

GCIC Market Analytics

Industry Report Brief

Inorganic Waste Recycling Industry
(Non-Plastic)



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Executive Summary

The World Bank forecasts a 70% annual waste generation growth from 2016 to 3.40 billion tonnes in 2050. Currently, 33% of this waste is mismanaged globally through open dumping or burning. Effective waste management, however, is expensive, often comprising 20%–50% of municipal budgets because it requires integrated systems that are efficient, sustainable, and socially supported (The World Bank, 2018); a commitment which many low-income countries are unable to afford. Inorganic waste and plastics is estimated at 19% of the total waste generated globally.

The waste recycling industry is experiencing the incorporation of technology in waste management. In developed countries like Japan, a sophisticated use of central databases manages waste around the country, while middle-income countries like Kenya and Ghana, have enterprises using simple USSD codes to support effective waste collection in urban centres with a general trend of increasing numbers of recycling businesses.

The Government of Ghana has renewed interest in the e-waste recycling sector with a \$30 million investment into a recycling facility as well as the emergence of private businesses recycling e-waste into high-end furniture and 3D printing. Although requiring significant investments, sorting, recovery and recycling, the most lucrative aspects of the value chain in Ghana, are buzzing with many opportunities estimated at 70% of a huge GHS 15.77 billion.

Innovative businesses within the space in developed countries include Strategic Materials with an annual turnover of \$500 million and Klaks Technology, in Ghana, turning over GHS 7 million endorse the viability and lucrative nature of the industry. The financial and operational (technological) support for enterprises within the space can transform some local business into waste management giants across the continent and beyond.

This report reveals analysis from data derived primarily from desk research to understand the Inorganic Waste Industry in Ghana and globally.

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Global Outlook of Industry

Inorganic waste, also known as non-biodegradable waste are chemical substances of mineral origin, derived from an artificial process such as construction and demolition. Common examples of inorganic waste include construction waste, e-waste, glass waste, plastics, synthetic fabrics, metals and tyres.

Waste recycling refers to the external recovery, reuse or reprocessing of post-consumer and post-product waste and is an important part of waste management hierarchy.

In 2016, the worlds' cities generated 2.01 billion tonnes of solid waste, amounting to a footprint of 0.74 kilograms per person a day. (Kaza, Yao, Bhada-Tata, & Van Woerden, 2018). With rapid population growth and urbanization, The World Bank forecasts a 70% annual waste generation growth from 2016 to 3.40 billion tonnes in 2050. Currently, 33% of this waste is mismanaged globally through open dumping or burning. (The World Bank, Solid Waste Management, 2018).

Proper waste management is essential for building sustainable and liveable cities, however, it remains a challenge for many countries and cities because effective waste management is expensive, often comprising 20%–50% of municipal budgets (Kinyanjui, 2014). Operating this essential service requires integrated systems that are efficient, sustainable, and socially supported. (The World Bank, Solid Waste Management, 2018).

Trends Affecting the Industry

As technology changes the way people live, communicate, and transact, it equally affects how waste is managed around the world. Governments and companies that manage waste are integrating technologies at all steps of the value chain to reduce costs. Despite the ability of technological solutions to improve the way resources are used and recycled, technology selection differs by context. (Kaza, Yao, Bhada-Tata, & Van Woerden, 2018). Technologies emerging in countries include Data Management in Japan, Radio Frequency Identification (RFID) chips in Korea, and India's I Got Garbage mobile app which is used by households to request waste collection services (Kaza, Yao, Bhada-Tata, & Van Woerden, 2018). Two of these technologies are explained below:

- **Data Management in Japan:** A central data system connects waste facilities around the country to a central national waste information system where measurements of toxins and emissions are reported in real time to the central database. Any problems in equipment operations trigger automatic reports to the plant operator so that emergencies can be addressed immediately.
- **Radio Frequency Identification (RFID) chips in Korea:** In the Republic of Korea, radio frequency identification (RFID) chips are often used to motivate citizens to reduce the waste that they generate. These small radio chips are embedded in personal cards that citizens use to open dumpsters and log the weight of the waste they dispose of. Citizens are billed by the weight registered on the chip, which as a result either motivates or forces them to reduce the waste that they produce.

