



Trade and Recycling of **USED LEAD ACID BATTERIES(ULAB)** **IN NIGERIA**

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LIST OF ABBREVIATION

LAB	Lead Acid Battery
ULAB	Used Lead Acid Batteries
EPR	Extended Producer Responsibility
FME _{env}	Federal Ministry of Environment
NESREA	National Environmental Standards and Regulations Enforcement Agency
NADDC	National Automotive Design and Development Council
ARBR	Alliance for Responsible Battery Recycling
PRO	Producer Responsibility Organisation
BCCC-Africa	Basel Convention Coordination Centre for the African Region
MSW	Municipal Solid Waste
ESM	Environmental Sound Management
PPE	Personal Protective Equipment
SDG	Sustainable Development Goals
NCS	Nigeria Custom Service
FRSC	Federal Road Safety Corps
NBS	National Bureau of Statistics
NESG	Nigeria Economic Summit Group
NCC	Nigerian Communications Commission

Major Key Findings

1. Approximately 185,558 tons of used lead acid batteries were generated in Nigeria from automotive batteries and other alternative energy battery systems in 2018 with an estimated increase of about 2% from previous year.
2. Nigeria has a fairly basic but organized collection, transportation and storage systems for used lead acid batteries (ULABs) around the country.
3. Most ULABs are bought by informal collectors and traders of new batteries who are usually the highest bidders and delivered to Onitsha, South-East Nigeria and Lagos State, South-West Nigeria which are major hubs in the country.
4. Retail cost of ULABs ranges from N4000 to N10,000 per unit when sold to a wholesale collector or primary recycler.
5. Wholesale collectors or primary recyclers sell to secondary recyclers in tonnage ranging between N300,000 and N340,000 per ton or about N340 per kilogram.
6. Only wholesale collectors are located in South-East Nigeria, while most secondary recyclers are based in Lagos and Ogun State with exception of Ibeto Group located in Nnewi in Anambra State, South-East Nigeria that recycles lead and electrolyte to produce new batteries.



1.0 INTRODUCTION

Batteries fall into 2 common types, Lead Acid and Lithium-ion Batteries. Lead Acid Batteries (LABs) are the most common types of batteries used in automobiles and for solar energy applications, because of their tested reliability and relatively lower cost. They store about 25 watt-hours per kg and contain lead electrodes in a dilute sulfuric acid solution. Deep cycle LABs contain thicker electrodes than the standard starter batteries. They are categorized as gel batteries and sealed LABs used commonly as power backup systems for energy storage.

Lithium-ion batteries (LIBs) are mostly used in computers and consumer electronics. In recent years, LIBs have been developed for wider applications because of their greater power density. They store about 150 watt-hours per kg. The electrodes are lithium cobalt oxide (LiCoO_2) and graphite with a solid lithium electrolyte. The batteries can explode at high temperature and when in contact with water because of the high reactivity of Lithium with water. Current research in the area requires improvement of electrode materials and electrolytes for better thermal stability in large battery applications.

Both LABs and LIBs contain heavy metals such as mercury, lead, cadmium, nickel or lithium that can contaminate the environment if not recycled or disposed of properly. With the adoption of solar energy in Nigeria, often requiring energy storage batteries, there is an increasing need to investigate the trade and disposal systems of used batteries, as well as workable policy recommendations that would mitigate the dangers of environmental pollution and hazards associated with the batteries in Nigeria.

“

About 70% of ULAB in Nigeria are recycled through industrial scale processes”

2.0 Recycling of Lead-Acid Batteries

Lead is highly toxic metal and once the battery becomes inoperative, it is necessary to ensure its proper collection and eco-friendly recycling. A single lead-acid battery disposed of incorrectly into a municipal solid waste (MSW) collection system, and not removed prior to entering a resource recovery facility for mixed MSW, could contaminate 25 tons of MSW and prevents the recovery of the organic resources within this waste because of high lead level. Recycling of LABs, provided it is done in an environmentally sound manner (ESM), is important because it keeps the batteries out of the waste stream destined for final disposal. Lead from storage batteries placed in unlined landfills can even contaminate sub-soil and groundwater.

Recycling prevents the emission of lead into the environment and also avoids the energy usage associated with manufacturing lead from virgin resources. Obtaining secondary lead from used lead-acid batteries (ULABs) can be economically attractive, depending upon the market price of lead. Recovery of lead from ULABs is easier and requires significantly less energy than producing primary lead from ore. Recycling also reduces dispersal of lead in the environment and conserves mineral resources for the future when undertaken in an environmentally and socially responsible manner.

