METHODOLOGY FOR INVENTORIZATION OF NON-HAZARDOUS INDUSTRIAL WASTE

TOOLKIT FOR UGANDA

Authors: Ishita Garg and Ahana Ghosh

Editor: Rituparna Sengupta

Cover and design: Ajit Bajaj

Production: Rakesh Shrivastava and Gundhar Das

The Centre for Science and Environment is grateful to the Swedish International Development Cooperation Agency (Sida) for their institutional support

Citation: Ishita Garg and Ahana Ghosh 2025. *Methodology for inventorization of non-hazardous industrial waste: Toolkit for Uganda*. Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: cseindia@cseindia.org
Website: www.cseindia.org

METHODOLOGY FOR INVENTORIZATION OF NON-HAZARDOUS INDUSTRIAL WASTE

TOOLKIT FOR UGANDA

Introduction

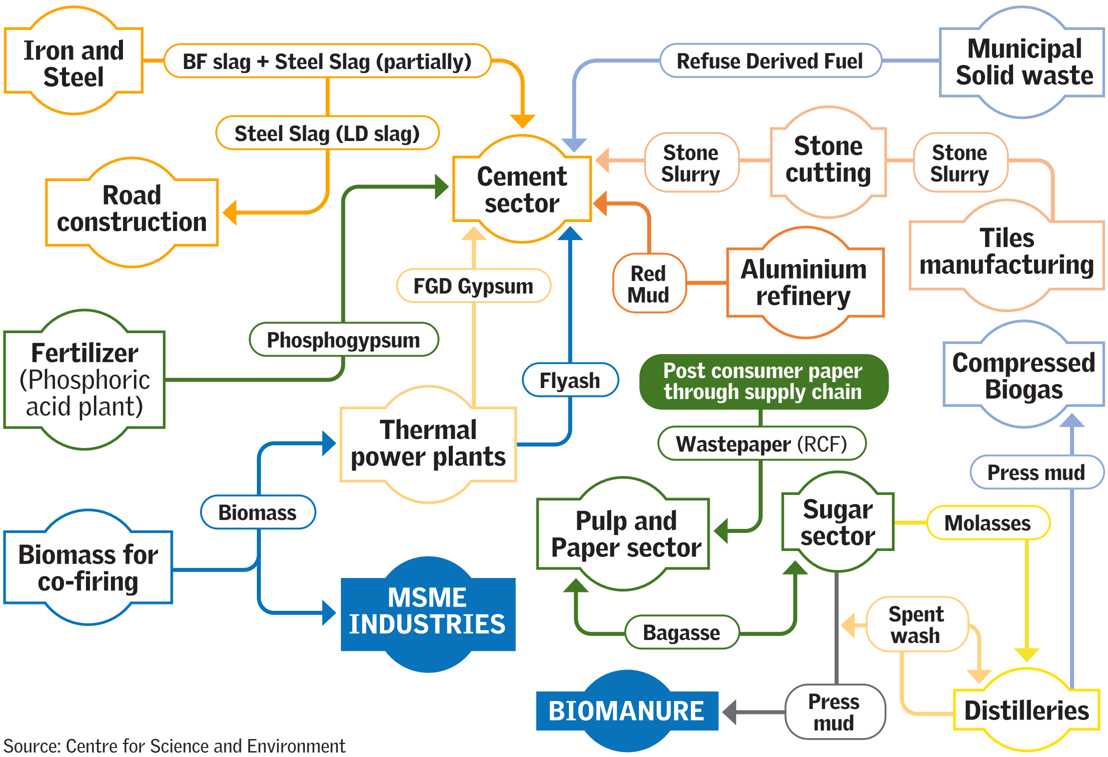
Africa's rapid population growth is complemented by changes in consumption patterns, along with a sharp increase in waste generation. Unfortunately, the waste management systems have not kept pace with this consumption spike. Over 90 per cent of the continent's waste is currently either dumped in unregulated dumpsites/landfills or is burnt in the open. The extent of waste generation in Africa is evident from the fact that 19 of the world's 50 largest dumpsites are located in this continent, and that the total waste volumes is projected to triple—from 174 million tonnes in 2016 to 516 million tonnes by 2050.[1]

The waste challenge in Africa extends beyond general or municipal waste; it also constitutes a large amount of industrial waste. Industrial development, while being a key driver of economic growth, is also one of the biggest contributors to waste generation. Much of this generated industrial waste is produced in large volumes, and is non-hazardous. Non-hazardous waste refers to the waste generated from industrial or non-industrial processes that may not pose a direct threat to human health or the environment like hazardous waste does, but still requires appropriate management due to the high volume and non-biodegradable characteristics. Common examples of such waste include plastics, glass, metals and e-waste. Non-hazardous waste has significant potential for reuse or recycling; however, unlike hazardous waste, which is managed through specific rules and regulations in most countries, non-hazardous waste often falls outside formal oversight. To overcome this lack of oversight and prevent this waste from becoming a burden, the principles and advantages of circular waste management can be applied to this category of waste. This can be done by assessing the utilization potential of various types of such waste and gaining an understanding of how they can be reused as raw material or fuel within the industrial systems.