Although open dumps and landfills are common in low and middle-income countries, there is a growing trend toward improving recycling and controlling waste disposal. Recycling is typically undertaken by the informal sector in an unorganized fashion and small-scale waste systems are increasing in prevalence. Also, waste sorting plants that involve manual or some form of automated sorting are becoming more common.

The Industry in Ghana

Recent trends in Ghana

Many African countries are increasingly investing in proper waste management practices, and this is certainly the case in Ghana where waste management is usually handled by the government through local or district assemblies, with 88% of total waste collected by the assemblies (Tiffany, 2018). However, in cities such as Accra, Kumasi, Takoradi and Tamale, waste management is mainly controlled by private waste management firms contracted by the local government. The usual practice is the utilization of imported refuse trucks which collect waste from source or transfer points and deliver to designated waste dump or recycling plants. Firms such as Jekora Ventures and Zoompak Ghana Limited in Accra, as well as J Stanley Owusu and Kumasi Waste Management Limited in Kumasi are key players in this field. There is also the emerging trend of young men, normally in a group of two or three, collecting waste in sacks on tricycles.

It is very typical for recycling plants, in Accra for example, not to recycle all the different kinds of waste they collect. As such, the waste collected is normally sold to another recycler who has the capacity to process them. One of such recyclers is the Tet Glass Beads Industry in Accra, who develops contemporary bead products from recycled glass.

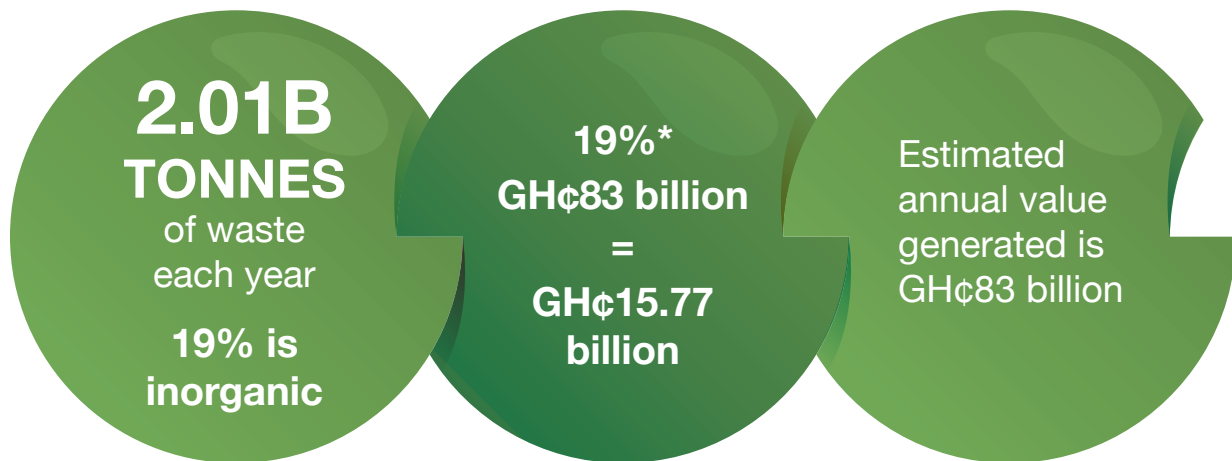
In addition, there is a growing trend in the e-waste recycling sector, where initiatives such as Shine Initiative and Klaks 3D are recycling e-waste into high-end furniture and 3D printing machines respectively. Also, as part of its long-term measures to address the improper disposal of electronic waste, the Government of Ghana, in line with implementing the Hazardous and Electronic Waste Control and Management Act, has initiated a US \$30 million Agbogbloshie E-waste Recycling Facility in Accra. This project is to be executed by the Ministry of Environment, Science, Technology and Innovation (MESTI) in partnership with the Environmental Protection Agency (EPA). The plant is expected to recycle electrical and electronic waste materials into final products in an environmentally sound manner. (Andoh, 2018).

