Capturing methane emissions from landfills is not only beneficial for the environment as it helps mitigate climate change, but also for the energy sector and the community.

Applications for LFG include direct use in boilers, thermal uses in kilns (cement, pottery, bricks), sludge dryers, infrared heaters, blacksmithing forges, leachate evaporation and electricity generation to name a few. LFG is increasingly being used for heating of processes that create fuels such as biodiesel or ethanol, or directly applied as feedstock for alternative fuels such as compressed natural gas, liquefied natural gas or methanol. The projects that use cogeneration (CHP) to generate electricity and capture the thermal energy are more efficient and more attractive in this sense. The process of capturing LFG involves partially covering the landfill and inserting collection systems with either vertical or horizontal trenches. Both systems of gas collection are effective, and the choice of design will depend on the site-specific conditions and the timing of installation. They can also be employed in combination and an example is the utilization of a vertical well and a horizontal collector. As gas travels through the collection system, the condensate (water) formed needs to be accumulated and treated. The gas will be pulled from the collection wells into the collection header and sent to downstream treatment with the aid of a blower. Depending on the gas flow rate and distance to downstream processes, the blowers will vary in number, size or type. The excess gas will be flared in open or enclosed conditions to control LFG emissions during start up or downtime of the energy recovery system, or to control the excess gas, when the capacity for energy conversion is surpassed. The LFG treatment of moisture, particulates and other impurities is necessary, but the type and the extent will depend of the sort of energy recovery used and the site-specific characteristics. Minimal treatment can be employed for boilers and most internal combustion systems, while other internal combustion systems, gas turbines and micro turbine applications will require more sophisticated procedures with absorption beds, biological scrubbers and others, to remove substances such as siloxane and hydrogen sulphide.

Case study in Riverton Landfill gas to energy project (Jamaica)

Mathematical models are a useful and economical tool for estimating the LFG generation potential at the site. The results of the model can be used to assess the potential for hazardous LFG emissions/migration, and for assessing the feasibility of the LFG management project. There are numerous models available to calculate LFG production. All of these models can be used to develop an LFG generation curve that predicts the gas generation over time. The total gas yield and rate at which the gases are generated can vary somewhat with the different models but the most important input parameter that is common to all models is the quantity of decomposable waste that is assumed. The other input parameters can vary depending on the model used, and are influenced by a number of variables including those factors influencing LFG generation, uncertainties in the available information for the site, and how the management of LFG extraction affects LFG generation by inducing any air infiltration.

The potential LFG generation of Riverton LFG generation is calculated using the ACM0001 – version 17: “Flaring or use of landfill gas” based on flow rate of the landfill gas to be produced from each landfill, methane concentration, and destruction/conversion efficiency of the combustion equipment. The key input parameter for the application of the ACM0001 – version 17: “Flaring or use of landfill gas” to determine the LFG projections is the waste input streams which was gathered during the site visit. The heterogeneous and time-variable nature of all landfills lends an inherent difficulty with collecting accurate data from a site without a large ongoing cost outlay. Any model output is only as good as the input data and often there are very broad assumptions necessary with respect to estimating waste quantities and types.

Table 9: *Technical parameters for GHG emission reductions calculation in a landfill*

Physical parameters of compounds				
Parameters	Unit	Value	Explanantion	Source
Φ	-	0.75	Model correction factor to account for model uncertainitites	According to the ""Emissions from solid waste disposal sites" (Version 06.0.1)", page 2
f	%	0.0	Fraction of CH4 catpured to the SWDS	Considered 0 since the Tool - Annex 13 also considers an Adjustment Factor
GWP	tCO2e/tCH4	25	Global Warming Potential	According to the "Emissions from solid waste disposal sites" (Version 06.0.1), page 2. Table 2.14 of the Fourth Assessment Report of the IPCCC.
OX	-	0.1	Oxidation factor	According to the "Tool v.6" page 3, considering the material utilized for covering the landfill (at the clousure)
F	%	0.5	Fraction of CH4 in the SWDS gas	According to the "Emissions from solid waste disposal sites" (Version 06.0.1), page 2
DOC_f	%	0.5	Fraction of degradable organic carbon that can decompose	According to the "Emissions from solid waste disposal sites" (Version 06.0.1), page 3
MCF	-	1.0	Methane Correction Factor	According to the "Emissions from solid waste disposal sites" (Version 06.0.1) page 4, considering the management of the landfill
r_{CH4}	tonnes/m^3	0.0007168	Density CH4	According to the ""Emissions from solid waste disposal sites" (Version 06.0.1), page 9 (density of methane at normal conditions)
OX_{top_layer}	-	0.1	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline	Consistent with how oxidation is accounted for in the methodological tool Emissions from solid waste disposal sites"
CH4 (%v/v)	%	50%	CH4 concentration	To be monitored (this value as a default per PDD calculations)