This approach has a two-pronged benefit. Firstly, this would reduce the pressure on already overburdened landfills, as the current general practice is to dump such waste there. Secondly, reusing this waste as raw materials or fuel would reduce the industrial dependence on virgin raw materials, thereby enabling industries to cut down on their greenhouse gas (GHG) emissions that arise from energy-intensive extraction and processing of virgin raw materials.

This second aspect is crucial in the African context, where manufacturing growth is accelerating and by extension, industrial emissions are steadily rising. For

Figure 1: Circularity and waste management- Interlinking non-hazardous wastes in industrial ecosystems



Source: Centre for Science and Environment

instance, in 2018, the manufacturing sector accounted for 30–40 per cent of the continent's total emissions, emitting around 440 megatonnes of carbon dioxide equivalent ($MtCO_2e$). By 2050, these emissions are likely to nearly double, reaching 830 $MtCO_2e$[2]. Reducing the reliance on virgin raw materials is one of the ways to mitigate these accelerating emissions—an area where proper reuse of non-hazardous waste can play a significant role. CSE's 2025 study, *Africa's Wasted Potential: Unlocking Industrial Waste in Circularity*, also highlighted various case studies showcasing how different high-volume, non-hazardous industrial wastes get managed through circular interventions across various African countries[3]. The study further notes that the reduction in greenhouse gas (GHG) emissions achieved from such intervention; for instance, recycling waste from only four waste streams—lead-acid batteries, glass, cashew, and e-waste—could achieve up to a two per cent reduction in Africa's total GHG emissions.

The recycling and reuse of non-hazardous waste, therefore, offers a practical opportunity to scale up circularity while minimizing environmental impact. A model on this potential symbiosis of different non-hazardous waste is shown in the figure below *(see Figure 1: Circularity and waste management- Interlinking non-hazardous wastes in industrial ecosystems)*. To make such symbiosis possible, it is first essential to develop an inventory of the types of waste that are being generated and their quantities, for different industrial sectors.

With this objective in mind, and in the absence of reliable data, this toolkit outlines a simple method for estimating waste quantities and compiles various reuse and recycling opportunities for non-hazardous industrial waste. This toolkit also aims to guide stakeholders in the inventorization and quantification of non-hazardous industrial waste in their regions, and in fostering the broader goal of developing a circular economy in the industrial sector.

Methodology for estimating non-hazardous industrial waste

Most African countries currently have little to no data on how much non-hazardous waste is generated by their industries. Even environmental clearance and audit reports rarely quantify the expected amounts of such waste from industrial operations. As already discussed, without this quantification, mapping the waste streams into circular pathways is not possible. Thus, filling this data gap is critical. To do so, it is essential to establish a baseline—a very clear understanding of the types and quantities of non-hazardous waste produced by different industrial sectors. This baseline can then serve as the foundation for effective waste management planning and strategic interventions.

One way to achieve this baseline is by establishing specific solid waste generation factors (SWGF) for each type of waste generated from an industrial process. SWGF represents the ratio of solid waste generated per unit of production within a specific period of time (day, month, or year). To maintain consistency and compatibility, monthly (kg/month) or yearly (tonne/year) data should be preferred where possible.

SWGF = Quantity of waste generated (in kg, tonnes, or units) per month or year / Quantity of production (in kg, tonnes, or units) per month or year.

The development of SWGF typically involves two key steps—first, a reconnaissance survey to collect industrial production and waste generation data, and second, forecasting to estimate waste generation trends across sectors and regions. Note that for the purpose of this toolkit, the term 'industrial type' or 'industrial sector' refers to a group of industries that are engaged in similar activities (for instance, the textile sector, food processing sector, or metal fabrication sector). Whereas, the term 'industrial facility,' 'industry' or simply, 'facility' refers to an individual industrial establishment or factory where production activities take place.

1. Reconnaissance survey

The reconnaissance survey comprises multiple steps, beginning with a preliminary information collection, before moving to an onsite survey, followed by data collation and finally using that compiled data to develop the SWGF.

Step 1: Preliminary information collection

Before initiating the process of the onsite survey, some preliminary information must be gathered to ensure that the survey is systematic and representative. This includes:

- Identification of major industrial areas or clusters.

- Mapping the locations of identified industrial areas/clusters.

- Identification of the type and number of industries located in each selected industrial area.