Market Size of Industry in Ghana

From analysis made on the 20.1 billion tonnes of waste generated by the world in 2016, it was deduced that waste generated each year comprises 44% food/green waste, 2% wood, 17% paper and cardboard, and 12% plastic. The remaining 19% is assumed to be inorganic waste with 4% metal, 5% glass, 9% e-waste, and 1% leather (The World Bank, What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, 2018).

Also, according to the UNDP, Ghana can generate GHS 83 billion annually through recycled waste (Quaicoo Duho, 2018). Thus, inferring from the above analysis, the inorganic waste recycling market constitutes 19% of the GHS 83 billion potential revenue from recycled waste which amounts to GHS 15.77 billion.

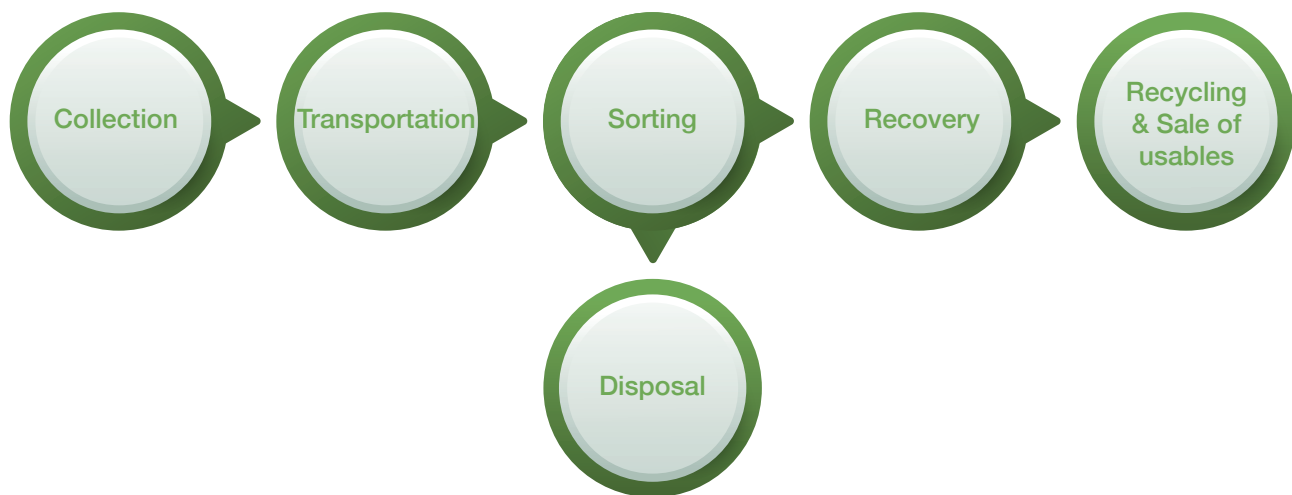
The initial cost of investment in the industry is high, however, the cost of operating the facility does not increase as waste disposal volume increases. As such, The Ghana National Solid Waste Management Association estimates that the average unit cost of a typical landfill may decline by about 70% as it increases capacity. (Samwine, et al., 2017)



The Industry's Value Chain

In Ghana, there is a large amount of inorganic waste lying in the open and available for collection, mostly in public areas. As a result, the value of such waste as an input material is cheap. The value of the waste increases as it gets transported to a recycling facility and goes through the sorting and recycling process. However, close to 70% of this value is not realised until there is a final recycled product. This makes the sorting, recovery and recycling stages of the process more lucrative. This value is, however, not easily realised as the cost of investment in machinery is high.

The figure below represents a supply chain broadly used by inorganic waste recyclers.