It is to be noted that recycling of used lead acid batteries is not a simple process that can be undertaken in small scale enterprises and by any untrained personnel. In fact crude ULAB recycling has been noted in the past to be associated with some of the worst polluting activities worldwide.

Certain control measures should to be taken to prevent adverse impacts to people and the ecology. With exponential rise in consumption of LABs, it is imperative that Nigeria put together a viable strategy to tackle the management of ULABs that will arise from the rising LAB applications. Figure 1 indicates the conventional ULAB recycling process.

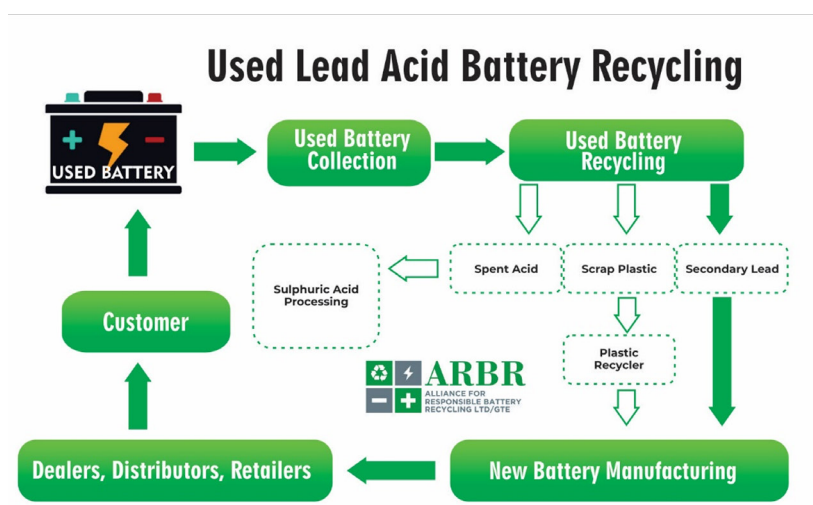


Figure 1: Used Lead Acid Battery Recycling Process ¹

¹ As designed and proposed for implementation by the National Environmental Standard and Regulations Enforcement Agency (NESREA)

This study analyses the trade and recycling of ULABs in Nigeria as well as introduction of the Extended Producer Responsibility (EPR) programme to the sub-sector with the aim of modernizing and achieving more value for wealth creation and environmental protection in Nigeria.

According to formal, informal and field estimates, approximately 185,558 tons of ULABs were generated in Nigeria in 2018 from automotive batteries, telecommunications, manufacturing, commercial and renewable energy systems with automotive sector generating a greater percentage of ULABs. It was noted that only about 70% of ULABs are currently recycled through industrial scale processes in Nigeria, with pockets of low scale illegal smelting activities littering the country's landscapes particularly in Lagos, Ogun and Anambra States.

Field investigations, suggested that Nigeria has a fairly basic but organized collection, transportation and storage system for ULABs around the country. Usually, ULABs are collected and delivered to the South East cities of Onitsha, Nnewi, Asaba and Lagos state in the south west of the country.

3.0 Methodology

This study employs basically primary data (sourced from structured questionnaire and interviews). Secondary data on ULABs in Nigeria is relatively scarce, however, the number of vehicles in Nigeria was obtained from National Bureau of Statistics (NBS)/FRSC platform [2]. Furthermore, secondary data on estimated quantities of ULABs from power generating sets, telecommunication and mini-grid sectors were obtained from a World Bank report, 2014 ³.

Primary data were collected from Onitsha and Aba, both in the South-Eastern Nigeria, Asaba in the South-South region of Nigeria and Lagos in the South western Nigeria. These locations were chosen as they were identified as the major ULABs collection and recycling hubs in Nigeria.

The quantities of ULABs generated from the different applications were estimated using the UNEP model ⁴.