Equipment Details				
Parameters	Unit	Value	Explanantion	Source
η_{PJ}	%	0.50	GCE of the equipment installed	Default value as per page 10/23 of ACM0001 / Version 13.0.0 "Flaring or use of landfill gas"
Blower	HP	60	1 blower engine 60HP; 3,600 RPM; 03Phase; 60HZ	Project Developer
$EC_{PJ,y}$	MWh/yr	357.9	Electricity Consumption, yearly	Calculated
ηflare,m	%	0.9	Flare Efficiency in the minute m	Default value according to the tool "Project emissions from flaring" version 02.0.0
CEG	MW	0.500	Capacity of Each Generator (G3516A)	Data for caterpillar Engine G3516A. Provided to the DOE as "Properties Caterpillar Engine" and available at http://pdf.cat.com/cda/files/555685/7/lehe1883.pdf
GE	%	32.10%	Generator efficiency	Data for caterpillar Engine G3516A. Provided to the DOE as "Properties Caterpillar Engine" and available at http://pdf.cat.com/cda/files/555685/7/lehe1883.pdf
FLGE	m3/h	281.27	Flow LFG each generator	Calculated
Tcn	m3/h	0	Thermal Consumption	NA
ε_{boiler}	%	0	Boiler efficiency	NA

Electrical considerations				
Parameters	Unit	Value	Explanantion	Source
EFgrid,y	tCO2e/MWh	0.4756	Grid Emission Factor	See detailed calculation in sheet "EF_Mexico_2010" provided to DOE as per the "Tool to calculate the emission factor for an electricity system" Version 4.0
TDLy	ratio	20.00%	Technical losses in the grid	Default value

Working times				
Parameters	Unit	Value	Explanantion	Source
helec	h/year	8,000	Hours of generators	Project developer
hbl	h/year	8,000	Hours of blowers	Project developer
hth	h/year	0	Hours of thermal consumption	NA

Source: own development

Site characteristics				
Parameters	Unit	Value	Explanantion	Source
MAT	ºC	27.1	Mean Average Temperature	http://worldweather.wmo.int/en/city.html?cityId=1209
MAP	mm/year	1,338	Mean average Precipitation	http://worldweather.wmo.int/en/city.html?cityId=1209
PET	mm^3/mm^2	1	Potential evapotranspiration	http://www.fao.org/geonetwork/srv/fr/graphover.show?id=12739&fname=aridity_index.gif&access=public
Waste basis	-	wet	Waste basis (wet / dry)	Project developer

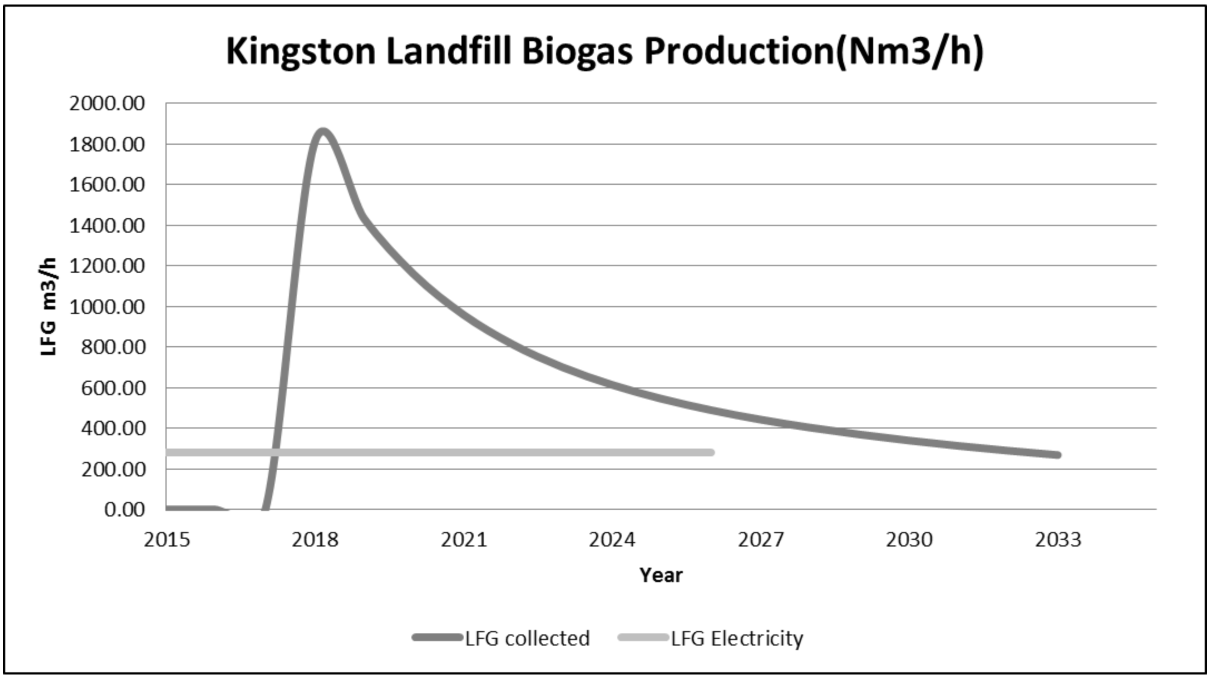
Waste Input	Year	0	Year	Waste	Year	Waste
	1998	76,334	2009	213,663	2020	0
	1999	83,883	2010	232,893	2021	0
	2000	92,179	2011	253,853	2022	0
	2001	101,296	2012	276,700	2023	0
	2002	111,314	2013	301,603	2024	0
	2003	122,324	2014	328,747	2025	0
	2004	134,421	2015	358,334	2026	0
	2005	147,716	2016	390,585	2027	0
	2006	162,325	2017	481,506	2028	0
	2007	178,379	2018	457,199	2029	0
	2008	196,021	2019	0	2030	0