Source: Field Data, December 2018 – January 2019

The Opportunities within the Value Chain

Several initiatives regarding waste have already been put in place around the world and these initiatives are contributing to the economic strength of the host countries. For instance, China's circular economy approach - which is an integral part of the national economic strategy - revolves around the transformation of industrial parks, by creating 'symbiotic relationships' in which the waste from one process is used as input for another. The market potential for remanufacturing the 16 million cars, fridges, computers and TVs that go out of warranty each year in China, is estimated at US \$30 billion. There are four main components of this approach: circular production, Circular systems of industry, agriculture and services, growth of recycling industry, and green consumption (Jeffries, 2018). There is also Japan's sound material recycling society: a principle of reducing waste, reusing and recycling resources and products.

These recycling programmes provide employment for the unemployed/underemployed, those who are physically and mentally handicapped, those on public assistance, and those involved in job-skill development programmes. According to a report by EcoCycle, 86% of the total US jobs in managing

their waste come from recycling activities, even though the country recycles only a one-third of their waste (EcoCycle.org, 2016)

Another benefit of recycling is that it can lead to the development of an environmental ethic in the community (Kinyanjui, 2014). An example is South Africa's Consol: returnable (refillable) glass bottles are used as many as 30 times before needing to be recycled, dramatically reducing their carbon footprints. By contrast, recycled glass (cullet) not only melts at a lower temperature, thereby reducing energy requirements, but nothing is lost in the melting process (Consol, 2019).

It is important to note that, the majority of the commercial waste recycling initiatives discussed in this report have been developed on an ad hoc basis and have been funded by the private sector, with minor support from the government.

Challenges existing in the Value Chain

Despite the environmental and social benefits of waste recycling, there are multiple challenges direct stakeholders face. The main challenge of operating a waste recycling venture is people's attitude towards waste recycling in general. Many people do not want to associate themselves with waste recycling as they consider waste collection and recycling a dirty business. This perception poses a huge marketing challenge for waste recycling.

Additionally, there is a lack of financial capacity and support on the part of stakeholders to operate waste collection and recycling on a large scale to attract potential markets.

There is also the issue of waste sorting or separation in households. Households in Ghana will typically put all kinds of waste together, which makes separation complicated and time consuming for recyclers. As a result, recyclers are required to invest hugely into separation machines.

Another challenge is the health risks waste collection poses to informal waste collectors. Their means of collection exposes them to diseases, injury and chronic toxicity through contact with infectious and carcinogenic materials during waste picking or separation (Kinyanjui, 2014).

Industry innovations – National & Global

E-waste to electricity - Indian Institute of Technology

Scientists at the Indian Institute of Technology, Madras (IITM) have developed an innovative technique where e-waste can be used as a resource, not only to treat waste water, but also to generate electricity simultaneously, making it an important innovation to deal with the fast-growing menace of hazardous waste in the country.

Under this technique, scientists use e-waste components like “LED\LCD (liquid crystal coated polaroid) glass” as an electrode material in “Microbial Fuel Cells” (MFCs), which is primarily a technology used for only waste water treatment. The use of e-waste as an electrode, however, helps to generate electricity from the waste and recover metals for reuse. The basic concept underlining the study is ‘use of waste to treat waste’. It considerably reduces the organic waste treatment cost by producing electrical energy without combustion of fossil fuels. Moreover, the MFC is a pollution-free process.

Even though the scientists at IITM invented the technology in 2015 and it was successfully tested and demonstrated, winning an award during the Innovation Festival at Rashtrapati Bhavan in India, the technology could not move onto the market because there were no takers as at March 2017. IITM by March 2017 then was planning to approach the Technology Development

Board (TDB) of the Science & Technology Ministry of India.

This innovation has a potential in Ghana. Considering the estimated 20 to 50 million tonnes of e-waste generated annually across the globe, a large proportion is being exported from the developed world to developing countries including Ghana. (Oteng-Ababio, 2012)

KLAKS 3D - Klaks Technologies

A group of five university students in Ghana built a machine for printing items in 3D in two weeks. The device was built from 45%-70% electronic waste and environmentally-friendly local materials such as screws, rods, square-pipes, motors from spoilt printers and photocopiers, bike tubes as well as land cables collected from Agblogbloshie market and other big markets. This approach reduces the cost of printing drastically, compared to when the materials mentioned above are imported. The initiative promises to stop what has become the norm of making small custom objects at relatively high costs, which could have been printed using the normal ink-jet printer.