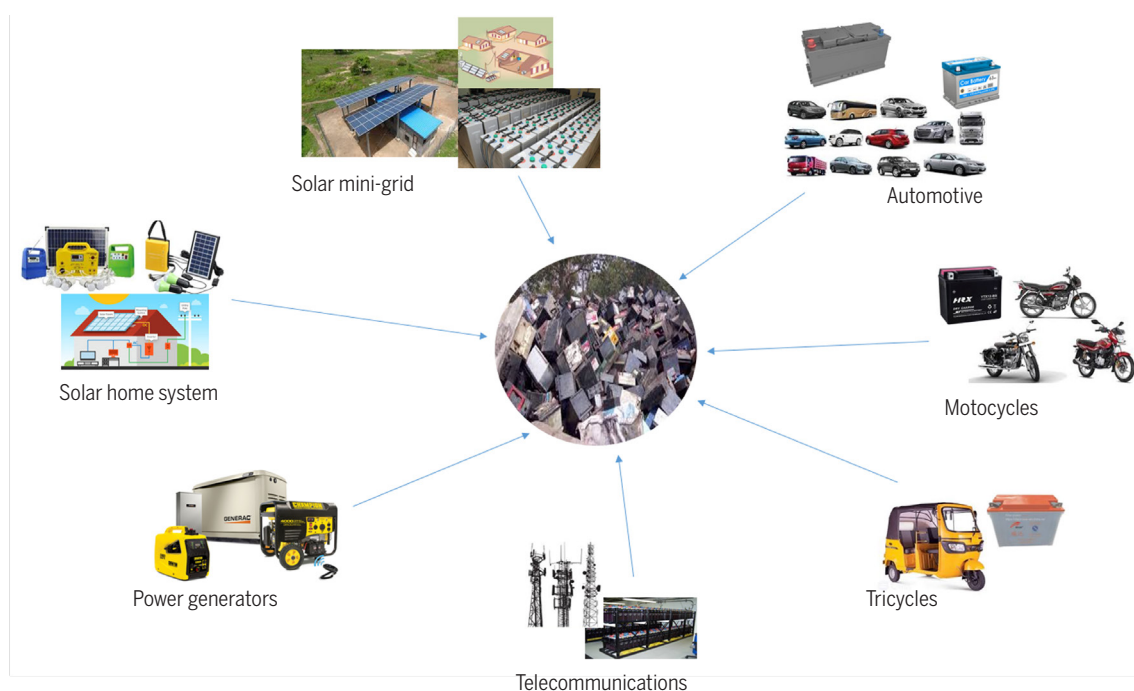
4.0

Market Estimation of ULAB Quantities in Nigeria

To arrive at an estimate of ULAB quantities in Nigeria, a survey of the automotive sector, telecommunications sector, banking sector and the power generating sector was carried out. The exact volumes were not feasible as a result of lack of systematic data collection framework in the country, however, the study was able to look at different segments of the economy with high battery application and obtained as much information as possible from stakeholders during field studies and interactions with sector experts.

The study surveyed several telecommunications companies to collect data on the number of batteries deployed for every cell site around the country. Secondary data on the number of telecommunications sites in the country were obtained and an estimate of batteries from that sector was made. Data from the banking sector was also reviewed to ascertain the total number of Automated Teller Machines (ATMs) in Nigeria and an average number of batteries per ATM to estimate the number of batteries from the banking sector. Survey was also carried out for stationary power generating sets in Nigeria. The largest generator manufacturers and importers in Nigeria were interviewed. An estimate of the average number of power generators in use in Nigeria was made.

4.1.0 Lead Acid Batteries



Sources of ULAB in Nigeria:

4.1.1 Automotive Sector

The automotive sector is one of the fastest growing sectors in the country. As at Q4 2018, the National Bureau of Statistics (NBS) estimated the number of vehicles in the country as 11,800,000[2] with a 2% rise from the preceding year. The vehicles, including large trucks, tricycle and motorcycle, use a starter battery with a capacity of between 5Ah to 100Ah, with a replacement rate of average of 2years or earlier. Therefore, the estimated number of ULABs is at the level of 5.9 million units of different capacities with an average weight of 20kg per battery.

4.1.2 Power Generating Systems

The Nigerian electricity system is unreliable requiring residential, commercial buildings, manufacturing facilities, government buildings, banks, hotels, schools and small and medium enterprises to all adopt backup generators. All generators of more than 4KVA use LABs as starters, while some from a certain capacity use two batteries of 100AH or more per generator with a replacement rate of 2 years. A 2014 World Bank report on Diesel Power Generation in Nigeria[3], conservatively estimates 17 million diesel and gasoline generators in use in the country across different segments. For the purpose of this study, we used data from manufacturing, telecommunications, oil and gas and commercial segments only. Going with the assumption that these segments are likely to use generators above 4KVA with LABs, this market is estimated at 14 million batteries annually. Using a replacement period of 3 years, it is accessed that power generating systems generate 4.6 million ULAB's annually with an average weight of 15kg per battery.