- Selection of a few representative units of each industrial type within the selected area. This sample size should be proportionate to the total number of industries. For instance, if there are ten industries in a selected region, three units can be selected for the survey. If there are 50, around ten units can be selected. The exact number of the industries selected is at the discretion of the surveyors.

Step 2: Onsite survey

Once the preliminary information is in place, an on-site survey should be conducted to collect ground-level data from the selected facilities. This data includes details on various aspects, such as production capacity, the major types of non-hazardous waste being generated, the actual quantities of each waste type, and the current waste management practices in that industry. To support this assessment, developing an industry-specific process flow/block diagram pinpointing the waste-generating unit operations can help in identifying and categorising the various waste streams. The data collected through this step forms the foundation for calculating SWGF across facilities and industry types.

A sample questionnaire for the data collection during the survey is provided in *Annexure 1.*

Step 3: Data collation

Once data is collected, the SWGF for each waste type generated at every surveyed facility should be calculated using the previously provided formula.

To illustrate this concept, consider a hypothetical sugar sector in an industrial region that has three facilities (Facility A, Facility B, Facility C). It is important to note that three facilities are taken as a representative sample for this industrial area. For example, if the area has around ten sugar industries, three are selected to represent the overall scenario.

The sugar industry generates three main types of non-hazardous waste: bagasse, press mud, and molasses. For illustration, consider *Facility A* with an annual production capacity of 1,00,000 tonnes. Based on survey data, the facility generates approximately 1,88,000 tonnes of bagasse, 31,000 tonnes of press mud, and 41,000 tonnes of molasses each year. From here, the specific SWGF for all three wastes from Facility A can be calculated as follows:

- SWGF for bagasse from Facility A (SWGF B1) = Quantity of bagasse (tonnes/annum)/Total production of facility (tonnes/annum) = 1,88,000/100,000 = 1.88

- SWGF for press mud from Facility A (SWGF P1) = Quantity of press mud (tonnes/annum)/Total production of Facility (tonnes/annum) = 31,000/100,000 = 0.31

- SWGF for molasses from Facility A (SWGF M1) = Quantity of molasses (tonnes/annum)/Total production of facility (tonnes/annum) =41,000/100,000 = 0.41

The above calculation applies to Facility A. Similarly, SWGFs for the three waste types should be computed for Facilities B and C. For illustration, assume that Facility B has SWGFs of 1.75 for bagasse (B2), 0.25 for press mud (P2), and 0.33 for molasses (M2); and Facility C has SWGFs of 1.92 for bagasse (B3), 0.34 for press mud (P3), and 0.46 for molasses (M3).

Step 4: Sectoral SWGF

After the SWGFs for each facility is known, to develop SWGFs for a particular industrial sector, an average of the facility-specific SWGFs for a particular waste is taken. Revisiting the sugar sector example, the SWGFs for the sugar sector can be established as follows:

- SWGF for bagasse (B) from the sugar sector = SWGF B1 + SWGF B2 +SWGF B3/ Total number of facilities = (1.88+1.75+1.92)/3 = 1.85

- SWGF for press mud (P) from the sugar sector = SWGF P1 + SWGF P2 +SWGF P3/ Total number of facilities = (0.31+0.25+0.34)/3 = 0.30

- SWGF for molasses (M) from the sugar sector = SWGF M1 + SWGF M2 +SWGF M3/ Total number of facilities = (0.41+0.33+0.46)/3 = 0.40

These calculated averages represent the sector-level SWGFs which indicate the typical quantity of each waste generated per unit of product for that sector.

It is vital to understand that the SWGF for each waste type is a sector-specific value and varies depending on the industrial sector it is generated from. Therefore, the SWGF for a particular waste must be calculated separately for each sector—one cannot apply a single SWGF value for a waste without considering its sector of generation. This is because waste generation is very process-dependent, and it would be misleading to compare or aggregate waste intensity across industries that operate differently, even if the waste looks similar. For instance, iron scraps are the waste products of both the foundry sector as well as the automobile manufacturing sector, but the processes involved to produce the same waste are different. Hence, the SWGF of iron scrap derived for the foundry sector cannot be applied to the iron scrap generated from the automobile manufacturing sector; it must be calculated separately using the process described above.

2. Forecasting

With the sector-specific SWGFs now established, the next step is to apply these factors to estimate the total generation of a particular waste from an industrial sector in an industrial area or the whole country. This is done by simply summing the production capacities of all industries of a particular industry type and multiplying the total by the calculated SWGF for that waste. This approach allows the findings from the onsite surveys to be scaled up to the present context using a relevant scaling factor.

The principle is illustrated continuing with the example of the sugar sector as discussed previously. If there are a total of nine sugar industries (A, B, C, D, E, F, G, H, I) in a country, the total quantity of wastes generated from the entire sector can be calculated as follows:

Assuming all facilities have 1,00,000 tonnes per annum of production capacity each, then the total production capacity (Z) will be the sum of their individual capacities.

