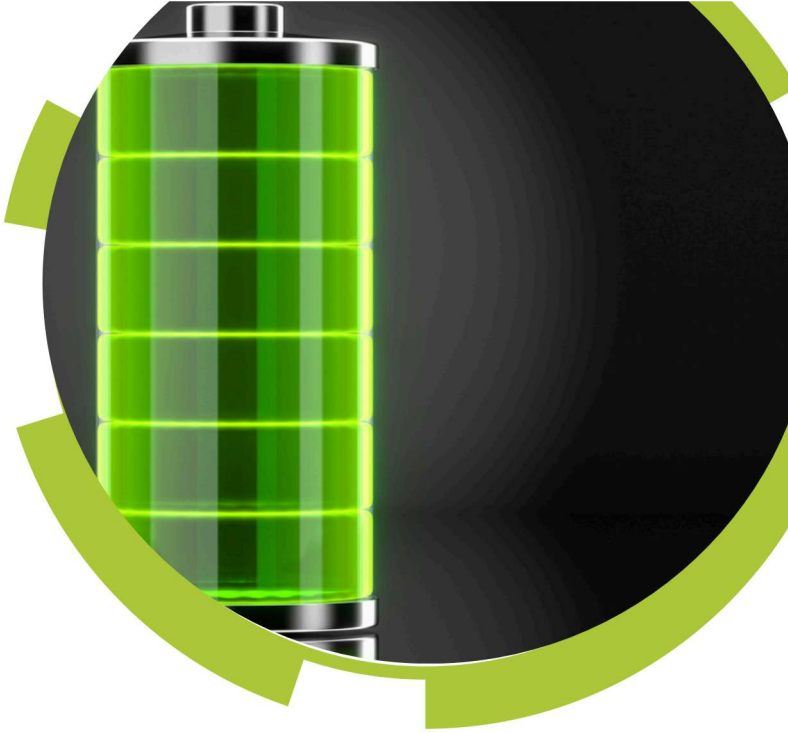


Clean Technology Hub
Energy Innovation Centre

STUDENT ENERGY



NIGERIA'S BATTERY WASTE VALUE CHAIN (BWVC) MARKET REPORT

A Focus on Solar & E-Mobility Sectors

Written By: Cohort 6, Team 3

In affiliation with the
Student Energy Career Training Program

December,2025

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all members of Clean Technology Hub and Student Energy for their invaluable guidance, feedback, and encouragement throughout this project. In particular, we wish to acknowledge David David, Daramfon Nnimmo Bassey, Kolade Kolawole, and our Student Energy Coach, Yazan Zamel, for their exceptional support throughout the research and review process.

We are also deeply grateful to the industry stakeholders and practitioners who generously shared their time and insights during interviews and surveys. Their perspectives were instrumental in shaping the depth and relevance of this market report.

AUTHORS' CONTRIBUTIONS

This report was jointly developed by the Student Energy Career Training Programme (SECT), Cohort 6, Team 3. The members of the team contributed to the research, data analysis, stakeholder engagement and writing, holding the following positions:

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EXECUTIVE SUMMARY

Nigeria is experiencing rapid growth in battery use, fuelled by the expansion of telecommunications, widespread adoption of solar home systems and inverter-based backup power, the gradual emergence of e-mobility, and the country's increasing reliance on digital devices. This accelerating demand is creating a corresponding rise in end-of-life (EoL) batteries particularly lithium-ion and lead–acid. Yet Nigeria currently lacks a cohesive, well-regulated, and efficient national system for managing this waste.

A significant proportion of EoL batteries remain stored in households, traded in informal scrap markets, or discarded in landfills, where they pose substantial environmental, public health, and fire safety risks. During one of our interviews, a policy advocate summed it up:

> ***"In Nigeria right now, the most prevalent practice is the unregulated market, where a lot of installers and developers sell used batteries into informal channels."***
>
> ***- Policymaker***

Despite these challenges, the battery waste value chain in Nigeria, from collection and aggregation to sorting, second-life repurposing, and material recovery represents a major untapped economic and industrial opportunity. With one of Africa's largest consumer markets, a rapidly growing energy-access sector, and an established informal recycling network, Nigeria is uniquely positioned to develop a robust circular battery economy. Realising this potential will require targeted policies, strategic investment, stronger enforcement, and the adoption of safer and more efficient technologies.

Key actors in this emerging value chain include federal and state regulatory bodies, battery producers and importers, solar companies, telecom operators, logistics providers, recyclers, informal waste pickers, financing institutions, and end-users. Major trends, such as the rapid growth of off-grid and renewable energy systems, the shift from lead–acid to lithium-ion batteries, tightening global regulations, and rising international demand for recycled critical minerals, are reshaping the landscape and opening new avenues for Nigeria to build a cleaner, safer, and more profitable battery waste management ecosystem.

In the short term, Nigeria can prioritise the development of national battery standards, pilot take-back and collection initiatives, formalise and integrate informal waste collectors, and improve national data systems for tracking battery flows. In the long term, the country has the opportunity to invest in advanced recycling facilities, establish regional material recovery hubs, adopt digital battery passport systems, expand second-life applications aligned with energy-access goals, and implement a comprehensive Extended Producer Responsibility (EPR) framework.



In this market report, we analyse Nigeria's battery waste management ecosystem, focusing on solar energy and e-mobility industries. Our research traces the flow of batteries from manufacturing and importation through use to disposal, assesses the interplay between formal and informal market actors, and evaluates existing policy frameworks using the DRIIF methodology. Drawing on desk research, stakeholder interviews, and international best practices, we provide a comprehensive assessment of current gaps and opportunities. The report delivers actionable recommendations for both near-term interventions, such as pilot collection schemes, data improvement, and engagement of informal collectors, as well as long-term structural measures such as national standards, advanced recycling, second-life applications, and an operational Extended Producer Responsibility framework.

Nigeria stands at a critical turning point: the batteries powering the nation today will inevitably become tomorrow's waste. Whether these materials become environmental burdens or economic assets depends on the frameworks and investments established now. This report outlines a roadmap for building a sustainable and competitive battery waste value chain in Nigeria

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GLOSSARY

Battery Waste Value Chain (BWVC)
The full system of activities involved in the management of batteries from production and use through collection, reuse, refurbishment, recycling, and final disposal.

End-of-Life (EoL) Batteries
Batteries that can no longer perform their intended function and require replacement, reuse, or disposal.

Lithium-Ion (Li-ion) Batteries
Rechargeable batteries commonly used in solar energy systems, electric vehicles, and electronic devices due to their high energy density and longer lifespan.

Lead-Acid Batteries
Rechargeable batteries widely used in solar backup systems and vehicles; valued for their recyclability but hazardous if improperly handled.

Extended Producer Responsibility (EPR)
A policy approach that holds producers, importers, or distributors responsible for the end-of-life management of products, including batteries.

Second-Life Batteries
Batteries that have been retired from their original application but are repurposed for less demanding uses, such as backup power or off-grid energy storage.

Battery Refurbishment
The process of testing, repairing, and reconditioning used batteries to extend their useful life.

Battery Recycling
The recovery of valuable materials (such as lead, lithium, cobalt, and nickel) from spent batteries for reuse in manufacturing.

Informal Waste Sector
Unregulated individuals or groups involved in waste collection, sorting, and recycling, often operating without formal safety or environmental protections.

Formal Recycling Facilities
Licensed and regulated facilities that process battery waste using controlled and environmentally compliant methods.

E-Mobility (Electric Mobility)
Transportation systems powered wholly or partly by electricity, including electric vehicles, motorcycles, and buses.



GLOSSARY

Solar Home Systems (SHS)
Small-scale solar power systems are designed to provide electricity to individual households, typically paired with battery storage.

Commercial and Industrial (C&I) Solar Systems
Medium- to large-scale solar energy systems installed for businesses, factories, institutions, and commercial facilities.

Battery Aggregation
The collection and consolidation of used batteries from multiple sources before testing, reuse, or recycling.

Energy Storage System (ESS)
A system that stores energy for later use, commonly using batteries in solar and backup power applications.

Second-Life Applications
New uses for batteries beyond their original purpose, often in off-grid, backup, or low-demand energy systems.

Circular Economy
An economic model that emphasises resource efficiency by keeping materials in use for as long as possible through reuse, refurbishment, and recycling.

Traceability
The ability to track batteries through their lifecycle, from production and use to end-of-life management.

Battery Passport
A digital record containing information about a battery's composition, origin, usage history, and recycling requirements.

Hazardous Waste
Waste materials that pose risks to human health or the environment if improperly managed, including many types of batteries.

Value Recovery
The process of extracting economic value from waste materials through reuse, recycling, or material recovery.

Extended Producer Responsibility (EPR) framework.
Environmental, Social, and Governance (ESG)
Criteria used to evaluate an organisation's environmental impact, social responsibility, and governance practices.

INTRODUCTION

Clean electrification is one of the core decarbonisation pathways, making electric vehicles (EVs) and renewable energy sources a means of reducing greenhouse gas emissions from the transport and power generation industries. (1)

Statistics on the Nigerian Solar PV

- By the end of 2024, Nigeria's installed PV capacity reached approximately 385.7 MWp[2].
- By mid-2025, Africa's cumulative PV capacity had surpassed approximately 20 GWp, with Nigeria recognised as a notable growth market [2].
- Nigeria's off-grid expansion is significant. The REA's DARES/NEP pipeline aims to deploy 1.6 million additional solar home systems and approximately 1,350 mini-grids to increase energy access [3].