4.1.3 Telecommunications

In order to power thousands of cell sites around the country, telecommunications companies have adopted a hybrid of power generating sets and backup Lead Acid Batteries. According to the 2018 Nigerian Communications Commissions (NCC) Subscriber Data/Network Report [5] the sector had installed 30,637 Base Stations and Towers nationwide with an average of 24 units of LABs of 200 Ah to 1000Ah at each location. A draft estimation is that this sector installed capacity of about 735,288 batteries with a 2 years replacement cycle. This sector generates not less than 367,644 ULAB's annually with an average weight of 60kg per battery.

4.1.4 Solar Power Mini-Grid

This sector has been the most difficult to find reliable data. According to a 2018 Nigerian Economic Summit Group (NESP) Mini-Grid Investment Report [6] Nigeria has at least 364KW of installed Solar Mini-Grid projects. This shows that the sector is still at an early stage, but we can estimate based on technical specifications that this sector utilizes at least 200,000 of 200AH LABs with an average weight of 60kg.

Table 1: Annual Estimated ULAB Volumes in Nigeria

ULAB Generation by Sector	Estimated Number of ULABs	Average Weight (kg)	ULAB Quantity (kg)	ULAB Quantity (MT)
Automotive	5,900,000	15	88,500,000	88,500
Power generating sets	4,600,000	15	69,000,000	69,000
Telecommunication	367,644	60	22,058,640	22,058
Solar Mini-grid	100,000	60	6,000,000	6,000
				185,558

5.0

Collection and Storage of ULABs in Nigeria

The most common and most efficient method for the collection of ULABs is through the battery retailer where a discount is given against the purchase price of a new LAB provided the customer returns the used battery. In some countries a deposit has to be paid when a new LAB is purchased and is only returned to the customer when the battery is returned to the retailer for recycling. In Nigeria, informal collection mechanism is through rag-pickers who scavenge for discarded materials that can be reused or recycled. Rag-pickers scour waste dumps, strip abandoned vehicles and wrecks and collect ULABs and those that have been used for standby power in domestic houses.

Figure 2: shows the standard basic form of storage in open spaces or sometimes in makeshift shops. Used Lead Acid Batteries are stored in batches of up to 1000 batteries at a time.



Figure 2: ULAB Collection and storage point at Otanja Market Onitsha
(Picture credit: present study)



Figure 3: ULAB collection and storage points at Asaba and Onitsha Markets
(Picture credit: present study)

6.0

Cost of Used Lead Acid Batteries

Retail cost of used lead acid batteries ranges between N4000 and N10, 000 per unit when sold to a wholesale collector or primary recycler. Wholesale collectors or primary recyclers sell to secondary recyclers in tonnage ranging between N300,000 and N340,000 per ton or about N340 per kilogram.

Table 2-4 indicate the average retail cost of batteries, wholesale costs and transportation costs.

Table 2: Average retail cost of battery per size

Battery Size	Unit cost Per Kg
45 AH	N2,500
62 AH	N4,000
75 AH	N4,300
100 AH	N5,400
120 AH	N9,400
150 AH	N9,900
200 AH	N12,000
1000 AH	N15,000

Table 2: Average retail cost of battery per size

ULAB in tonnage	Average cost
1 ton	N300,000

Table 3: Average retail cost of battery per size

Transportation	Average cost
1 ton	N11,000
20 tons	N220,000

7.0

Transportation of ULABs In Nigeria

Figure 4 depicts the loading of ULAB's into trucks for transfer to secondary recyclers. Used batteries are usually transported in 20 feet - 40 feet containers depending on the request.



Figure 4: Common mode of transport of ULAB in Onitsha

(Picture credit: present study)

8.0

Health, Safety and Pollution Control

Figure 4 depicts the loading of ULAB's into trucks for transfer to secondary recyclers. Used batteries are usually transported in 20 feet - 40 feet containers depending on the request.

8.1.0 Harmful Effects of ULABs

Lead-acid batteries contain dilute sulphuric acid as electrolyte and large amounts of lead. The acid is extremely corrosive and is also a good carrier for soluble lead and lead particulates. Lead is a highly toxic metal that produces a range of adverse health effects particularly in young children ⁷.