Composition	Waste composition	Source
Glass, plastic, metal, other inert waste	30.60%	LF information, Waste composition
Pulp, paper, cardboard (other sludge)	17.00%	
Textiles	4.00%	
Wood and wood products	2.00%	
Garden, yard and park waste	8.00%	
Food, food waste, beverages and tobacco (other than sludge)	38.40%	

Source: own development

Using the input data shown in the previous tables, the landfill gas (LFG) generation for Riverton site was calculated. The following graph shows the Nm3/h of LFG to be expected from Riverton site:

Figure 4: *LFG production in Riverton site*



Source: own development

The result shown in the previous graph indicates that Riverton LFS, if operated during the next 20 years (considering its closure in 2018), will produce a peak of LFG destroyed estimated to be 1800 Nm3/h.

The expected LFG could be used in 1 engine for electricity generation of 500 KW as seen in the following table:

Table 10: *Yearly GHG emission reductions calculated for a landfill to energy project*

Period		$LFG_{project,y}$ (Nm3/year)	$BE_{CH4,y}$ (tonnes of CH4)	$LFG_{electricity,y}$ (Nm3/year)	Electricity (MWh/year)
Start Date	**End Date**				
01/01/2018	31/12/2018	14,444,257	116,478	0	0
01/01/2019	31/12/2019	11,409,818	92,009	281	4,000
01/01/2020	31/12/2020	9,262,718	74,695	281	4,000
01/01/2021	31/12/2021	7,655,812	61,736	281	4,000
01/01/2022	31/12/2022	6,482,069	52,271	281	4,000
01/01/2023	31/12/2023	5,592,033	45,094	281	4,000
01/01/2024	31/12/2024	4,914,864	39,633	281	4,000
Total		**59,761,571**	**481,916**	**1,686**	**24,000**
Annual average		**8,537,367**	**68,845**	**241**	**3,429**

Source: own development

Financial analysis for Landfill gas to Flare and Energy

Under the proposed project activity to collect and flare the gas from the Riverton disposal site, the required investment should consist on the capping of the site, a LFG collecting and pre-treatment system (fieldwork), a flaring system and electricity generation equipment. First, the landfill should be covered by clay to prevent the biogas to come out through the landfill surface (capping). Then, the landfill gas is collected with the use of blowers, and then through a pipe system (fieldwork), the landfill gas will reach a pre-treatment system, in which the moisture and impurities of the landfill gas will be removed. Finally, the landfill gas will be transported with the use of a blower, to the enclosed flare for its combustion and utilization in electricity generation engines.

The flare will be under continuous monitoring of compliance with its manufacturer's specifications in order to ensure methane destruction. The considered investment of each site is considering the following items:

- Landfill gas capping: It is necessary to conduct the sealing of the landfill to prevent the entry (ingress) of oxygen (creating aerobic condition inhibiting methane production) and the escape (egress) of gas, odor and other fugitive emissions. A 500 mm cap of clay or local material is proposed to be a reasonable solution for the site.

- Landfill gas collection System (Fieldwork): The equipment that will be installed by the project activity for the landfill gas collection system should include:

  - Drilling of vertical wells used to extract gas and leachate;
  - Optimal well spacing for maximum gas collection whilst minimizing costs;
  - Wellheads designed as a looping system in order to allow for partial or total loss of header function in one direction without losing gas system functionality;
  - Condensate extraction and storage systems designed at strategic low points

  - Pipeline collection system to connect the LFG collected with the flare system

- Landfill gas flaring system: The equipment that to be installed by the project activity for the landfill gas flaring system should include:

  - One enclosed flare with burning controlled system; all burners will be anti-flashback type, with an internal stainless-steel flame arresting seal, a stainless-steel diverter plate, and no adjustable, or moving parts;
  - Blower system used to direct the landfill gas for flaring;
  - Equipment to continuously monitor the landfill gas methane composition, gas flow, and flare temperature;
  - Security restart system in case the system is turned off; and
  - Flare efficiency continuous monitoring.