Statistics on E-mobility

- Lagos launched an electric bus pilot program in partnership with Oando Clean Energy and Yutong. The initiative aims to scale up over seven years, with initial units already delivered [4,5].
- Nigeria has signed the global ZEV Declaration, committing to all new car and van sales being zero-emission by 2040. This demonstrates policy intent, although the domestic market remains nascent [6].
- Nigeria's Energy Transition Plan identifies mode-shift to e-buses and two- and three-wheelers, along with public transport electrification, as primary strategies to reduce transport emissions [7].

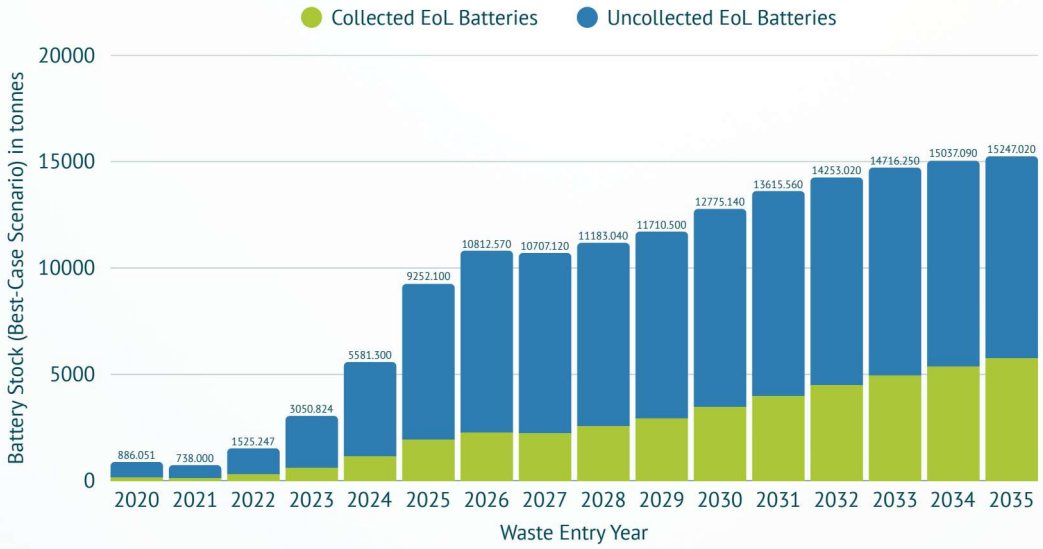


Figure 1.1: This chart illustrates projected EoL batteries in Nigeria from import data. This chart models under the best scenarios of increasing collection rates (Current ~ 21% collection rate (10% increase after 2028), Battery Cycle Life - 5 years). Estimates are based on Nigeria's battery import data from UN COMTRADE and projected using Microsoft Excel's Forecast tool.

This push for electrification is driving a surge in global battery demand. The growth in battery use is fuelled by the widespread adoption of solar home systems and inverter-based backup power, the gradual emergence of e-mobility, and the country's increasing reliance on digital systems and devices. Over time, these batteries will reach the end of their operational life. However, battery end-of-life management has received far less attention than deployment and access.

Figure 1.1 presents projected end-of-life (EoL) battery volumes in Nigeria based on battery import data and assumed battery lifespans. The chart distinguishes between batteries that are likely to be collected and those that remain uncollected under a best-case scenario of improved collection rates, highlighting the growing accumulation of unmanaged battery waste over time.

Nigeria's battery waste value chain can be understood across four interconnected streams:

- Upstream: Importation and limited local production of batteries and battery materials.
- Midstream: Assembly, distribution, and integration of batteries into solar systems, inverters, and vehicles.
- Downstream: Installation, operation, maintenance, and replacement of batteries by users.
- End-of-Life (Feedback Stream): Collection, reuse, refurbishment, recycling, or disposal of spent batteries.

This report includes 6 Sections addressing the landscape of the battery waste value chain

1. Battery Technologies in the Solar/EV Value Chain
2. Overview of the Battery Waste Value Chain in Nigeria.
3. Key Players in the Solar/EV Battery Waste Value Chain
4. Trends within the Battery Waste Value Chain
5. Opportunities for Growth within the Battery Waste Value Chain
6. Recommendations

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Battery Technologies in the Solar/EV Value Chain



Batteries are an efficient, widely used, and cost-effective means of storing electrical energy and power. In solar applications, batteries enable households, businesses, and institutions to cope with intermittent power supply and reduce the reliance on petrol or diesel generators. In EVs, their specifications influence mileage, charging frequency, safety, and total cost of ownership.

They typically comprise three core components:

1. Electrodes (anode and cathode), which are responsible for the transfer of charges,
2. A separator which prevents direct connection between the electrodes, and
3. An electrolyte that facilitates ion transfer between the anode and cathode, enabling electrochemical reactions.

Batteries used across Nigeria's solar and electric mobility sectors differ by their underlying chemistries, each with unique performance parameters and lifecycle implications. This section of the report will detail the battery technologies in use in Nigeria, including their composition, chemistry, performance, lifespan, hazards, and end-of-life implications.

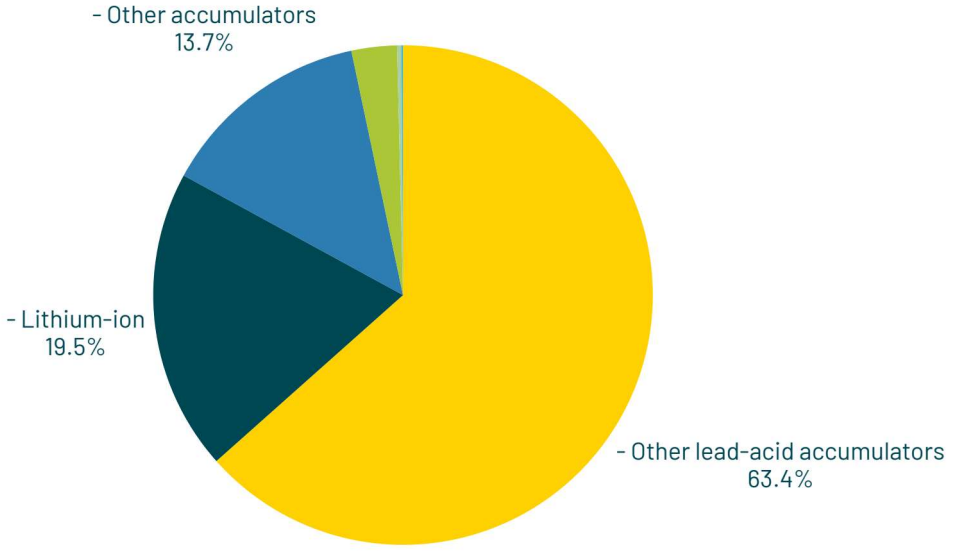


Figure 2.1: The Distribution of Imported Battery Technologies in Nigeria (2024) by Net Weight (kg)[1]

Nigeria's import profile in 2024 highlights the dominance of lead-acid accumulators, which accounted for approximately 63% of total battery imports by net weight. Lithium-ion batteries represented 19.5% [1].

[1] United Nations, Department of Economic and Social Affairs, Statistics Division. UN Comtrade Database. Available at: https://comtradeplus.un.org. Accessed (insert date).

LEAD-ACID BATTERIES (LABs)

Invented in 1859 by Gaston Planté, a French physicist fascinated with natural phenomena and electrochemistry, the Lead Acid Battery (LAB) is the oldest rechargeable battery still in mainstream use [2]. They are composed of a Lead (Pb) anode (positive electrode), a Lead dioxide (PbO_2) cathode (negative electrode), diluted sulfuric acid (H_2SO_4), lead grid current collectors, and a separator. The LABs attracted attention and gained traction quickly in Nigeria because of their ability to deliver high current densities, low manufacturing costs, and high availability.
LABs in the Nigerian market can be classified by their application and maintenance requirements, namely:

1. The Flooded (FLA)
2. Sealed/ Maintenance-free (SLA)
3. And Valve-Regulated (VRLA), which has two sub-types: Absorbent Glass Mat (AGM) and Gel Cell (GEL) batteries.

End-of-life (EoL) indicators for flooded lead-acid batteries (LABs) include electrolyte oxidation (often due to high heat), brown or black discolouration, prolonged discharge, casing swelling, and the hardening formation of lead sulphate ($PbSO_4$) crystals. Other physical EoL indicators are permanent capacity loss, sulphation, corrosion, active material shedding, swelling, and internal short circuits.[3] Nigeria's heavy reliance on lead-acid batteries (LABs) in both solar systems and vehicles has led to substantial waste. Between 1980 and 2014, an estimated **4.8 million tonnes of vehicle LABs were used nationwide, of which 2.6 Mt reached end-of-life. [4]** Roughly 2.3 Mt were recycled, while 0.3 Mt were disposed of in landfills. These figures exclude additional WLABs from smaller devices such as rechargeable lamps, mobile phones, and solar home systems.