Klaks Technologies 3D printers is a combination of works from other businesses in the Techfortrade Network which includes SticLab, Tanzania and AB3D Kenya. Over the years, Klaks has made changes in its software, printing resolution, cooling mechanisms, frame material, power supply, wire

routing among others, to improve its performance. These changes have, among other things, enhanced the overall cooling of the printer, resulting in fast and fine printing. Since March 2018, the company has focused primarily on the output of the printer (Abakah-Paintsil, 2019).

While their 3D printers are currently undergoing market testing to gain feedback, the team has already made sales and has reported a high demand for their printers. As at December 2017, the company recorded a total revenue of GHS 7,432.96 and had sold 2022 units of various products including customised key holders, 3D printers and Earphone holders etc.

With the 3D printing industry valued at approximately US \$4.8 billion, and with both industrial and consumer 3D printers currently selling well across several sectors, governments of various countries are beginning to incentivise the production of 3D printers and 3D printing equipment. South Korea, for instance, has plans to offer significant tax exemptions for 3D printing. The Dutch government has also invested €134 million in 3D printing while France announced new strategies for improving 3D printing and advanced manufacturing. This investment trend could be experienced soon in Ghana, where experts have been crying out for investment in additive technologies that would potentially transform the nation's economy (Benedict, 2016).

Recycling glass into highway beads, containers, fibre glass etc. - Strategic Materials

Strategic Materials spun-off from Allwaste to become its own company in 1994. The company provides glass and plastic recycling services in North America. The company recycles glass bottles, window panes, and single-stream MRF glasses, as well as automobile products such as side glasses and windshields. The company also processes, recycles, and markets ground glass products, such as abrasives, beads for reflective highway striping, and frictionators for bullets and matches, as well as grits for steel and aluminium mills, and dental products. They also market swimming pools, fire pits, fibre glass, landscaping products, aquariums, containers, matches, abrasives, highway beads, and ceramics. The company has locations in the United States, Canada, and Mexico (Bloomberg, 2019).

Strategic Materials' finely tuned production processes use a series of equipment to process the various types of inbound glass material.

- Crushers and screens are used to size the material to either course 5/8' size which is primarily used in the container industry or to a finely ground powder which is used by the fiberglass and specialty product customers.
- Finely ground material also goes through a drying process to ensure a proper material flow through the screening and silo storage process.
- Optical sorters are used to separate the various glass colours from each other (clear glass from brown from green).
- Sorters are also used to separate ceramic and stone contamination from good glass.
- Magnets of all types and vacuum systems are used to further clean up the glass stream by removing ferrous and non-ferrous metals and light material (paper & organics) from heavier glass fragments. (Strategic Materials, 2019)

In August 2009, waste360.com reported that Strategic Materials Inc. recorded a revenue of US \$215.0 million in 2008, \$208.0 million in 2009, and projected a US \$216.0 million revenue for 2010 (Waste 360, 2009). Incfact.com reported an annual revenue of over US \$500 million as at January 21, 2019.

Summary and Conclusion

Although the world is seeing improvements and innovations in inorganic waste management, the pace has been less than par with that of waste production. The world is on a trajectory where waste generation will drastically outpace population growth by more than double by 2050, with an estimated 3.40 billion tonnes.

With non-plastic inorganic waste about 20% of total waste produced, Ghana could take advantage to improve its waste management culture while exploring economic opportunities such amount of waste holds. Current and potential recyclers should develop or explore existing innovations while identifying where mutual benefits are possible within the inorganic waste recycling value chain.