- Electricity Generation Equipment: One unit of 0.5 MW was considered to be installed. This unit facility includes blowers, heat exchangers and chillers. In case of a system maintenance or shutdown, all LFG will be redirected to the flaring system, in order to properly destroy the methane that would not be used to for energy generation.

Investment for Riverton disposal site should include the capping, the LFG collection system, the flare and the electricity generator (1*500 kW) as the key elements. The investment costs of each element have been determined based on other quotations for similar projects. The following table summarizes the required investment cost expected to be around $4,3 million :

Table 11: *Investment cost summary for a landfill to energy project*

Units	INVESTMENT	UNIT	Initial
Gas header piping (assume 14 in) - above ground			
1	Electric Generator	USD	1,426,780
INPUT ECONOMIC VARIABLES			
1	Mobilization and project management	USD	50,000
129	Gas extraction wells (average depth 20 m)	USD	877,200
4	Road crossings	USD	12,000
9,000	Gas header piping (assume 14 in) - above ground	USD	711,000
3,000	Gas lateral piping to wells (assume 4 in)	USD	90,000
3	Condensate traps, self-draining	USD	24,000
1	Condensate manholes with pumping	USD	19,500
1	Construction and sitework	USD	20,000
1	Flare start-up	USD	20,000
1	Source test	USD	25,000
Parameters			
129	Gas extraction wells (average depth 20 m)	USD	877,200
Construction and sitework			
1	Engineering (LFG Collection System)	USD	145,000
TOTAL INVESTMENT		**USD**	4,297,680

Source: own development

The following O&M cost has been considered for the project:

- O&M LFG collection system cost: 10% (vs investment collection system cost)
- O&M LFG flare cost: 10% (vs investment flare system)
- O&M Electricity generator cost: 15% (vs investment electricity generator cost)

Considering the Investment on CAPEX and O&M, the expected IRR of the project results in 11.61%, which is another possible case of commercial viability as can be seen in the financial model presented below:

Units		Unit	Initial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Period	Initial	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3
		Year	Average	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
				01/01/2018	01/01/2019	01/01/2020	01/01/2021	01/01/2022	01/01/2023	01/01/2024	01/01/2025	01/01/2026	01/01/2027	01/01/2028	01/01/2029	01/01/2030	01/01/2031	01/01/2032	01/01/2033	01/01/2034	01/01/2035	01/01/2036	01/01/2037	01/01/2038
	REVENUES			31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022	31/12/2023	31/12/2024	31/12/2025	31/12/2026	31/12/2027	31/12/2028	31/12/2029	31/12/2030	31/12/2031	31/12/2032	31/12/2033	31/12/2034	31/12/2035	31/12/2036	31/12/2037	31/12/2038
	ER_Y	Tonnes CO2e/y	39,655.3	116,274	94,087	76,773	63,815	54,350	47,173	41,712	37,179	33,580	30,589	28,124	25,866	23,951	22,254	20,787	19,366	19,366	19,366	19,414	19,366	19,366
	CERs price	USD/CER	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CER Revenue from Methane Reductions	**USD/year**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Electrical generation	MWh/year	4,000.0	-	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
	Nº of generators	-	1.0	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Electric price	USD/MWh	314.1	230.00	236.90	244.01	251.33	258.87	266.63	274.63	282.87	291.36	300.10	309.10	318.37	327.93	337.76	347.90	358.33	369.08	380.15	391.56	403.31	415.41
	Electrical Revenue	**USD/year**	**1,212,493.7**	**-**	**947,600**	**976,028**	**1,005,309**	**1,035,468**	**1,066,532**	**1,098,528**	**1,131,484**	**1,165,428**	**1,200,391**	**1,236,403**	**1,273,495**	**1,311,700**	**1,351,051**	**1,391,583**	**1,433,330**	**1,476,330**	**1,520,620**	**1,566,238**	**1,613,226**	**1,661,622**
	TOTAL REVENUES	USD/year		-	947,600	976,028	1,005,309	1,035,468	1,066,532	1,098,528	1,131,484	1,165,428	1,200,391	1,236,403	1,273,495	1,311,700	1,351,051	1,391,583	1,433,330	1,476,330	1,520,620	1,566,238	1,613,226	1,661,622
Units	**INVESTMENT**	**UNIT**	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
LFG ELECTRICITY SYSTEM																								
1	Electric Generator	USD	0	0	1,426,780		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LFG COLLECTING SYSTEM																								
1	Mobilization and project management	USD	50,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129	Gas extraction wells (average depth 20 m)	USD	877,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Road crossings	USD	12,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9,000	Gas header piping (assume 14 in) - above ground	USD	711,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	0	0	0	0
3,000	Gas lateral piping to wells (assume 4 in)	USD	90,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Condensate traps, self-draining	USD	24,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Condensate manholes with pumping	USD	19,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Construction and sitework	USD	20,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Flare start-up	USD	20,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Source test	USD	25,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LFG FLARE SYSTEM																								
1	LFG enclosed flare station (1,900 m3/hr LFG capacity)	USD	300,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENGINEERING (non-depreciable)																								
	Engineering (LFG Collection System)	USD	145,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL INVESTMENT	**USD**	2,293,700	0	1,426,780	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	0	0	0	0
	Anual depreciation on the LFG collection and flaring system	**USD**		214,870	214,870	214,870	214,870	214,870	214,870	214,870	214,870	214,870	214,870	0	0	0	0	0	0	0	0	0	0	0
	Anual depreciation on generator 1	**USD**		0	0	142,678	142,678	142,678	142,678	142,678	142,678	142,678	142,678	142,678	142,678	0	0	0	0	0	0	0	0	0
	Anual depreciation on generator 2	**USD**		0	0	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	50,000	0	0	0	0	0	0
													3,421,782											
	O&M COSTS	**UNIT**	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
10%	**O&M LFG collection system cost**	**USD/Year**		**184,870**	**190,416**	**196,129**	**202,012**	**208,073**	**214,315**	**220,744**	**227,367**	**234,188**	**241,213**	**248,450**	**255,903**	**263,580**	**271,488**	**279,632**	**288,021**	**296,662**	**305,562**	**314,729**	**324,171**	**333,896**
10%	**O&M flare system cost**	**USD/Year**		**30,000**	**30,900**	**31,827**	**32,782**	**33,765**	**34,778**	**35,822**	**36,896**	**38,003**	**39,143**	**40,317**	**41,527**	**42,773**	**44,056**	**45,378**	**46,739**	**48,141**	**49,585**	**51,073**	**52,605**	**54,183**
15%	O&M Electric generator	USD/each		0	0	214,017	220,438	227,051	233,862	240,878	248,104	255,548	263,214	271,110	279,244	287,621	296,250	305,137	314,291	323,720	333,432	343,435	353,738	364,350
	O&M Electric generator cost	**USD/Year**		**0**	**0**	**214,017**	**220,438**	**227,051**	**233,862**	**240,878**	**248,104**	**255,548**	**263,214**	**271,110**	**279,244**	**287,621**	**296,250**	**305,137**	**314,291**	**323,720**	**333,432**	**343,435**	**353,738**	**364,350**
0.3%	**Contingencies**	**USD/Year**		**6,881**	**7,088**	**11,911**	**12,269**	**12,637**	**13,016**	**13,406**	**13,809**	**14,223**	**14,650**	**15,089**	**15,542**	**16,008**	**16,488**	**16,983**	**17,492**	**18,017**	**18,558**	**19,114**	**19,688**	**20,278**
	TOTAL COSTS	**USD/year**		221,751	228,404	453,884	467,501	481,526	495,971	510,851	526,176	541,961	558,220	574,967	592,216	609,982	628,282	647,130	666,544	686,540	707,137	728,351	750,201	772,707
	ANALYSIS	**UNIT**	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	EBITDA	USD		- 221,751	719,196	522,144	537,808	553,942	570,561	587,678	605,308	623,467	642,171	661,436	681,279	701,718	722,769	744,452	766,786	789,790	813,483	837,888	863,024	888,915
	EBITDA	%		NA	76%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%
	Depreciation	USD		214,870	214,870	407,548	357,548	357,548	407,548	357,548	357,548	407,548	357,548	142,678	192,678	-	-	50,000	-	-	-	-	-	-
	EBIT	USD		- 436,621	504,326	114,596	180,260	196,394	163,013	230,130	247,760	215,919	284,623	518,758	488,601	701,718	722,769	694,452	766,786	789,790	813,483	837,888	863,024	888,915
	EBIT	%		NA	53%	12%	18%	19%	15%	21%	22%	19%	24%	42%	38%	53%	53%	50%	53%	53%	53%	53%	53%	53%
	Tax lost	USD		-	126,082	28,649	45,065	49,099	40,753	57,532	61,940	53,980	71,156	129,690	122,150	175,429	180,692	173,613	191,696	197,447	203,371	209,472	215,756	222,229
	Net profit	USD	-	- 436,621	378,245	85,947	135,195	147,296	122,260	172,597	185,820	161,939	213,467	389,069	366,451	526,288	542,077	520,839	575,089	592,342	610,112	628,416	647,268	666,686
	NET CASH FLOW	**USD**	**- 2,293,700**	**- 221,751**	**- 833,666**	**443,495**	**492,743**	**504,844**	**479,808**	**530,145**	**543,368**	**519,487**	**571,015**	**531,747**	**509,129**	**526,288**	**542,077**	**520,839**	**575,089**	**592,342**	**610,112**	**628,416**	**647,268**	**666,686**
	IRR	**%**	**11.61%**																					