Nigeria has one of the largest lead-acid battery recycling industries in Sub-Saharan Africa, with over 10 major recycling plants, most of which are located in Ogun State [5]. The industry is heavily export-oriented, with estimates suggesting the recycled lead produced in Nigeria is exported to international markets. The majority of these plants operate with dangerously low environmental and safety standards. Many facilities have poor dust control, inadequate protective gear for workers, and release excessive amounts of lead into the air and the surrounding environment. This has led to widespread lead poisoning and pollution in the communities where they operate. However, there are standout examples of how it can be done correctly. Two companies, both located in the Ogun State industrial corridor, lead the formal sector:

Green Recycling Industries Ltd:
Located in Agbara, Green Recycling has distinguished itself with a strong emphasis on environmental best practices.[5] The company's commitment to higher standards has earned it a unique position as the only Nigerian recycler to be included on the "positive list" of responsible recyclers by the International Partnership for Responsible Battery and Metal Recycling (ProBaMet)[5]. The facility utilises modern European technology, including an automated breakage-and-separation system that recovers 99.5% of the lead from batteries.[6] Its process is a model of circularity, also converting plastic casings into pellets and electrolyte into sodium sulphate crystals for sale to other industries. The plant operates with a stated monthly capacity of 1,000 tonnes.[6]

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[5] Partnership for Responsible Battery and Metal Recycling (ProBaMet) - The Alliance for Rural Electrification, https://www.ruralelec.org/campaign/partnership-for-responsible-battery-and-metal-recycling/
[6] Green Recycling, https://www.greenrecycling.ng/

BPL Nigeria Ltd.:

A dominant force in the market, BPL Nigeria is not only a major ULAB recycler but also one of Africa's largest exporters of pure lead.[7] Its significance to the national economy was recognised by the Central Bank of Nigeria, which named it one of the country's top 20 exporters.[8] Located in the Opic Industrial Estate, the company employs a pyrometallurgical process centred around a rotary furnace to produce high-purity lead ingots (99.7% to 99.985%) and various lead alloys.[9] The company is in a significant growth phase, supported by a refinancing facility from United Capital to expand its plant capacity from an initial 7,000 metric tonnes up to 28,000 metric tonnes.[8]

LITHIUM-ION BATTERIES (LIBs)

The Lithium-ion battery (LIB) is a member of the family of metal-ion rechargeable batteries (RBs). Lithium-ion batteries, particularly lithium iron phosphate ($LiFePO_4$) for residential and commercial energy storage and lithium nickel manganese cobalt oxide (NMC) for E-mobility, are increasingly being adopted in Nigeria due to their higher energy density, relatively low maintenance requirements, growing affordability, and longer lifecycle performance.[10,11]

A Lithium-ion battery (LIB) typically consists of an anode, commonly made from carbon-based materials such as graphite powder, carbon-coated graphite, or, more recently, lithium alloys [10], [13], [14] and a metal oxide cathode. The three leading cathode chemistries are ***layered oxides, spinel oxides, and polyanion oxides***, with the latter increasingly preferred for their stability, safety, long lifespan, lower cost, strong structural ordering, excellent electrochemical performance, and high reversibility [15], [10]. Additional components include a polyethene separator, a PVDF (Polyvinylidene Fluoride) binder, non-aqueous electrolyte solutions such as $LiPF_6$, $LiClO_4$, or $LiCoO_2$, as well as copper (anode) and aluminium (cathode) current collectors. The reactions taking place in an LIB mainly involve the electrodes; they are termed Intercalation reactions. During discharge, Li^+ ions slip out of the anode and move through the electrolyte to the cathode. The cathode then intercalates these Li-ions into its layered structure without destroying its layers. So, during discharge, the lithium ions move from the anode to the cathode during discharge. And during charge, the lithium ions leave the cathode and re-intercalate into the anode [5].

Along with key chemical characteristics such as cell voltage, cathode particle size, diffusivity, and electrical conductivity, subtle features of the electrodes, including microstructure, texture, crystallinity, and morphology, directly influence overall battery performance [12], [15]. LIBs are a great example of how small features can make a great difference in battery performance, health, and durability.

LFP (LiFePO4) is the most widely used lithium-ion chemistry in Nigeria, especially for large solar inverters, residential energy storage, and commercial backup systems. It is preferred because of its very high thermal stability, resistance to thermal runaway, long cycle life (≅ 3,000–7,000 cycles), excellent chemical stability, tolerance to high temperatures typical of Nigeria, lower cost compared to NMC, and relative non-toxicity. While the ULAB sector is mature, the EoL LIBs management industry in Nigeria is in its infancy, which raises concerns about its long-term sustainability in Nigeria.

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[8] BPL Nigeria | A metal recycling and commodity trading company, https://bplnigeria.com/
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OVERVIEW OF THE BATTERY WASTE VALUE CHAIN IN NIGERIA.

The various battery chemistries follow a similar value chain. The battery waste value chain includes all the activities within the battery industry that its stakeholders partake in. As reviewed in the literature, the battery value chain can be divided into four streams: upstream, midstream, downstream, and end-of-life or recycling streams[1–6].

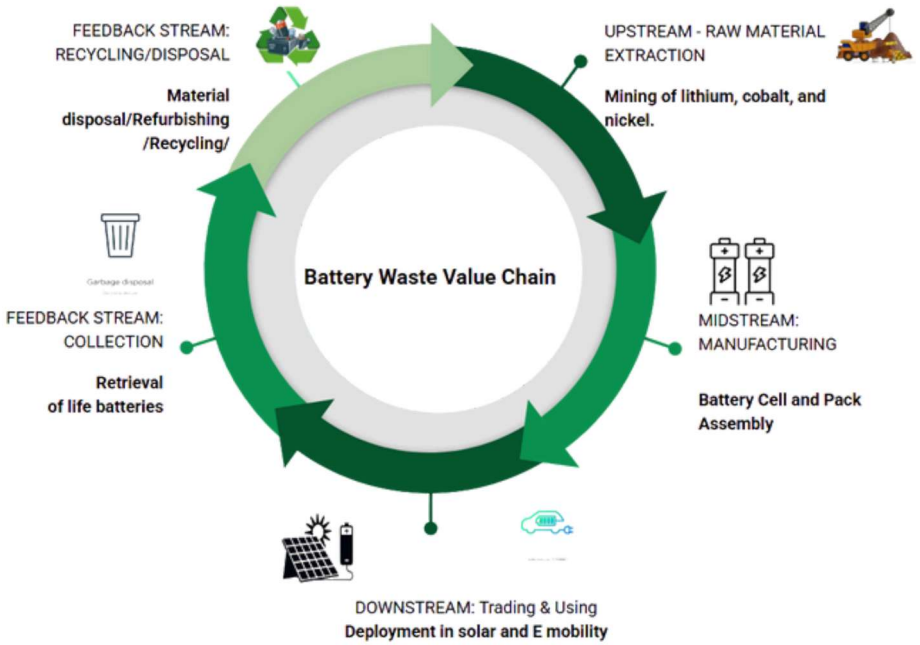


Figure 3.1: The Battery Waste Value Chain

Upstream

The value chain upstream involves the exploration, extraction, beneficiation, and refining of raw materials to form precursors required for the development of battery technologies[1]. These raw materials are also known as critical minerals or critical raw materials (CRM), as their demand is set to increase with the adoption of greener technologies for the energy transition [7]. Critical materials for battery technologies typically used in EV and solar system applications include minerals such as lithium, cobalt, nickel, manganese, graphite, aluminium, copper, lead, cadmium, iron, and rare earth elements [8,9]. These minerals are not readily available unless they are found through exploration, mined, and refined for final use in EVs, Solar Systems, and other battery applications.

The CRM mining industry in Nigeria, compared to countries such as Australia, China, the United States, South Korea, and the Democratic Republic of the Congo (DRC), remains underdeveloped, with a smaller share of the upstream market. According to the International Energy Agency, China has the most competitive advantage over most countries, with more than 50% of the world's lithium, cobalt, and graphite being processed and refined there [6].

Several states in Nigeria have deposits of lithium, copper, iron, graphite, lead, nickel, and other minerals that can be used in designing batteries [8]. The Clean Technology Hub highlights the critical minerals within Nigeria, key developments made in the industry, and the lack of a framework that provides a guide for all stakeholders in the critical raw material value chain. CTH also suggests that priority needs to be placed on the CRM framework. [8].

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Case Studies

- In 2024, two lithium processing plants were commissioned: Kangimi, located in Kaduna State, and Endo, located in Nasarawa State. These projects were developed with the aid of foreign investors, Avatar New Energy Materials Company Limited, a Chinese mining firm, and Ming Xin Mineral Separation Nigeria Ltd [10,11].
- In 2016, the Nigerian government showed interest in developing a nickel processing plant. This interest stemmed from the discovery of nickel balls, known as Titan, in both Jos State and Kaduna State by an Australian Mining Company, Comet. However, concrete plans have not been laid [12].
- The Itakpe Mine, located in Kogi State, plays an important role within the BVC as it provides the raw materials required in steel production, Iron Ore. The Itakpe Mine is estimated to have a reserve of 200 million tonnes of Iron ore. The mine also has ore beneficiation plants [13 12].

Upstream procedures have raised geopolitical, environmental, and financial concerns, as they are capital, labour, and energy-intensive [14 13]. Although foreign companies sponsor some projects, such ventures raise concerns about foreign dependence and neo-extraction, which could later affect the country. Other issues, such as insecurity, illegal mining, and limited technical know-how, also affect the country.