We observed that when used lead-acid batteries are stored in close proximity with human habitation or illegally dumped, the lead and sulfuric acid can seep into the soil and contaminate ground water, potentially affecting the quality of our drinking water supply.

Our study did not reveal any noticeable environmental or health impacts to those engaged in the trade as most respondents to our questionnaires did not complain of any effects to their health and environment. This could have been possible as the major activities at this value chain was only collection and storage.

Batteries were usually stacked in the upright position (see Figures 2 and 3) to avoid leakage of acid and no form of mechanized or crude processing was noticed in the east, however, we learnt that in some parts of Lagos and Ogun States, there were pockets of small-scale smelters involved in crude recycling with potential of releasing dilute acid and lead to the environment which in turn would have deleterious effects on human health and the entire ecosystem.

The primary recyclers handled the batteries without any protection and stored the batteries in open spaces without any safety standards.

9.0

ULAB Recycling Value Chain

A summary is presented of the roles of the different type of persons and companies involved in the ULAB recycling industry in Nigeria and how many of them are failing to meet the basic requirements for handling hazardous waste.

9.1.0 ULAB Generators (ULABGs)

ULAB Generators – are organizations that produce reasonable quantities of ULABs such as from automotive fleets, telecommunication operators, renewable energy operators, manufacturing companies, hospitals, commercial businesses and government organizations. The ULABGs store their ULABs on their premises until they are collected by a collector or scrap dealer for a fee.

² Illegal dumping entails the disposal of used lead acid batteries without any consideration for the environmental or health hazards of associated with such practice.

9.2.0 ULAB Collectors (ULABCs)

ULAB Collectors – are generally small to large scale, sometimes, a one-man business dealing in the collection of ULABs with or without a permit despite that ULABs are designated as dangerous good and hazardous material. ULABCs are middlemen between generators and recyclers. Large scale collectors normally transport the collected ULABs to the secondary recyclers who separate the ULAB components and smelt the lead into ingot for export to Europe and Asia. Despite the large-scale collection of ULABs, majority of collectors were failing to transport, process and store ULABs using recommended procedures in environmentally sound manner.

9.3.0 ULAB Recycling Facilities

ULAB Recycling Facilities – are the companies that recycle the ULABs and sell the recycled lead or produce new batteries for the Nigerian market. They normally accept ULABs with or without acids (see Figure 5) and transport them without any safety or environmental concerns. They also have to deal with significant waste in the form of plastic wrap and strapping, as well as Lithium batteries that are “inadvertently” mixed up with the ULABs.



Figure 5: Manual braking of ULABs in Onitsha

(Picture credit: present study)

Figure 6: indicates the major pathways of ULABs movement from primary generators to the secondary recyclers.

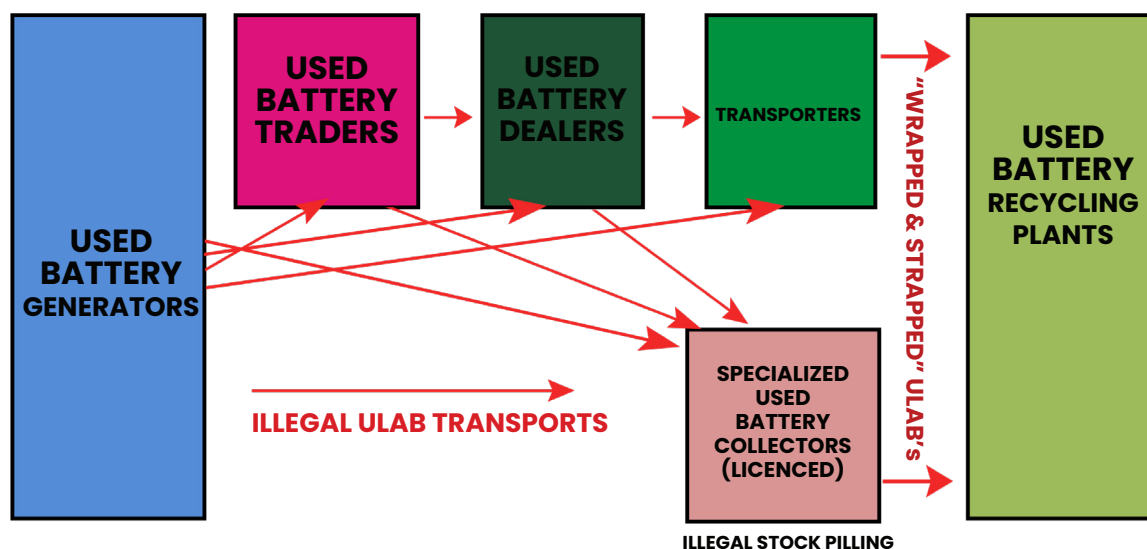


Figure 6: Movement of ULABs along the value chain
(Figure credit: present study)