Total production capacity of the sector (Z) = A+B+C+D+E+F+G+H+I = 900,000 tonnes per annum

The production capacity of a facility can be obtained from the environmental impact assessments, environmental audit reports or even from their licenses. Once the total production capacity of the sector is known, the total quantity of non-hazardous waste produced by that sector can be calculated as follows:

Total quantity of bagasse from sector: SWGF for bagasse (B) x Z = 1.85*900,000 = 1,655,000 tonnes per annum

Total quantity of press mud from the sector: SWGF for press mud(P) x Z = 0.30*900,000 = 270,000 tonnes per annum

Total quantity of molasses from the sector: SWGF for molasses (M) x Z = 0.40*900,000 = 360,000 tonnes per annum.

These calculations illustrate how established SWGFs can be applied to estimate sector-level waste generation, offering a clearer understanding of each industrial sector's contribution and forming a basis for targeted waste management and resource recovery strategies.

With this objective in mind, CSE has developed specific solid waste generation factors (SWGFs) for various industrial sectors as part of this toolkit (*Refer Table 1*). The provided SWGFs are based on surveys conducted in industries, consultations with sector experts, and information from secondary sources. Sectors with a highly diverse range of waste types, such as the FMCG sector, have not been included in this toolkit.

Table 1: Template for specific solid waste generation factor (range) for various non-hazardous industrial waste and estimation of waste generation

S no.	Industrial sector	Type of waste	Specific solid waste generation factor	Total production (tonnes/ annum) or specify units	Estimated quantity of waste generated (tonnes/ annum)	Present practices for waste (recycle /disposal)	Potential applications
	1	2	3	4	5=3*4	6	7
1	Engineering fabrication						
	a. Bearing industry (forged)	Metal scrap	12–14 per cent of total production			Sent to scrap dealers, Melted in furnaces	
		Iron dust	1–2 per cent of total production			Landfilled	Briquetting-reused in sinter plants or Blast Furnace in steel industries
		Waste cloth	1–2 per cent per tonne of production			Burned or dumped in nearby area	
	b. Metal fabrication	Metal scrap	15-20 per cent of total production			Sent to scrap dealers, Melted in furnaces	
2	Plastic Manufacturing Industries (PET bottles, plastic granules, HDFE and PVC pipes, polypropylene. Bags, HDPE products)	Plastic scrap	4-6 per cent of total production			Recycled and dumped	Shredded and recycled into packaging/ fibers.
3	Sponge iron	Iron oxide fines	0.03–0.05 tonnes per tonne of production			Landfilled if unrecoverable.	Can be used in pigments or cement.
		Char	0.2–0.4 tonnes per tonne of production				As fuel, adsorbing agent
4	Foundry						
	a. Induction furnace	Silica sand	5–6 per cent of total production			Very few industries send slag to cement plants, most industries dump this waste	Reuse in foundries/ construction.

S no.	Industrial sector	Type of waste	Specific solid waste generation factor	Total production (tonnes/ annum) or specify units	Estimated quantity of waste generated (tonnes/ annum)	Present practices for waste (recycle /disposal)	Potential applications
	1	2	3	4	5=3*4	6	7
	b. Cupola furnace	Slag	5-6 per cent of total production			Landfilled	Mix in concrete for construction purposes
5	Wire and cable						
	a. Copper and aluminum wire units	Metal scrap	2–3 per cent of total production			Sent to scrap dealers, Melted in furnaces	
	b. MS wire/GI wire/Barbed wire	Metal scrap	2–3 per cent of total production			Sent to scrap dealers, Melted in furnaces	
	c. PVC & XPLE (cross linked polyethylene) cable and conductor units	Metal scrap	0.2–0.5 tonne/ kilometre			Sent to scrap dealers, melted in furnaces	
6	Rolling mill	Mill scale	2–4 per cent of total production			Either used in cement plant as additive or dumped	As raw material in sinter plants in steel industry or iron palletization
		Metal scrap	4–5 per cent of total production			Sent to scrap dealers, melted in furnaces	
7	Footwear	Polyurethane	1–2 per cent of total production			Dumped	Crushed and use as carpet underlay or as soundproofing material.
		Rubber	10–12 per cent of total production			Recycled and dumped	Co-process in cement plants
		PVC	8–10 per cent of total production			Secured landfill (hazardous if burned).	Reprocess into pipes/flooring.
8	Rice mills	Rice husk	220 kg per tonne of paddy processed			Used as fuel in biomass-based boilers	Silica extraction, and biochar production