Midstream

The midstream involves developing battery components such as the anode, cathode, electrolyte, casings, and separator. Typical steps in developing battery components include transporting precursors from upstream and downstream suppliers to manufacturers producing the various battery components. These components are then fabricated to form battery cells or packs, which can have other electronics added to them for further applications.

China also dominates the midstream section of the battery value chain by making over 80% of the cathode and anode of battery cells[6]. Some other countries that also contribute to the midstream include Korea, Poland, Japan, and the United States of America [6,15]. Thus, most of the batteries used in Nigeria are manufactured internationally, but some companies in Nigeria manufacture precursors for battery production, such as Metal Manufacturing Nigeria Ltd (MMNL), a Lead Billet and Grey Oxide manufacturing and supplying company in Nigeria.

Apart from lead-acid battery manufacturing, there are other efforts in this stream in Nigeria. Dafe Energy Solutions Limited, located in the Federal Capital Territory, Abuja, manufactures zinc-air fuel cell battery technology locally for deployment in EVs and Solar System [18]. Some tertiary institutions, such as PRODA in Enugu State, are exploring the possibility of producing lithium-ion battery cells in Nigeria.

There are still several opportunities for development within this industry in Nigeria. Precursors can also be obtained from battery waste and used to design battery waste. Since the stream is still new and budding within the country, the industry may face issues such as limited capital and technical knowledge, lack of resources and data to build state-of-the-art facilities, and inadequately equipped tertiary institutions and research facilities for procuring battery cells and packs [2].

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Downstream

The downstream involves designing, developing, and selling battery application-specific systems[1]. Activities within this stream include integrating assembled battery packs for end applications, such as Inverter systems, EVs, Solar Systems, and others. It also includes transportation, installation, marketing, and the sale of final products to customers.

The typical PV system architecture includes solar panels, batteries, an inverter or DC-to-DC converter, loads, and charge controllers to keep the batteries safe. Electric Vehicles come in various types and forms. They can be classified by power unit structure as Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Fuel Cell Electric Vehicles (FCVs) [19] [18], and Extended-Range Electric Vehicles (ERVs) [20] [19].

Although the majority of institutions and companies within the EV and PV systems manufacturing and distribution sectors are outside Nigeria, some companies have taken steps that can aid the development of a circular battery chain in Nigeria. The following sections will discuss case studies of battery manufacturers in Nigeria, as well as companies that encourage the use of EV and PV system technologies by offering consultation, easy access, and installation of these systems.

Companies in Nigeria that manufacture PV and EV technologies used by Nigerians
Some Electric Vehicle Companies

- **Zolair Energy Solutions Ltd.** is an energy solutions company in Nigeria that focuses on various areas of energy transition, including clean cooking, electric mobility, solar power systems, and communications. They are based in Kaduna State. Within the EV space, they have succeeded in developing a 3-minute Zinc-air battery swapping system for electric tricycles [21], solar-hybrid charging stations [22], as well as vehicle conversions from pure gasoline ICEs to gasoline/electric hybrids [23]. Within the Solar Energy and Inverter space, Zolair offers Sodium-Ion batteries for use in inverter applications, which have comparable performance to both Lead-acid and Lithium-ion batteries [24]. They also offer their ZOLAIR power box, which is powered by Zinc-air fuel batteries as a solar home system [25].

- **Siltech World** is another renewable energy solutions company that looks into the development of an electric mobility ecosystem in Africa. They are based in Lagos, Nigeria. Their primary activities include battery assembly, vehicle manufacturing, vehicle conversion, EV battery charging, consultation, and after-sales services. A notable fact about Siltech is that it sources 65% of its raw materials in Nigeria. They have developed a range of EV prototypes from 2-wheelers to 4-wheelers [26].

- **JET Motor Company** is another company offering E-mobility solutions in Nigeria. They assemble electric vehicles for different applications, such as delivery vans, ambulances, military vehicles, and passenger vehicles [27].

17 BPL Nigeria | A metal recycling and commodity trading company. http://bplnigeria.com/.
18. Dafe Energy - About. https://dafe.netvoucher.com.ng/Home/About#.
19. The Different Types of Electric and Electrified Vehicles. Car and Driver https://www.caranddriver.com/features/a43863538/types-of-electric-vehicles/ (2023).
20. How Does An Extended-Range Electric Vehicle Work? InsideEVs https://insideevs.com/features/722276/extended-range-electric-vehcles-explained/.
21. Battery Swapping – Zolair Energy Solutions Limited. https://zolairenergy.com/solutions-archives/swap-centers/.
22. Charging Stations – Zolair Energy Solutions Limited. https://zolairenergy.com/solutions-archives/ev-charging/.
23. Vehicle Conversion – Zolair Energy Solutions Limited. https://zolairenergy.com/solutions-archives/vehicle-conversion/.
24. Sodium (ion) Battery – Zolair Energy Solutions Limited. https://zolairenergy.com/solutions-archives/home-inverter/.
25 Solar Home Systems – Zolair Energy Solutions Limited. https://zolairenergy.com/solutions-archives/sme-power-box/.
26. Siltech World - the First Electric Vehicle Distributor in Africa emerging as early as 2012. https://www.siltechworld.com/ev-maufacturing.
27. About us. http://_.com.

- **QuadLoop**: They manufacture affordable solar lanterns and home systems, with 70% of the materials sourced from electronic waste.[28] Their key innovation is the repurposing of still-viable lithium-ion battery cells recovered from discarded laptops. By partnering with formal collectors like Hinckley, QuadLoop has created a scalable model that prevents e-waste from entering landfills while providing clean energy solutions.

- **Thinkbikes**: Thinkbikes manufactures Nigeria's first locally produced electric cargo bikes.[29] Similar to QuadLoop, its innovation lies in its power source: the company repurposes lithium-ion batteries from old laptops to create the battery packs for its e-bikes. This approach makes its products more affordable for small businesses, logistics companies, and farmers.[29]

Other companies include: Electric Motor Vehicle Company (EMVC), Innoson Vehicle Manufacturing Company, MAX, Trekk, Possible EVs, and SAGLEV EVs [30].

Nigerian companies that sell EV and PV products to customers in Nigeria.
Several companies in Nigeria offer different solar packages for their customers. According to ENFsolar, there are more than 357 companies within the solar panel installation industry in Nigeria[31].

- **Sun King**, a popular solar brand in Nigeria, offers its customers off-grid solar products and packages to help them cope with the effects of an unreliable grid. The company was founded by University of Illinois graduates to create affordable clean energy solutions for off-grid communities. Some of the packages offered to their customers include solar lanterns, solar home systems, and solar inverter systems. Their packages include consultation, installation, and flexible payment options for customers to pay in instalments.[32]

- **Solar Depot** is also a well-known solar brand in Nigeria, which offers its customers products like PV panels, batteries, charge controllers, solar water pumps, and inverters. It is based in Lagos, offering different packages for individuals and companies.[33]

- **Ashdam Solar**. Ashdam Solar also offers clean energy solutions and packages to its customers. It is a female-led renewable energy business founded in Ibadan, Oyo State. A unique feature is that they provide training programmes to learners passionate about solar PV installation, especially women[34].

The Electric Vehicle industry is also growing within some regions in Nigeria, such as Lagos State, Kano State, and Abuja. Climate Scorecard noted in 2025, electric vehicles represent 1% of the total vehicle population, with prices ranging from 12 million Naira to 150 million Naira[12]. Some brands in Nigeria include Tesla, BYD automobile, Nissan, BMW, Audi, Hyundai, Chevrolet, Porsche, and Kia [35]. Other companies providing solutions targeting the EV space in Nigeria include Spiro, Swap Station Mobility, and Swap Energies.

28 Solar Lanterns from E-waste – Make it Circular Challenge, https://makeitcircular.whatdesigncando.com/projects/solar-lanterns-from-e-waste/
29 About Us – Thinkbikes, https://thinkbikes.com.ng/about-us/
30 6 Nigerian electric vehicle companies you should know in 2024. https://techpoint.africa/insight/ev-startups-in-nigeria/ (2024).
31. Ltd, E. N. F. ENF Ltd. https://www.enfsolar.com/directory/seller/Nigeria.
32. Home. Sun King https://ng.sunking.com/.
33 Welcome To Solar Depot – Biggest Solar Showroom In Nigeria. https://solardepot.ng/.
34. Ashdam Solar. https://ashdamsolar.com/.
35. Vehiclespot. Top 10 Electric Cars In Nigeria 2025 and Their Prices - Vehiclespot | Car Dealer in Nigeria | Car Dealer in Lagos | Vehicle Dealer | Car seller. https://vehiclespot.ng/top-10-electric-cars-in-nigeria-2025-and-their-prices/ (2025).

End-of-Life / Feedback Stream

The End-of-Life or Feedback stream is the section of the battery value chain that includes the disposal or recycling of batteries within the battery waste value chain. It is a key component in building a circular economy within the battery value chain. After a battery's life span expires, customers can replace their present batteries with new ones, giving the appliance another life, or dispose of the product and buy a replacement.

These batteries can be classified as Electronic Waste (E-waste) and as End-of-life batteries (EoLBs). EoLBs come from various devices, such as mobile phones, PCs, rechargeable devices, vehicles, energy storage systems, and many more. Customers' or battery users' behaviour towards expired batteries depends on both their knowledge and the availability of services for End-of-life batteries (EoLB). Waste batteries that are not properly disposed of can pollute the environment, exposing it to minerals such as cadmium, zinc, and lead.