10.0 Extended Producer Responsibility (EPR) for ULABs in Nigeria

In recent times, Nigeria is in a bid to develop specific policies and regulations to manage ULABs in environmentally sound manner. In exercising it powers the National Environmental Standards and Regulations Enforcement Agency (NESREA) drafted regulations for the purpose of preventing and minimizing pollution and wastes emanating from batteries to the Nigerian environment for both new and used batteries. These Regulations are based on life cycle approach and cover all aspects of Batteries from “cradle to cradle”. The principles of these Regulations include the 5Rs which are: Reduce, Re-use, Repair, Recover and Recycle and shall cover all categories of batteries. Furthermore, the Federal Ministry of Environment also is currently putting a ULAB policy together all to ensure sustainable ULAB management in Nigeria.

In January of 2018, stakeholders of the battery sector began the process of establishing the Alliance for Responsible Battery Recycling (ARBR) for the purpose of ensuring shared responsibility in the environmentally sound management of Used Lead Acid Batteries in Nigeria.

The Alliance received consent from the Attorney General of the Federation and was subsequently registered with the Corporate Affairs Commission as an organization Limited by Guarantee in January 2019. This propelled the establishment of its operational office in Abuja. The ARBR has subsequently been awarded a Certificate of Registration by NESREA as the Producer Responsibility Organization (PRO) for the Battery Sector under the Extended Producer Responsibility (EPR) Programme. The EPR Programme is part of the strategies for ensuring the principle of Circular Economy is implemented in Nigeria to mitigate against hazardous recycling of used batteries in Nigeria

The EPR require businesses to:

- Minimize waste arising from these products by encouraging battery users return of old batteries at the point of purchasing a new one.
- Ensure the waste products are treated and meet recovery and recycling targets for the waste materials by incentivizing collection and recycling by smelting companies.
- Design products by reducing material use and enhancing reusability and recyclability
- Ensure documentation and data collection in the sector
- Ensure the sound environmental management of ULAB's in Nigeria.

The Extended Producer Responsibility (EPR) program will provide effective consumer awareness, expanding waste collection infrastructure, and shifting costs of end-of-life management from municipalities to stewardship organizations.

To achieve its mandate of sound monitoring and recycling of used batteries in Nigeria, ARBR is implementing a Battery Stewardship Programme and Battery Recycling Project across all sectors contributing to the huge volumes of used batteries generated across the country. This is to ensure that all sellers of new and used batteries in the Nigerian marketplace must contribute to the cost of mitigating the hazards of collection and recycling activities. Those who make and sell products that contain or utilize battery make informed decisions based on the effects of their battery choices and implement a battery take-back scheme.

The ARBR also pursues vigorous membership and administers recycling fees on all batteries deployed in Nigeria for the purpose of upgrading the used battery collection, transportation and recycling value chain in the country. Membership is open to all companies involved in battery production or importation, and all businesses involved in collection and recycling of used batteries. It is also required that all companies interested in participating in any solar mini grid project or renewable energy projects should be registered with the PRO as part of their commitment to the environmental and shared responsibility for the recovery of used batteries at end of life.



11.0

Selected ULAB Legislations by country³

Belgium. In 1995, Belgium formed Bebat to collect used batteries in compliance with Belgian regulations. Costs of the program are financed through an environmental fee per battery to the consumer. Today, more than 800 companies are registered with Bebat. Used batteries may be returned at more than 20,000 Bebat locations at retail establishments, schools, and elsewhere. Recycling rates are high in Belgium relative to other Member Nations.

Netherlands. Under the Batteries Disposal Decree in 1995, producers and importers of batteries have formed an organization called Sibat. Batteries are labeled as household hazardous waste. Public information campaigns are employed to encourage consumers to keep batteries separate from municipal waste, and schools participate in battery collection initiatives. Through collection fees paid to Sibat by industry members, local authorities finance battery collection at municipal facilities and retail outlets, while Sibat members bear the costs of transport, storage, sorting, retreating, and recycling used batteries.[8]

Poland. Reba Organizacja Odzysku[9] is a national battery recovery organization in Poland established and owned by manufacturers and importers of batteries to perform the functions necessary to implement the 2006 EU Battery Directive and two subsequent Polish ordinances. Reba has established a system of collection and recovery for waste batteries and portable accumulators, in collaboration with a broadly expanded network of partner entities and institutions. Prizes are awarded to schools for their battery collection efforts.