S no.	Industrial sector	Type of waste	Specific solid waste generation factor	Total production (tonnes/ annum) or specify units	Estimated quantity of waste generated (tonnes/ annum)	Present practices for waste (recycle /disposal)	Potential applications
	1	2	3	4	5=3*4	6	7
9	Sugar and distillery (molasses based)	Bagasse	1.85 tonnes per tonne of production			Used as fuel for boiler	Raw material in paper industry for making moulded products like plates/trays
		Molasses	0.4 tonnes per tonne of production			Used in distillery	
		Press mud	0.3 tonnes per tonne of production			Used as soil nutrient	Raw material for compressed biogas production
		Spent wash	8-12 litres/ litre of alcohol produced			Treated in ETP	Fuel in boilers in distillery
10.	Iron and steel industry	Blast furnace slag	0.3-0.5 tonne per tonne of production			As an additive in cement making and in road construction	Cement substitute, and road construction
		Steel slag	0.15-0.2 tonnes per tonne of production			Majorly landfilled	As an additive in cement making and in road construction
		Electric arc furnace slag/ Induction furnace slag	0.2 tonnes per tonne of steel			Internal road making within the industries or landfilled	
		Desulphurization slag	14-16 kilogram per tonne of hot metal			Internal road making within the industries or landfilled	
11	Aluminium	Red mud	1-1.5 tonnes per tonne of production			Stored in ponds	As a raw material for cement
12	Rubber	Cured rubber waste	2-5 per cent of total production			Landfilled	As a filler in new rubber
13	Copper	Ferro sand	1.6-1.9 tonnes per tonne of production			Landfilled	Sand replacement in concrete.

S no.	Industrial sector	Type of waste	Specific solid waste generation factor	Total production (tonnes/ annum) or specify units	Estimated quantity of waste generated (tonnes/ annum)	Present practices for waste (recycle /disposal)	Potential applications
	1	2	3	4	5=3*4	6	7
14	Zinc smelting (pyro-metallurgical)	Zinc slag	0.8-1 tonne per tonne of production			Secured landfill	Zinc recovery and road construction.
15	Textile sector	Yarn and fabric trimmings	2-5 per cent of total production			Landfilled or sent to informal units	Upcycle to make rugs, cushions, bags etc.
16	Leather manufacturing (finished leather)	Unusable wet blue splits, wet blue shavings and trimmings	171-180 tonnes per tonne of finished leather (for heavy bovine leather) 180-513 tonnes per million m^2 finished leather (for sheep and goat leather and light bovine leather)			----	Shred and use as filler for composite boards
		Dry leather wastes (trimmings, dust)	28-30 tonnes per tonne of finished leather (for heavy bovine leather) 83-151 tonnes per million m^2 finished leather (for sheep and goat leather and light bovine leather)			---	Recycle into bonded leather
17	Automobile and auto parts	Metal scrap (steel, aluminium)	3-6 per cent of total production			Sent to scrap dealers, Melted in furnaces	
		Plastic and rubber parts	1-2 per cent of plastic and rubber components			Landfilled or sold to informal recyclers	As alternative fuel in cement plants
18	Ferro alloys	Silica fines	0.1-0.2 tonnes per tonne of total production			Reused within the process or dumped	
		Fe-Cr slag	0.8-1.2 tonnes per tonne of total production			Dumped in Slag yards	Metal recovery (Cr/Fe), cement/road construction.
		Charcoaland coke fines	0.1-0.2 tonnes per tonne of total production			Reused as fuel	

S no.	Industrial sector	Type of waste	Specific solid waste generation factor	Total production (tonnes/ annum) or specify units	Estimated quantity of waste generated (tonnes/ annum)	Present practices for waste (recycle /disposal)	Potential applications
	1	2	3	4	5=3*4	6	7
19	Chlor-alkali						
	Caustic soda	Brine sludge	20-30 kilogram per tonne of caustic soda			Landfilled or TSDF	Utilize for brick making
	Soda ash	Fines of raw limestone from screening	30–300 kilogram per tonne of soda ash			Either dumped or used in construction	
		Grits from slaker containing inert material	10–120 kilogram per tonne of soda ash			Landfilled	As construction material

Note: The range of solid waste generation factors derived in the table is based on survey of industries, inputs of sectoral experts and secondary resources. These are indicative in nature and tend to change with production capacity as well as efficiency of the manufacturing process.

APPLYING THE METHODOLOGY FOR INDUSTRIAL SECTORS IN UGANDA

Uganda is one of East Africa's most steadily growing economies. The country's economics rely on three main sectors, with the service sector accounting for approximately 43.1 per cent of GDP in FY2023/24, while the industry and agriculture sector (crops, forestry and fishing) accounted for 24.9 per cent and 24.7 per cent respectively. Between 2019 and 2023, the industrial sector showed steady growth. Manufacturing growth increased from 1.3 per cent in 2019 to 4.7 per cent in 2023, while the construction sector expanded from 3.8 per cent to 5.3 per cent over the same period.[4] Both these sectors have shown consistent growth and resilience, expanding alongside the broader economy.