The battery waste value chain is connected to many streams of the battery value chain, particularly the midstream and downstream segments. Midstream, it provides battery precursor materials to manufacturers. At the same time, downstream, it is the provider of second-life or refurbished batteries to manufacturers and consumers. More information on the current landscape of the battery waste value chain can be found in section four of the literature review.

Disposal Strategy

In Nigeria, the journey of a used battery is dictated by its chemistry and economic value. Used lead-acid batteries (ULABs) are highly toxic but have an established market value due to their lead content, which in turn fuels a hazardous, polluting informal recycling industry. Conversely, lithium-ion (Li-ion) batteries, while still posing significant environmental risks, have no established informal value.

This leads not to unsafe recycling but to widespread neglect and improper disposal. For LIBs, collection is the primary bottleneck. Once a battery is considered "dead," it enters a complex system of collection and disposal that is split into two vastly different worlds: **the informal and the formal.**

The Informal Path: How Most Batteries Are Handled

The informal sector is by far the main channel for collecting used batteries in Nigeria. It is a massive, unorganised network of individuals, often called "scavengers" or informal collectors, who are responsible for collecting between 80% and 90% of all recyclable electronic waste. This network employs up to 100,000 people and is incredibly effective at reaching every corner of the country[37].
The typical process is as follows:

1. An informal collector acquires used batteries from households, mechanics, and businesses.
2. To reduce the weight and facilitate sale, the collector often dismantles the battery and pours the toxic acid directly onto the ground or into local drains.
3. This acid contains lead and other hazardous chemicals, which can contaminate soil and water sources.
4. At times, components of the battery are incinerated in open air to recover valuable metals such as copper.
5. This process emits toxic fumes and hazardous substances, posing significant health risks to individuals and the surrounding community.

36 (n.d.). Working Paper No. 322. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/publication/wcms_741013.pdf
37 Ogungbuyi O, Nnorom IC, Osibanjo O, Schluep M. e-Waste Country Assessment Nigeria. e-Waste Africa Project of the Secretariat of the Basel Convention; 2012.

The Formal Path: A Safer yet Challenged Alternative

The Nigerian government, through the National Environmental (Battery Control) Regulations of 2024, seeks to establish a formal, safe system for the disposal of batteries. This framework is founded on the principle of Extended Producer Responsibility (EPR), which mandates that companies that produce or import batteries are financially responsible for the collection and recycling of these products at the end of their life cycles[38].

Once the EoL batteries are collected, they are directed into two principal pathways:

- **Recycling**, which aims to recover raw materials such as lead, cobalt, and lithium;
- **Repurposing or Refurbishing**, where batteries are granted a "second life" in less demanding applications, such as stationary energy storage.[39]

The advancement of both pathways is critical to the realisation of a truly circular battery economy.

38 Closing the Loop. Whitepaper: The Business Case for Battery Recycling in Nigeria [Internet]. 2020 Sep 30 [cited 2025 Dec 19]. Available from: https://closingtheloop.eu/wp-content/uploads/2024/08/CTL-Whitepaper-BusinessCase-Battery-Recycling-20200930.pdf

39 National Environmental (Battery Control) Regulations, 2024 (Nigeria).

KEY PLAYERS IN THE SOLAR/EV BATTERY WASTE VALUE CHAIN

Most visible stakeholder activity in the space comes from the following eight (8) groups:

Manufacturers, Suppliers, and Importers
These are individuals or institutions that are involved in the design, manufacturing, or importation of battery technologies for electric vehicles (EVs) and solar energy applications. They influence battery chemistry selection, design standards, durability, safety features, and traceability, all of which directly affect battery lifespan, reuse potential, and recyclability at EoL. Decisions taken at this upstream stage of the value chain shape the volume, type, and complexity of battery waste that will eventually enter Nigeria's waste management system.

Key Actors:
Battery Manufacturers, EV or Solar Energy System Manufacturers, Original Equipment Manufacturers (OEMs), Battery Importers, EV, Solar Energy, or Battery Researchers, Battery, EV, and Solar Energy System Suppliers.

E-Mobility and Solar Energy Operators and Businesses
These are companies and enterprises within the solar and EV value chain that offer products and services directly to customers. They serve as the interface between manufacturers and end-users and are often responsible for battery installation, operation, maintenance, replacement, and, in some cases, collection. Their operational practices significantly influence how batteries are handled during use and at the end-of-life.

Key Actors:
Battery, EV, Solar, and Inverter Retailers & Wholesalers, E-mobility Operators, Solar Installers, Battery Swapping Station Workers, Consultants, Battery Renters.

Researchers and Policy Advocates
These are individuals or non-governmental institutions that advocate for issues within the energy, circular economy, and waste management sectors in Nigeria. They generate evidence, influence public discourse, and support the development of policies, standards, and frameworks related to sustainable energy systems and responsible battery end-of-life management.

Policymakers
These are individuals within government agencies or regulatory institutions who participate legally in drafting, implementing, or enforcing policies in Nigeria, particularly those relating to waste management, e-mobility, energy, and environmental protection. Their actions determine the regulatory incentives, compliance mechanisms, and enforcement capacity governing battery production, use, and disposal.

Customers & End-Users
These are individuals, households, companies, and organisations that have purchased and used EVs or solar energy systems. They are the primary sources of end-of-life batteries and play a decisive role in determining whether batteries are reused, resold, recycled, stored, or disposed of unsafely. Their awareness, incentives, and access to disposal options directly influence battery waste outcomes.

Informal Battery Waste Workers

These are individuals or groups who operate within the battery waste value chain outside formal regulatory frameworks. Informal collectors and scrap dealers control how most used batteries move through Nigeria. Their decisions determine whether batteries are recycled, exported, reused, or dumped unsafely. Understanding their incentives, risks, and constraints is essential for designing realistic and inclusive battery waste management policies.

Key Actors:

Scrap Collectors; Scrap Dealers; Battery Breakers; Transporters; Recycling Cooperatives; Informal Recyclers.



Figure 4.1: Image of a Informal Waste Worker in his Shop Source: Author

Formal Battery Waste Workers

These are registered individuals and companies that operate within the battery waste value chain under formal regulatory oversight. Formal recyclers provide critical infrastructure for safe storage, dismantling, processing, and material recovery. Their perspectives highlight operational bottlenecks, economic viability, compliance costs, and regulatory gaps within Nigeria's battery recycling ecosystem.

Key Actors:

Registered battery recyclers, Licensed waste collection companies, authorised dismantling and refurbishing firms.

Investors and Donors

Investors and donors are individuals and institutions that support the growth of businesses within the energy, e-mobility, and circular economy sectors through financial contributions, blended finance, or technical assistance. Their assessment of risk, profitability, and policy certainty determines whether battery recycling and circular solutions can scale sustainably in Nigeria.

TRENDS WITHIN THE BATTERY WASTE VALUE CHAIN

To garner insights into practices and emerging trends within the battery waste value chain, this report draws on interviews and surveys conducted with **56 key stakeholders** operating within and beyond Nigeria's battery waste value chain. These respondents represent a cross-section of actors across the battery lifecycle, providing diverse perspectives on manufacturing, selling, use, collection, recycling, the policy, and economic viability within the BWVC.

Findings from stakeholder engagements were divided across four thematic areas:

1. Awareness of battery disposal practices
2. Practices within the battery waste value chain
3. Stakeholder opinions on the battery waste value chain
4. Circular economy solutions

The demographic characteristics of respondents are presented below.

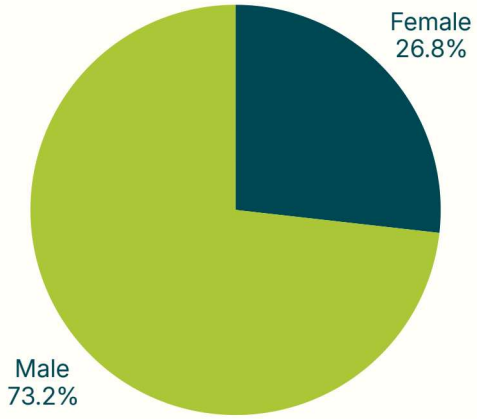


Figure 4.2: Gender Distribution of Interviewed and Surveyed Stakeholders

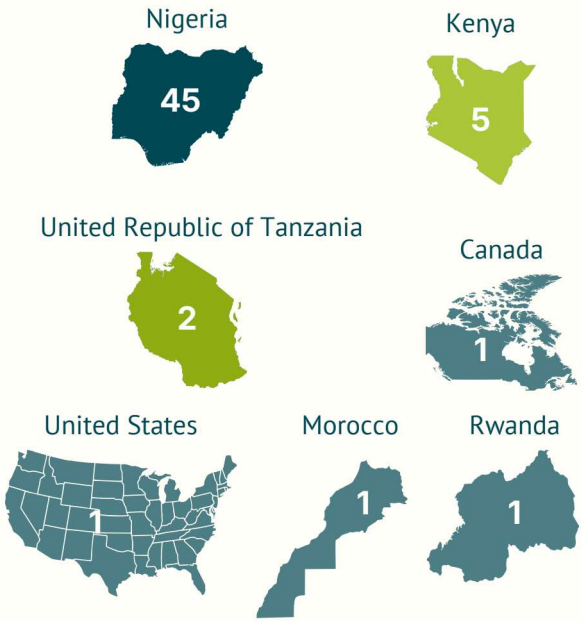


Figure 4.3: Distribution of Interviewed and Surveyed Stakeholders across Countries