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Annex 1: List of Innovations – National and Global

Innovation Description	Sub Sector	Type of Waste/ Type of Technology	Name of Business	Country	Links (Business, Sample Product)
KLAKS 3D: Use of e-waste to build 3D printers with aim of to enhancing creativity, innovation as well as improving quality of education and healthcare	Technology / Electronic Manufacturing	E-waste processing	Klaks Technologies	Ghana	https://www.facebook.com/klaks3d/posts/d41d8cd9/1174304642685060/ https://www.facebook.com/pg/klaks3d/photos/?ref=page_internal https://3dprint.com/159654/ghana-students-e-waste-3d-printer/
Fabric Waste: Making sac bags, dusters, and rags	Fashion	Fabric Waste	Yeg Design	Ghana	
E-waste recycling	Electronics	E-waste	Kumasi Hive	Ghana	
Extraction of metals including copper and tin into alloys, and plastics from computers and printers for use in 3D printing or to produce materials for industrial-grade ceramics	Technology / Manufacturing	E-waste processing	New South Wales University & Australian Research Council	Australia	https://www.triplepundit.com/2018/04/tech-innovation-converts-e-waste-reusable-materials/ https://newsroom.unsw.edu.au/news/science-tech/world-first-e-waste-microfactory-launched-unsw

E-waste to electricity: use of e-waste component like "LED/LCD (liquid crystal coated polaroid) glass" as an electrode material in 'Microbial Fuel Cells' (MFCs) for waste water treatment and generation electricity	Technology / Energy	E-waste processing	Indian Institute of Technology	India	https://economictimes.indiatimes.com/news/environment/pollution/iit-scientists-develop-a-technique-to-generate-electricity-from-e-waste-in-eco-friendly-manner/articleshow/57334316.cms
Glass recycling: waste glass is crushed, sorted, cleaned and re-melted	Manufacturing	Glass waste	G.R.L.- Glasrecycling	Belgium	https://ec.europa.eu/environment/eoap/about-eco-innovation/good-practices/eu/759_en https://www.grl.be/
(Research) Glass recycling in cement production: mixing ground waste glass into cement to make stronger and more water-resistant concrete	Manufacturing	Glass waste	Michigan State University	United States of America	https://msutoday.msu.edu/news/2012/recipe-for-success-recycled-glass-and-cement/
Art from recycled glass: cutting, grinding, buffing and polishing glass, to create useful and useable items from free and unutilised waste glass	Manufacturing	Glass waste	Upcycle SA Consol	South Africa South Africa	https://www.upcycle.co.za/initiatives/glass https://www.consol.co.za/why-glass/sustainability-and-recycling
Recycling glass into highway beads, containers, fibre glass etc.	Manufacturing	Glass waste	Strategic Materials	United States of America	https://www.strategicmaterials.com/

Gas-To-Hydrogen Fuel Project: recovery of fuel cell - quality hydrogen from a landfill gas source	Renewable Energy	Gas waste	BMW Plant (South Carolina)	United States of America	https://www.energy.gov/articles/garbage-power-out-south-carolina-bmw-plant-demonstrates-landfill-gas-hydrogen-fuel
Bicycles made from aluminium cans	Manufacturing	Aluminium	The ReCycle	United States of America	http://www.riderecycle.com/motionpictures/
Tyre recycling: Making compost bins out of old tyres	Composting	Truck Tyres	Do it Yourself (online)		https://www.doityourself.com/stry/making-a-compost-bin-out-of-old-tires
Footwear: handcrafted sneakers, flats, lace-ups, sandals, slip-ons, bags, and belts	Manufacturing	Car tyres	US Tyre Manufacturers Association	United States of America	https://www.ustires.org/scrap-tire-markets
Fenders for docks, tugs and workboats	Manufacturing	Bus and Truck tyres	Schuyler Rubber Company	United States of America	http://www.goschuyler.com/
Recycling different solid waste into musical instruments	Manufacturing	Solid waste	Landfill Harmonic	Paraguay	https://youtu.be/fXynrsrTKbl
Sustainable building product –brick with 90% recycled content from demolition and construction waste	Construction	Construction waste	Kenoteq	United Kingdom	http://www.kenoteq.com/



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