The country's ambitions are slowly shifting towards industrialization, and recent investments in infrastructure, energy, and logistics have created a supportive base for the manufacturing sector, which is a sector that the government views as a key driver for job creation and economic diversification in the coming decade.[5]

As the manufacturing sector expands, this is the right moment to integrate circular economy practices into non-hazardous waste management while the overall waste burden is still relatively low. Early adoption will ensure that as production capacity and waste generation increase, these systems can be scaled up rather than built from scratch when the challenge becomes more complex. As discussed earlier, effective industrial symbiosis depends on a clear inventory of the types and quantities of waste generated across sectors. Building on this foundation, the following sections apply the methodology to the cement industry to illustrate how a waste inventory can help map each sector's non-hazardous waste footprint, supporting regulators in planning waste utilization and circularity interventions at the national level.

Cement sector

Uganda's construction sector has shown a remarkable jump in growth during the last year, expanding from a growth rate of 4.7 per cent in 2024 to an impressive

12.2 per cent in 2025, in contrast to the incremental rises during the period from 2019 to 2024.[6] This sharp rise reflects the country's accelerating infrastructure drive that has been largely driven by the government's focus on housing and industrial development through continuous development of residential and commercial buildings. This positions construction as one of the fastest-growing engines of Uganda's economy. As construction increases, so does the demand for cement. To meet this demand, Uganda's cement industry is supported by five operating companies—Tororo Cement, Hima Cement, Simba Cement (National Cement Co), Kampala Cement, and Metro Cement. These companies collectively possess an effective production capacity of approximately six million tonnes per annum (MTPA).[7] Out of these, only Tororo and Hima are integrated cement units, carrying out the full manufacturing process from clinker production to power generation through in-house coal-based power plants. These two companies form the backbone of Uganda's cement production system, jointly commanding nearly 80 per cent of the total domestic capacity, with Tororo Cement holding around 56 per cent and Hima Cement about 22 per cent. As a result, they are also responsible for the generation of associated non-hazardous industrial waste fly ash from the power plants that use coal. The remaining facilities are primarily grinding units, relying on imported clinker, and mainly handle blending and packaging.

As for the raw materials needed for cement production, currently, Uganda imports the coal needed as fuel from South Africa and the limestone from various countries in East Africa as the domestic limestone availability is not able to meet the production demand. In spite of this dependence, the cement industry is set to expand further, with several articles in Uganda highlighting a surge of capacity plans across the major cement producers. For instance, the biggest cement company, Tororo Cement, is set on expanding its production capacity by 2 MTPA, an expansion that is anticipated to raise Uganda's effective cement capacity to 8 MTPA.[8] Additionally, Yaobai Cement has announced plans to establish a new integrated cement facility in Moroto, with construction set to begin in 2026. The project is expected to increase the country's total cement production capacity by about 60 per cent, bringing it to roughly 9.6 million tonnes per annum (MTPA).[9] With all these planned expansions in cement production, an increase in the volume of the fly ash generated is also expected.

Instead of being treated as a waste burden, the generated fly ash can be transformed into a valuable resource that contributes to global efforts toward a greener and more sustainable future. This contribution could be achieved by recovering and then using fly ash to replace a portion of the clinker, which is the most energy and carbon-intensive component of cement. Typically, 15 per cent to 30 per cent of the Portland cement can be replaced with fly ash,[10] with the amount increasing depending on the grade of fly ash. Since the clinker production stage of cement manufacturing accounts for between 60–70 per cent of the total CO_2 emissions of the industry as a whole, this substitution will reduce GHG emissions, lower production costs and conserve the virgin natural resource limestone. Further, fly ash could also be used in the construction industry in the form of fly ash bricks, replacing natural clay as the primary raw material. The uses of this waste extend both within individual industries and across different industrial sectors.

Thus, to make effective use of fly ash, it is vital to understand the total fly ash waste generated at a national level. This can be done systematically by applying the SWGF methodology previously discussed.