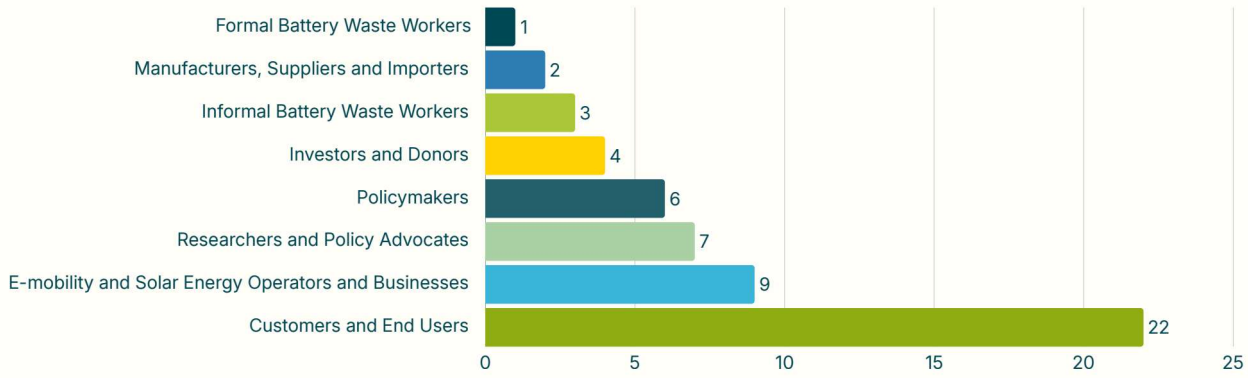


Figure 4.4: Distribution of Interviewed and Surveyed Stakeholders by Category

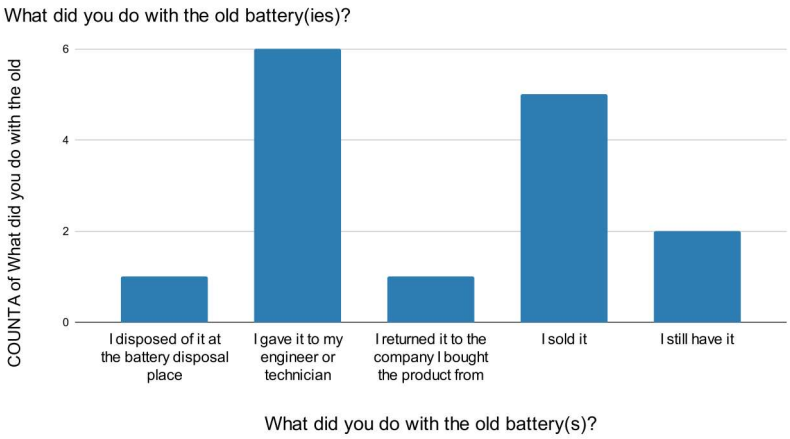
Awareness of battery disposal practices

1. **Informal waste workers are aware of safe disposal practices:**

> ***Interviewer:*** *So you wear gloves and boots. Okay, what of overalls? If you can protect your body, you can wear overalls. Is it anywhere, like in your shop now, like if you want to break this thing, will you go to a landfill, like where do you dismantle these batteries?*
>
> ***Informal Waste Worker:*** *We do break these batteries here sometimes. But when we break it,* ***we have to protect the ground. We do not like the water to pour into the ground. Because if you pour it, they destroy the ground****. I think it's a very strong chemical, you know...* ***People that do not know these things are simply people that don't know what they're doing.*** *Because if you don't do it, if you don't do it, sometimes, like, the thing will start destroying your body that very day. Other times, it's after some time. Even breathing in the chemicals through the nose is harmful, because it will destroy something inside your system, you know what I mean?*

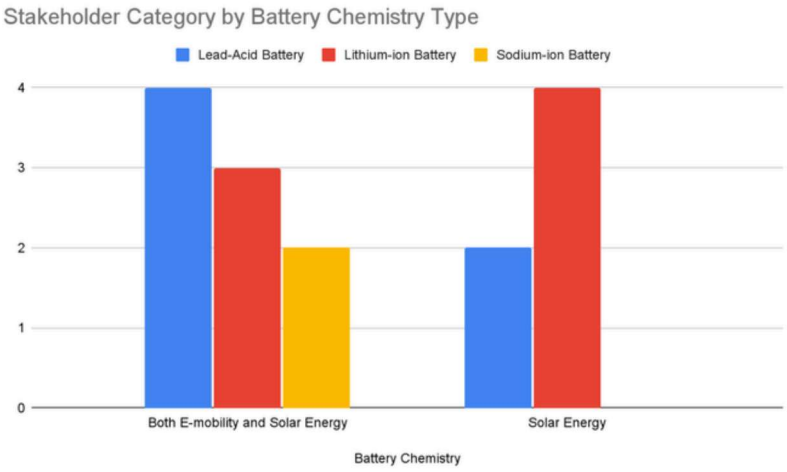
2. **Some members of the general public are yet to practise safe battery disposal**

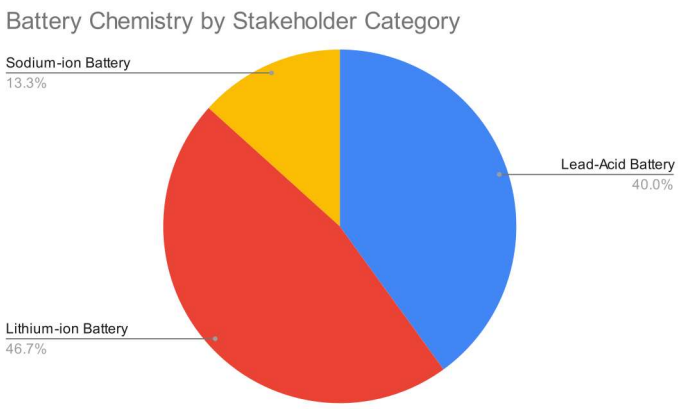
> ***Interviewer...***
> *So I was wondering what is like the current battery industry in Nigeria? Like to you, sir, how,*
>
> ***Policymaker***
> *The battery ehn.. in my own opinion,* ***most people have not even understood the battery activities in Nigeria...***



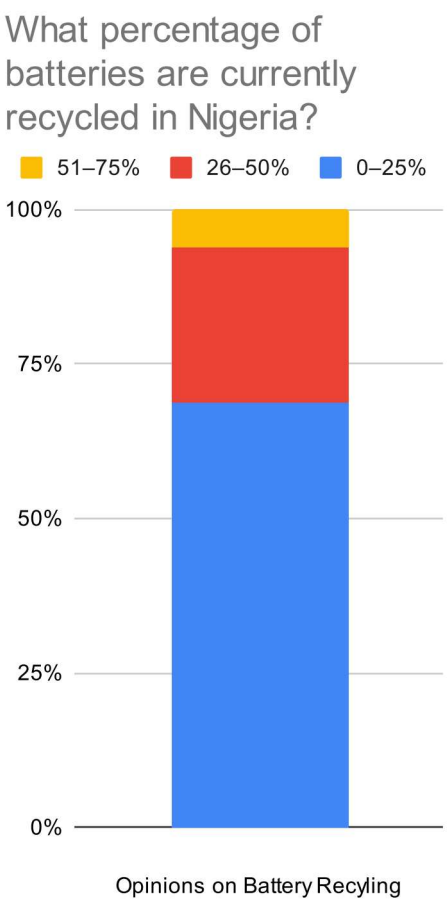
Practices within the battery waste value chain

1. **The majority of businesses within the E-mobility and Solar Energy battery value chain use Lithium-ion and Lead-Acid battery chemistries. Amongst these individuals 62.5% offer takeback schemes**



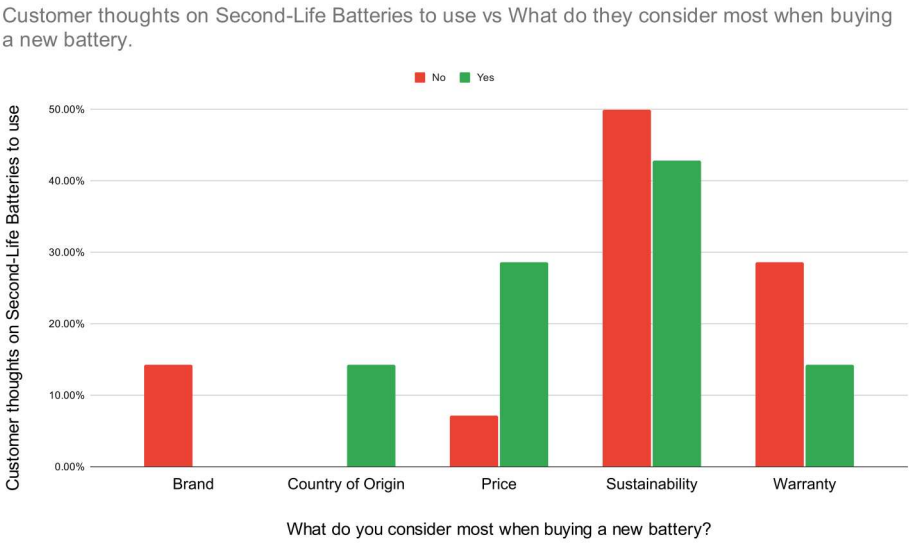


Practices within the battery waste value chain



2. Most stakeholders across the battery value chain agree that only 0–25% of batteries are currently being recycled at the end of life. This perception reflects a widely shared concern that the majority of batteries are either stockpiled, exported, improperly disposed of, or lost from formal recovery systems altogether.