Table 12: Investment assessment for a landfill to energy project. Source: own development

These cases of study have been provided as examples of commercial viability and provide a general approach of the financial structure of these types of waste management strategies which could be replicated in Uganda.

BIBLIOGRAPHY

- Abarca-Guerrero, L (2013) "Gender and Recycling: Tools for Project Design and Implementation: Regional Initiative for Inclusive Recycling". Inter-American Development Bank. Retrieved from:

https://www.researchgate.net/publication/259921861_Gender_and_Recycling_Tools_for_Project_Design_and_Implementation_REGIONAL_INITIATIVE_FOR_INCLUSIVE_RECYCLING

- Allan J. Komakech , Noble E. Banadda , Joel R. Kinobe , Levi Kasisira , Cecilia Sundberg , Girma Gebresenbet & Björn Vinnerås (2014) "Characterization of municipal waste in Kampala, Uganda"

- African Development Bank Group (2016) "Uganda country gender profile"

- Ask your Government (2012) "Kampala slum profiles: Nakawa". Retrieved from: http://askyourgov.ug/request/37/response/37/attach/4/Nakawa%20Municipality.pdf

- Alabaster, R. and Kručková, L. (2015) "Uganda Country Mapping the Status of Implementation and Monitoring of the Human Right to Water and Sanitation". Waterlex. Retrieved from: https://www.waterlex.org/beta/wp-content/uploads/2018/08/Uganda-Country-Mapping.pdf".

- Aryampa, M. et.al (2019) "Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability". Retrieved from: https://www.mdpi.com/2071-1050/11/19/5523/htm

- AUC (2015a) "Agenda 2063: The Africa we want". Retrieved from: https://au.int/sites/default/files/pages/3657-file-agenda2063_popular_ version_en.pdf

- AUC (2015b). "Agenda 2063. First ten-year implementation plan 2014-2023". Retrieved from: http://www.un.org/en/africa/osaa/pdf/au/ agenda2063-first10yearimplementation.pdf

- Buyana, K. & Lwasa, S. (2014) "Gender responsiveness in infrastructure provision for African cities: The case of Kampala in Uganda". Journal of Geography and Urban planning. Vol. 7(1), pp. 1-9

- Gender and Environment Resource Center (IUCN) "Climate Change Gender Action Plans (ccGAPs)". Retrieved from: https://genderandenvironment.org/works/ccgaps/

- Chandni, J. (2018) "A perspective on a locally managed decentralized circular economy for waste plastic in developing countries"

- Chant, S (2013) Cities through a "gender lens": A golden "urban age" for women in the global South?". - Gedefaw, M. (2015) "Assessing The Current Status of Solid Waste Management of Gondar Town, Ethiopia"

- Global Green Growth Institute (GGGI) (2018) "Kampala municipal solid waste value chain mapping". Ministry of Water and Environment, Uganda.

- Global Green Growth Institute (GGGI) (2018) "Value chain analysis report and investment options study on municipal solid waste management (MSWM) in Kampala". Ministry of Water and Environment, Uganda.

- Gold Standard for the Global Goals (GS4GG) (2018) “Gender Equality Requirements & Guidelines”

- Green, Elliott (2015) Decentralization and development in contemporary Uganda. Regional and Federal Studies. pp. 1-18. ISSN 1359-7566

- Gutberlet, J. (2016) “Urban Recycling Cooperatives: Building Resilient Communities”. London: Routledge.

- Gutberlet, J. (2017) “Waste in the City: Challenges and Opportunities for Urban Agglomerations.

- Heuër, A. (2016) “All Women Recycling: Empowering women in South Africa through plastic recycling”. SEED Case Studies.

- Inter American Development Bank (2013) “Gender and Recycling: Tools for Project Design and Implementation Regional Initiative For Inclusive Recycling”.

- International Labour Organization (ILO) and Women in Informal Employment: Globalizing and Organizing (WIEGO). 2017. “Cooperation among Workers in the Informal Economy: A Focus on Home-Based Workers and Waste Pickers”. Geneva: ILO and WIEGO.