Germany. The German Battery Decree of 2001 obligates manufacturers to take back portable and rechargeable batteries free of charge from retailers or municipalities, and to recycle them (or dispose of non-recyclable batteries) in accordance with the provisions of the German Waste Management and Recycling Act. Batteries are labeled as hazardous when they contain hazardous chemicals. GRS Batterian,[10] the organization of German battery manufacturers and importers, prepares an annual report on battery circulation, collection, and recycling.

³ This examples of country directives on Battery recycling were gotten from the: Recycling and Reuse: Batteries and Accumulators: European Union Directive

12.0 RECOMMENDATIONS

12.1 Ministerial Declaration on ESM of HZW

- a) The Ministerial Declaration on Environmentally Sound Management of Hazardous Wastes was adopted by the 5th Conference of the Parties to the Basel Convention in December 1999.
- b) The Ministerial Declaration called for enhanced partnerships between the public and private sector to improve the manner in which hazardous wastes and recyclables are managed in developing countries, thereby minimizing the potential risks to human health and the environment posed by these substances
- c) The Federal Ministry of Environment will provide policy and administrative support and collaborate with the stakeholders under the “Battery Alliance” to implement environmental policies and strategies for better battery recycling and export activities in Nigeria under the Basel Convention recommendations and guidelines.

12.2 Regulators, Agencies, Renewable Energy Operators, Banks, Telecommunications Operators, Hospitals, etc.

- a) The Ministerial Declaration on Environmentally Sound Management of Hazardous Wastes was adopted by the 5th Conference of the Parties to the Basel Convention in December 1999.
- b) The Ministerial Declaration called for enhanced partnerships between the public and private sector to improve the manner in which hazardous wastes and recyclables are managed in developing countries, thereby minimizing the potential risks to human health and the environment posed by these substances
- c) The Federal Ministry of Environment will provide policy and administrative support and collaborate with the stakeholders under the “Battery Alliance” to implement environmental policies and strategies for better battery recycling and export activities in Nigeria under the Basel Convention recommendations and guidelines.

12.3 National Information/Data Gaps¹¹

- a) Data on all kinds of battery imports into Nigeria must be documented regularly
- b) Information on actual quantities of lead recycled in Nigeria and formal and informal smelters operating in Nigeria should be documented.
- c) Scientific data on environmental impacts of lead recycling in Nigeria must be measured.

- e) Inventory on the generation, collection, storage, transport, recovery operations, recycling and disposal of ULAB (or its residues) in Nigeria.
- f) Socio-economic, environmental & human health impacts; and a National Capacity Building component for the Environmentally Sound Management (ESM) of ULAB in the country should be carried out.
- g) Identification of gaps in policy, regulatory infrastructure, compliance monitoring and enforcement mechanisms for controlling the trade of ULABs in Nigeria.

12.4 Enforcement

Battery producers, recyclers and collectors should be notified of their responsibility to the environment and a mandatory directive given on how used batteries must be collected, transported, stored and recycled in Nigeria, with failure to comply attracting penalties.

13.0 CONCLUSION

This study seems to be the first formal study on the trade of Used Lead Acid Batteries in Nigeria as confirmed by the respondents in the interviews and questionnaires, further follow-up studies may be required to consolidate data from other ULAB collection centers and recycling. A comprehensive report concerning activities of primary and secondary lead smelters in Nigeria will also have to be conducted to determine the actual quantities of lead recycled and environmental impacts of their activities, most of who are based in Lagos Nigeria.

A major hindrance to this report was the unavailability of data on lead acid batteries in Nigeria. Neither the National Automotive Design and Development Council (NADDCC), National Bureau of Statistics (NBS), Customs nor the Standards Organization of Nigeria (SON) was able to provide detailed data on lead acid batteries in Nigeria.

Greater effort needs to be put towards developing this sector by enhancing data collection by NGO's, government agencies and stakeholders responsible for this sector so that Nigeria can tap the full benefits derivable from recycling this waste stream.



Figure 6: Principal Consultant Mr Terseer Ugbor in Onitsha

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