3. Customer Perceptions on Second-Life Battery Adoption: When asked about second-life batteries, respondents who were open to using them were primarily motivated by price and sustainability, while those unwilling to use second-life batteries placed greater emphasis on warranty and brand trust.



Stakeholder opinions and observations on the battery waste value chain

1. **EoL Batteries are a source of free raw materials and the market is profitable:** While most E-mobility and Solar Energy Operators are quite hesitant to venture into battery waste, Some manufacturers believe in the profitability of the sector that can offer the country a lasting revenue stream.

> *Waste is like free, raw material, free raw materials. it's If, if our economy had focused on waste alone, We will be better off today. The investment in recycling is quite big...*
>
> *When you mentioned Hinkley, it is a for-profit organisation. And you know electronic waste is a billion-dollar market.*
>
> *— ITA - Manufacturing*

> *Foreign-standard batteries last longer but are very expensive and not always available." "Many people now even prefer to buy Belgium (used) battery than new ones because the recent Nigerian production runs down quickly."*
>
> *— ITC- Researcher*
>
> *"The initial experience to install everything is always very expensive, and batteries sometimes fail before warranty."Solar and batteries are very expensive, and sometimes the batteries die even before warranty."*
>
> *— ITE-Customer*

2. **Batteries are Costly:** Some stakeholders believe that products outside Nigeria last longer and are more durable to locally made batteries. However, buying such products require a lot of investment.

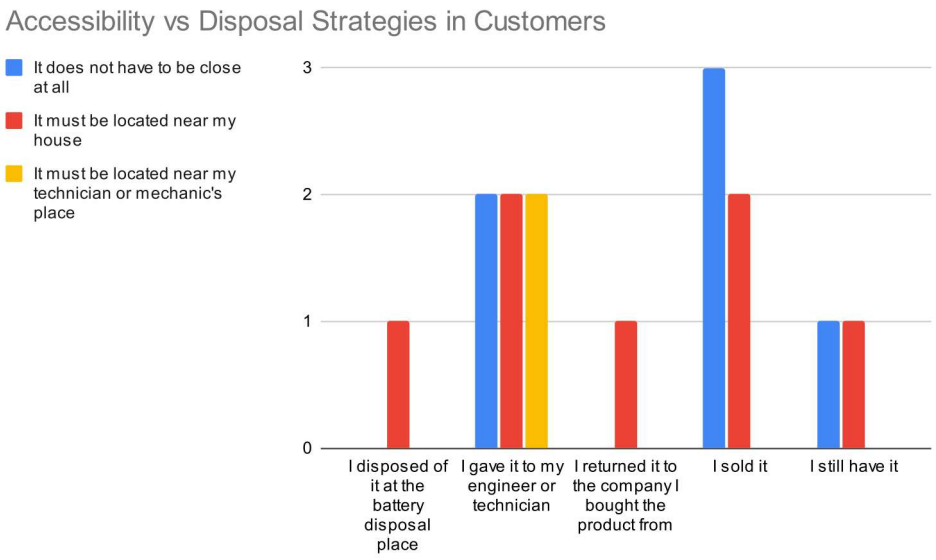
3. **Batteries are not lasting as long as they should:** The typical battery life cycle is estimated to be 5 years, but for customers who have replaced their batteries, there seems to be an average lifecycle of approximately 3 years for all customers, as shown in the table below.

Table Comparing the Frequency of Replacing Batteries and the Length of Using the Product

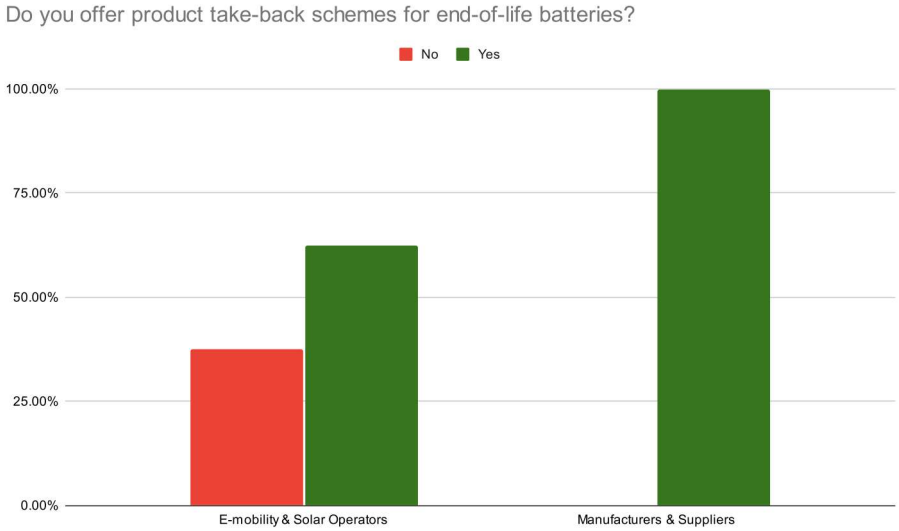
How many times have you replaced it	Mean How long (in years) have you been using this product?	Mean How long (in years) did the battery last before you replaced it?
More than once but less than ten times	10.12 (6.46)	2.57(1.75)
Once	5.5 (0.7)	3

Circular economy solutions

1. Customer Perceptions on Accessibility of Recycling Sites: Customers use a range of disposal pathways for end-of-life batteries, most commonly handing them to engineers or technicians or reselling them. Proximity to a disposal location is helpful but not essential, indicating flexibility as long as a convenient handover option exists.



2. Take-back Schemes: Most manufacturers and suppliers offer battery take-back schemes, while participation among e-mobility and solar operators is more mixed, highlighting an implementation and awareness gap in end-of-life battery recovery



Policy and Regulatory Overview

Regulations and policies are key instruments through which the Nigerian government addresses socio-economic challenges and sets national development targets.

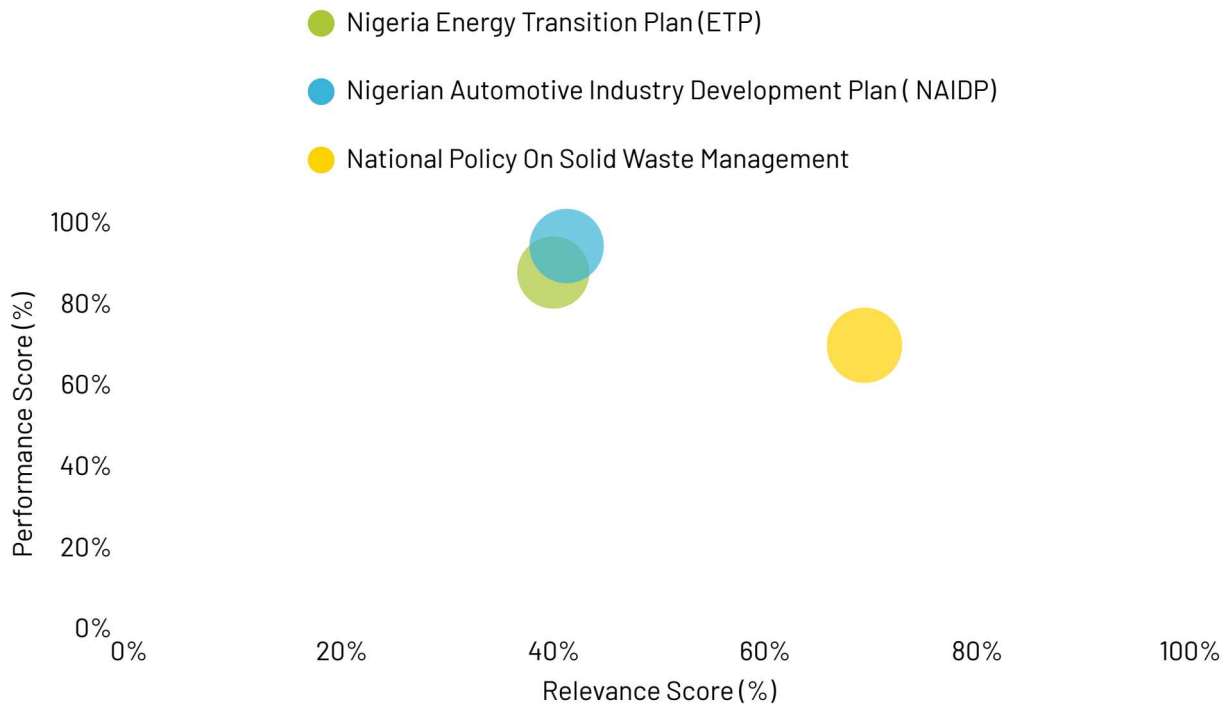
Yet, evidence from stakeholder surveys reveals a gap between intent, stated objectives, and actual implementation. **Most stakeholders believe that the government has contributed very little to the development of recycling pathways**, with a median response of 2 on a 5-point scale (where 1 indicates no contribution. Many respondents perceive limited government interest in this space, **noting that international organisations and NGOs appear more active than national institutions within the battery waste value chain.**

During stakeholder interviews, a policymaker was asked whether the government has made it easier for citizens to become aware of battery recycling. They stated:

> ***Well, it is, it is some of the NGOs, even some NGOs that are just putting on activities, battery activities in Nigeria. The government have not shown much interest in that area.***
>
> ***- Policymaker***

This section of the report analyses the policy and regulatory environment within the battery waste value chain using the DRIIF Framework. DRIIF stands for Data Reliability, Impact (Social, Economic, Infrastructural and Environmental), Implementation Feasibility. The framework can be used to measure the relevance and estimate the impact and performance of policies in addressing issues and challenges in industries relevant to the policy or regulation objectives. More information on the DRIIF framework and its measures can be found in the Appendix.