Step 1: The first step is to take a representative sample from the two integrated units. Note, grinding units are not considered as they do not produce any fly ash. Since there are only two integrated units, one facility will suffice as a representative sample. Assume that is Hima Cement, which has a production capacity of two MTPA (2024)[11] and produces approximately 1,50,000 tonnes per annum of fly ash (assuming one million tonnes of coal usage with 15 per cent fly ash content as per the coal standard imported from South Africa). This quantity of fly ash produced by a facility—1,50,000 tonnes per annum—needs to be obtained by the reconnaissance survey, if not already available. From this, the facility-specific SWGF for fly ash can be calculated as follows:

The facility-level SWGF for fly ash= Quantity of fly ash generated (tonnes/annum)/ Total production of facility (tonnes/annum) = 1,50,000/20,00,000 = 0.08

Step 2: Since only one facility is the representative sample here, this facility-specific SWGF will be considered as the sector-level SWGF as well. With the sector-specific SWGF for fly ash available, the next step is to apply this factor to estimate the total generation of fly ash from the integrated units of the cement sector in Uganda. Since it is known that 80 per cent of the total effective production capacity of the cement industry (6 MTPA) is attributed to the two integrated units, the two integrated units will have a production capacity of approximately 5 MTPA. Thus, the total quantity of fly ash produced in the country will be:

Total quantity of fly ash currently produced = Sector-level SWGF * Production capacity of the integrated units = 0.08*5 million tonnes per annum = 4,00,000 tonnes per annum.

Step 3: The methodology can also be used to forecast future waste amounts. The total cement production capacity of the country is forecasted to increase to 9.6 MTPA by 2026 from the current capacity 6 MTPA. The entire increase—of 3.6 MTPA—will be due to the establishment of a new integrated cement unit, increasing the projected cement production capacity of the integrated units to 8.6 MTPA from 5 MTPA.

Total quantity of projected fly ash produced = Sector-level SWGF * Production capacity of the integrated units = 0.08*8.6 million tonnes per annum = 6,88,000 tonnes per annum.

Such large quantities of fly ash generated each year require robust handling and management to minimize environmental pollution. Access to this information supports data-driven decision making for sustainable industrial development.

Apart from fly ash, the cement industry also generates a by-product called clinker dust, which is a fine particulate matter produced during the handling of clinker. While it is not classified as a waste and is reused within the production itself, it can also be repurposed to address a pressing problem of not only Uganda, but East Africa as well—that of soil acidity.

East African soils are acidic by nature, especially in regions with heavy rainfall and continuous cultivation. When soil is too acidic, key nutrients like nitrogen, phosphorus, and potassium are no longer easily available for plant uptake. At the same time, elements such as aluminum and manganese can reach toxic levels, affecting root growth and crop health. Over time, this leads to weaker plants, reduced crop yields, and gradual decline in soil productivity.

Restoring this soil imbalance requires materials that can correct pH levels—an area where cement plants could play an important role by supplying clinker dust. This dust can be recovered and used as Agricultural lime (Agric-lime), which is a fine powdery substance with calcium carbonate ($CaCO3$) as its active ingredient. When added to acidic soil, it aids in neutralizing the pH levels and improves soil health. Agric-lime is already used across Uganda as a soil conditioner and has witnessed steady growth in demand over the recent years.[12]

At present, Uganda meets this demand mostly through imports from Kenya, with some support from domestic production. However, imported Agric-lime is significantly more expensive, costing around UGX 1.5 million per tonne (USD 400) compared to UGX 3,33,000 per tonne (US $89) for locally produced lime.[13]

This large price differential, as well as the reliance on imports to tackle a domestic issue, make a strong case for expanding the domestic resources. Cement plants produce readily available clinker dust as a by-product of their operations and by harnessing this local resource, Uganda could ensure a consistent supply for their farmers, reduce costs as well as move towards a circular industrial system.

To make effective use of this by-product it is vital to understand the total clinker dust generated at a national level. Currently, such data remains scarce. A recent regional study by the International Institute for Sustainable Development (IISD) on soil acidity in East Africa highlights this gap, noting that the lack of reliable data on industrial by-products like clinker dust limits efforts to develop local solutions. The report specifically recommends that governments collaborate with cement plants to quantify the potential of clinker dust for producing agricultural lime[14] Such quantification can be done by systematically applying the SWGF methodology previously discussed.

Step 1: Since there are only two units that produce clinker, one facility will suffice as a representative sample. Assume that is Hima Cement, which has a production capacity of two MTPA (2024) and produces approximately 35,040 tonnes per annum of clinker dust in its two facilities. (assuming a clinker dust production rate of two tonnes per hour, as shared by the facility itself). This quantity of clinker dust produced by a facility—35,040 tonnes per annum—needs to be obtained by the reconnaissance survey, if not already available. The quantity of clinker dust generated varies based on the technology used and the efficiency of the air pollution control devices. From this, the facility-specific SWGF for clinker dust can be calculated as follows:

The facility-level SWGF for clinker dust = Quantity of clinker dust generated (tonnes/annum)/Total production of facility (tonnes/annum) = 35,040/20,00,000 = 0.02 (2 tonne/hr)

***Step 2*:** Since only one facility is the representative sample here, this facility-specific SWGF will be considered as the sector-level SWGF as well. Considering 80 per cent of the total production capacity of the cement industry (6 MTPA) is attributed to the two units, the two units will have a production capacity of approximately 5 MTPA**.** Thus, the total quantity of clinker dust produced in the country will be:

Total quantity of clinker dust currently produced = Sector-level SWGF * Production capacity of the clinker-producing units = 0.02 * 5 MTPA = 1,00,000 tonnes per annum.