- James Okot-Okumu “Solid Waste Management in African Cities – East Africa”. Department of Environmental Management; School of Forestry Environmental and Geographical Sciences; College of Agricultural and Environmental Sciences; Makerere University Kampala, Uganda

- Kabera, T., Wilson, D. C., & Nishimwe, H. (2019). “Benchmarking performance of solid waste management and recycling systems in East Africa: Comparing Kigali Rwanda with other major cities”. Waste Management & Research, 37(1), 58–72.

- Kareem Buyapa (2015) “The Waste Economy as a Transformative Gendered Practice for Sustainable Resource Management in Urban Africa”. The Nature of Cities. Kampala.

- KCCA (2015) “Waste Collection and Transportation” Retrieved from: https://kcca.go.ug/WasteCollection-and-Transportation

- KCCA (2017) “National Population and Housing Census 2014, Area Specific Profiles”

-KCCA (2019) “Composition of the Authority”. Retrieved from: https://kcca.go.ug/about-the-authority

- KCCA (2019) “About the authority” Available: https://kcca.go.ug/about-the-authority

- Kaffoko, M. (2015) “Analysis of social economic factors affecting household solid waste management in urban areas of Uganda, Case Study: Kawempe division”.

- Katusiimeh, M and Buerger, K. et al. (2013) Informal waste collection and its co-existence with the formal waste sector: The case of Kampala, Uganda. Habitat International.

- Katusiimeh, M. (2012) “Public and Private Service Provision of Solid Waste Management in Kampala,

Uganda”.

- Kaza, S. et. al (2018) "What a waste 2.0: A global snapshot of solid waste management 2050" World Bank Group. Urban Development Series. Retrieved from: https://openknowledge.worldbank.org/handle/10986/2174

- Kinobe, J.R et. al (2015) "Mapping out the solid waste generation and collection models: The case of Kampala City". Journal of the Air & Waste Management Association, 65:2, 197-205.

- Kinobe, J. (2015) "Assessment of Urban Solid Waste Logistics Systems: The Case of Kampala, Uganda", Faculty of Natural Resources and Agricultural Sciences Department of Energy and Technology, Uppsala.

- Klundert, A.V. and Lardinois, I. (1995) "Community and private (formal and informal) sector involvement in municipal solid waste management in developing countries".

- Least Developed Countries Expert Group (2015) "Strengthening gender considerations in adaptation planning and implementation in the least developed countries". United Nations. Framework Convention on Climate Change.

- Maloney, W. F. & J. Saavedra-Chanduvi. (2007). "The Informal Sector: What Is It, Why Do We Care, and How Do We Measure It?" in G. E. Perry, W. F. Maloney, O. S. Arias, P. Fajnzylber, A. D. Mason & J. Saavedra-Chanduvi (eds). Informality: Exit and exclusion. Washington DC: World Bank.

- Ministry of water and Environment (2018) "Water and sanitation gender strategy 2018 – 2022". Retrieved from: https://www.mwe.go.ug/sites/default/files/library/Water%20and%20Sanitation%20Gender%20Strategy.pdf

- Mwansa B. & Mbohwa, C. (2017) "Drivers to Sustainable Plastic Solid Waste Recycling: A Review".

- NEMA (2014). "National state of the environment report for Uganda 2014: Harnessing our environment as infrastructure for sustainable livelihood & development". Retrieved from: https://nema.go.ug/sites/all/themes/nema/docs/FINAL%20NSOER%202014.pdf

- Oates, L. Gillard, R. Kasaija, P. Sudmant, A. and Gouldson, A. (2019) "Supporting decent livelihoods through sustainable service provision: Lessons on solid waste management from Kampala, Uganda". Coalition for urban transitions. University of Leeds. Retrieved from: https://newclimateeconomy.report/workingpapers/wpcontent/uploads/sites/5/2019/04/CUT19_frontrunners_kampala_ waste_rev.pdf

- OECD (2014), "Social Institutions and Gender Index 2014 synthesis report", OECD, Paris, available at: www.oecd.org/dev/development-gender/BrochureSIGI2015- web.pdf.

- Okot-Okumu, J. (2011) "Municipal solid waste management under decentralization in Uganda". Habitat International, 35(4), 537–543.

- Parliament of the Republic of Uganda, (2018) "Streamline solid waste management in Kampala – MMPs". Retrieved from: https://www.parliament.go.ug/news/1496/streamline-solid-waste-managementkampala-%E2%80%93-mps

- Pilot Program for Climate Resilience (PPCR), 2017 "Strategic Program for Climate Resilience: Uganda Pilot Program for Climate Resilience (PPCR)". Republic of Uganda.