Step 3**:** Considering the clinker-producing cement units will have a forecasted capacity of 8.6 MTPA by 2026, the projected quantity of clinker dust generation will be:

Total quantity of projected clinker dust produced = Sector-level SWGF * Production capacity of the clinker-producing units =0.02 * 8.6 million tonnes per annum = 1,72,000 tonnes per annum.

If imported, this amount of clinker dust would cost the country UGX 258 billion (USD 71 million). In contrast, if this is sourced locally, it will cost only UGX 57 billion (USD 16 million), saving around UGX 201 billion (USD 48 million). The use of such data at the national level isn't limited to circular interventions, it can also play a vital role in shaping countries' economic and investment mechanisms.

Annexure: Sample questionnaire for reconnaissance survey

1. Name of industry

2. Type of industry

3. Address

4. Type of products and quantity

S. No	Name of product	Production (tonnes/year)

5. Type of non-hazardous solid waste and quantity of generation

S. No	Type of non-hazardous waste	Waste generation (tonnes/year)

6. Quantity of waste recycled

S. No	Name of waste	Waste generation (tonnes per year)	Quantity of waste recycled (tonnes per year)	Applications where recycled

7. Quantity of waste reused within the industry

S. No	Name of waste	Waste generation (tonnes per year)	Quantity of waste recycled (tonnes per year)	Frequency of reuse

References

1. Ishita Garg and Ahana Ghosh 2025. *Africa's Wasted Potential: Unlocking Industrial Waste in Circularity*, Centre for Science and Environment, New Delhi. Accessed on 27 October, 2025.

2. Lyes Bouchene, Kartik Jayaram, Adam Kendall, and Ken Somers 2021. *Africa's green manufacturing crossroads: Choices for a low-carbon industrial future.* McKinsey & Company, accessed on 22 October, 2025.

3. Ibid

4. Ministry of Finance, Planning and Economic Development (MoFPED) 2023. *Microeconomic Framework Paper FY 2023/24.* Government of Uganda, accessed on 2 November, 2025.

5. Rogers Atukunda 2024. *Manufacturing sector key to economic growth and employment, says Minister Mwebesa.* SoftPower News , accessed on 2 November 2025.

6. Uganda Bureau of Statistics (UBOS) 2024. *Quarterly Gross Domestic Product Press Release Q2 2023/24* , accessed on 3 November 2025.

7. Jagdeep Verma 2023. *Uganda's upturn awaits.* Holtec Consulting Pvt Ltd / Tradeship Publications Ltd, accessed on 3 November 2025.

8. Isaac Khisa 2018. *Uganda's cement industry faces glut.* The Independent (Uganda), accessed on 31 October 2025.

9. Saleh Ssennyonjo 2024. *USD 300 million Yaobai Cement Plant Set to Revolutionize Uganda's Cement Production Industry.* APT News, accessed on 3 November 2025.

10. U.S. Department of Transportation, Federal Highway Administration (FHWA). 2024. Fly Ash in Portland Cement Concrete – Chapter 3. Washington, D.C.: FHWA. Accessed on 26 October, 2025.

11. Information shared by Hima Cement to CSE

12. DataHorizzon Research. 2024. *Ag-Lime Market Size, Share, Growth, Trends, Statistics Analysis Report and By Segment Forecasts 2024 to 2033.* Accessed on 2 November 2025.

13. Data shared by Hima Cement to CSE

14. Erika Luna and Cristina Larrea. 2024. *Addressing Soil Acidity and Enhancing Soil Health: Recommendations for the use of lime and other conservation measures.* International Institute for Sustainable Development (IISD), accessed on 1 November 2025

Industrialization in Uganda is accelerating, bringing with it a sharp rise in waste generation. Although a major part of this waste is non-hazardous, it still requires proper management due to its high volume and non-biodegradable nature. Such waste holds significant utilization potential and can play a vital role in advancing circularity principles; however, in the absence of any reliable data on its quantity, its reuse potential remains substantially underutilized.

The toolkit offers a practical step-by-step methodology to quantify and map non-hazardous industrial waste as well as by-products even in data-scarce contexts. It also illustrates how early inventorization can help countries like Uganda integrate circular economy principles by turning industrial wastes into valuable resources rather than environmental burdens. By enabling data-based waste management, this toolkit aims to support regulators and policymakers in building a foundation for sustainable industrial growth in Uganda.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: cseindia@cseindia.org Website: www.cseindia.org