- Pollicy (2017) "Drowning in Waste: Whose responsibility is it to keep Kampala's sprawl clean? Reflections from service providers in the trenches of waste management". Retrieved from: https://medium.com/@pollicy/drowning-in-waste-whose-responsibility-is-it-to-keep-kampalas-sprawl-cleanbf5587d82792

- Rui, S (2016) "All women recycling". Retrieved from: https://datadrivenlab.org/project/all-women-recyclingsouth-africa/

- SADC (2001). Southern African Development Community Regional Indicative Strategic Development Plan. Gabarone. Retrieved from: http://www.sadc.int/files/5713/5292/8372/Regional_ Indicative_Strategic_Development_Plan.pdf

- Shamim Aryampa , Basant Maheshwari , Elly Sabiiti, Najib L Bateganya and Brian Bukenya (2019) "Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability"

- Ssali, S. et. al (2019) "A matrix and analysis of gender equality laws and policies in Uganda". School of Women and Gender Studies in partnership with University Forum on Governance under the Gender Equality Project." School of Women and Gender Studies in partnership with University Forum on Governance under the Gender Equality Project.

- Saphores, J. Nixon, H. Ogunseitan, O. & Shapiro, A. (2006) "Household willingness to recycle electronic waste: an application to California". Environ Behav; Vol 38:183–208

Seager, J. (2008) "Expert Group Meeting Gender-disaggregated Data on Water and Sanitation". United Nations Headquarters, New York 2–3.

- SEED (2015). "Turning Ideas into Impact: Setting the Stage for the next 10 Years of Green and Inclusive Growth through Entrepreneurship".

- Sterenberg, P. (2016) "Plastic Recycling Industries Uganda Ltd. (PRI)". Retrieved from: "http://www.sterenbergsalinas.nl/2005/12/plastic-recycling-industries-uganda-ltd-pri/

- The Independent (2019) "Government takes over determination of garbage collection fees in Kampala" Retrieved from:https://www.independent.co.ug/government-takes-over-determination-ofgarbage-collection-fees-in-kampala/

- T.T. Poswa (2004) "The Importance of Gender in Waste Management Planning: A Challenge for Solid Waste Managers". Durban Institute of Technology (DIT). South Africa.

- Tukahirwa, J. T., A. P. J. Mol & P. Oosterveer. 2013. "Comparing urban sanitation and solid waste management in East African metropolises: The role of civil society organizations". Cities, 30, 204–211.

- Uganda Bureau Of Statistics (2015). "The National Population and Housing Census 2014-Main Report".

- UBOS (2017) "Uganda National Household Survey (UNHS) 2016/2017". Retrieved from: https://www.ubos.org/wp-content/uploads/publications/03_20182016_UNHS_FINAL_REPORT.pdf

- Uganda Bureau Of Statistics (2018) "Uganda Demographic and Health Survey 2016". Retrieved from: https://www.ubos.org/wp-content/uploads/publications/07_2018UDHS_2016_FInal.pdf

- Uganda Bureau Of Statistics (2014) "National Population and housing Census: Together we count".

- UNDP (2015) "UGANDA COUNTRY GENDER ASSESSMENT". Retrieved from: https://www.undp.org/content/dam/uganda/docs/UNDPUg2016%20-UNDP%20Uganda%20%20Country%20Gender%20Assessment.pdf

- UNEP-IETC and GRID-Arendal (2019). Gender and waste nexus: experiences from Bhutan, Mongolia and Nepal. Retrieved from: file:///C:/Users/catal/OneDrive/Escritorio/Gender%20ALLCOT/Gender/varios/Gender%20and%20waste%20e xperienc%20e%20from%20bhutan%20and%20mongolia%20UN.pdf

- UNICEF (2019) "UNICEF breaks ground on Africa's first-of-its-kind recycled plastic brick factory in Côte d'Ivoire" Retrieved from: https://www.unicef.org/press-releases/unicef-breaks-ground-africas-firstits-kind-recycled-plastic-brick-factory-c%C3%B4te.

- United Nations (2019) "World Urbanization Prospects The 2018 Revision".

- United Nations (2018) "Africa Waste Management Outlook".

- The Guardian (2015) "Gambian community project helps women turn waste to worth "Retrieved from: https://www.theguardian.com/global-development/2015/sep/18/the-gambia-recycling-innovationcentre-womens-initiative

-WaterAid (2011) "Solid waste management study report - WASH Matters".

- Waste Aid (2019) "Volunteer Voices: plastics recycling training in the Gambia "Retrieved from: https://wasteaid.org/volunteer-voices-plastics-recycling-training-in-the-gambia/

- World bank, (2015) "Promoting Green Urban Development in African Cities. Kampala, Uganda". Retrieved from: http://documents.worldbank.org/curated/en/172411468190763021/text/100090-REVISEDP148662-Report-Kampala-UEP-Final-September-2015.txt

- World Bank Blog (2013) "Waste Not, Want Not: "Waste Banks" in Indonesia "Retrieved from: http://blogs.worldbank.org/eastasiapacific/waste-not-want-not-waste-banks-indonesia