Nigerian Policies Related to Battery Waste Value Chain and their respective DRIIF Scores.





Policy Overview

The Nigerian Energy Transition Plan (ETP)

It outlines the country's pathway to achieving net-zero emissions by 2060. The ETP is the national blueprint designed to improve access to energy, reduce poverty, create jobs, and promote a *'fair, inclusive and equitable energy transition in Africa'* [(1)]. Some of its transition initiatives include the Solar Naija Programme, which aims to deploy millions of off-grid solar systems, and the Decade of Gas, which positions gas as a transitional fuel for power generation and industrial development.

Moreover, it has set long-term ambitions to begin local manufacturing and assembly of Electric Vehicles and Decentralised Solar Systems in Nigeria by 2050. Based on these key objectives and programmes, the ETP stands out as one of the drivers of battery demand in Nigeria over the next three decades.

The DRIIF analysis indicates it has a strong performance rating (87.50%), as its indicators and objectives were data-driven and modelled using scenario-based strategies that align with global energy transition pathways. It was also designed with support from notable global partners, such as the World Bank and SEforAll. Although stakeholder roles and monitoring organisations are clearly defined, the implementation timelines and structures are not. **Its relevance to the battery waste value is quite low (40.03%),** as the growing battery waste from solar energy and EV adoption was not accounted for. Projections and models generated within the ETP focus on clean energy expansion, but not the waste externalities it will generate.

The Nigerian Automotive Industry Development Plan.

It was introduced in 2014 and focuses on expanding the automotive value chain. It targets the local manufacture of 200,000 passenger and commercial vehicles by 2033, with at least 30% of these being Electric Vehicles (EVs)[(2)]. NAIDP identifies the development of Lithium batteries (for both Internal Combustion Engine and EV uses) as a means to achieve its objectives [(2)]. The automotive industry has historically been a major source of battery waste, owing to the widespread use of lead-acid batteries in ignition systems for ICE vehicles. With the gradual shift toward EVs, hybrid technologies, and local production, this waste stream is expected to expand in volume, chemical complexity, and environmental risk.

Using the DRIIF Framework, the NAIDP records a low relevance score of 41.29% but a high performance score of 94.03%, indicating that while the policy is quite feasible given the industry's worth and implementation strategies. The policy focuses on stimulating local vehicle production and engaging OEMs, assemblers, and suppliers, yet fails to address material flows, end-of-life management, recycling pathways, or circular-economy strategies for batteries. However, it fails to recognise the need for a battery waste value chain in Nigeria.

[(1)] KEY OBJECTIVES – NIGERIA ENERGY TRANSITION PLAN (INTERNET). (CITED 2025 DEC 5). AVAILABLE FROM: HTTPS://ENERGYTRANSITION.GOV.NG/OBJECTIVES/
[(2)] NIGERIAN AUTOMOTIVE INDUSTRY DEVELOPMENT PLAN (INTERNET). 2023. AVAILABLE FROM: HTTPS://NADDC.GOV.NG/WP-CONTENT/UPLOADS/2023/06/NIGERIAN-AUTOMOTIVE-INDUSTRY-DEVELOPMENT-PLAN-2023.PDF

The National Policy on Solid Waste Management

It is the most relevant federal policy for Nigeria's battery waste value chain, as it was developed to guide the efficient, safe, and sustainable management of solid waste nationwide. Although the policy provides broad strategic direction for waste management, its replicable research methods are not documented, resulting in a low Data Reliability score under the DRIIF Framework. This aligns with the policy's own acknowledgement of data gaps. *It openly states that "accurate data on solid waste generated in Nigeria are not readily available,"*[3] a critical gap that limits strategy development, waste quantification, and the effective allocation of resources.

Despite these limitations, the NPSWM recognises many of the realistic operational challenges, such as inadequate budgetary provisions and poor monitoring and evaluation within the solid waste sector, informal sector dominance, and limited infrastructure, which pose significant risks to the development of battery value chains.

NPSWM also classifies used batteries as a waste category, requiring appropriate procedures and certification when handling them. This shows that the government acknowledges battery waste as hazardous and requiring specialised treatment. The NPSWM also mandates the application of the Extended Producer Responsibility (EPR) Principle, placing responsibility on manufacturers, importers, and distributors to manage products at the end of life. It also encourages practices, such as separation at source, that improve the collection and recycling efficiency of batteries at the end of life. It also supports the establishment of waste recovery, reuse, and recycling facilities, positioning it as a foundational document for future circular-economy development.

[3]NATIONAL POLICY ON SOLID WASTE MANAGEMENT (INTERNET). (CITED 2025 DEC 18). AVAILABLE FROM: HTTP://ENVIRONMENT.GOV.NG/DOWNLOAD/NATIONAL-POLICY-ON-SOLID-WASTE-MANAGEMENT/



Strengths of Nigerian Policies Related to the Battery Waste Value Chain.



Support the Energy Transition: All policies demonstrate the Nigerian Government's commitment to the Sustainable Development Goals for access to clean energy.



Nigerian policies recognise the need for recycling pathways: although the ETP and the NAIDP do not include recycling in their modelling scenarios and data analysis, they do acknowledge its importance.



Strong Commitment to Workforce Formalisation: All policies emphasise the need to formalise labour, particularly in the waste management, manufacturing, and energy sectors. The informal sector accounts for the majority of activities in the battery waste value chain. NPSWM seeks to license and train formalised waste workers to create space for greener jobs.



Clear Intent for Local Production: All policies set targets to localise the production of solar energy systems, battery systems and electric vehicles



High Implementation Feasibility: All policies clearly identify the duties and roles of implementation stakeholders, some funding sources, and the monitoring lead. Improvements on timelines and review strategies could increase impact scores

Weaknesses of Nigerian Policies Related to the Battery Waste Value Chain.



Significant Data Gaps: Nigeria lacks credible, nation-level statistics across the battery waste value chain. The NPSWM acknowledge this gap. Tracking performance indicators and key metrics within the battery value chain enables the creation of markets and the development of evidence-based solutions.



Lack of Specific Recycling Targets and Mandates: Nigeria's existing policies do not include battery-specific recycling targets, minimum recovery rates, or mandated recycled-content requirements for key stakeholders.



Low Priority in Social Inclusion: The informal sector plays a central role in Nigeria's battery and e-waste ecosystem. Yet there are no structured plans to formalise informal collectors or to encourage gender- or youth-focused interventions in the recycling sector.



Weak Platforms for Market Creation: Recycling as a profitable business is yet to be considered in Nigerian policy. If the battery waste market is left underdeveloped while recycling is encouraged, it will be unattractive to investors, limiting the industry's economic value.



Unreviewed and Expired Policies with Limited Transparency: Several policies commit to regular review cycles, typically every 3 to 5 years, to incorporate new market trends and insights. However, many of these reviews have not been conducted, nor have any progress reports or mid-term evaluations been published.

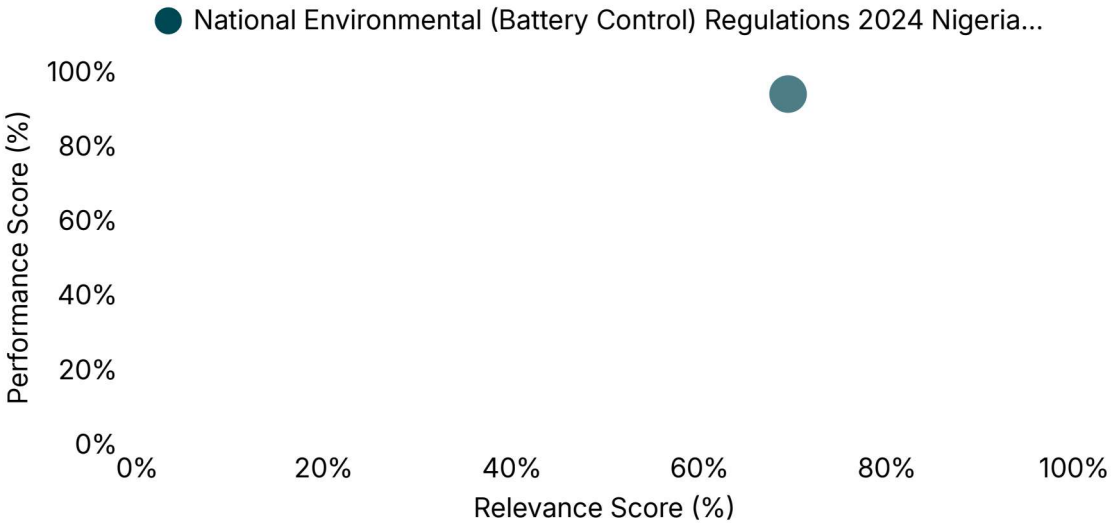


Regulatory Analysis

The global regulatory landscape for batteries features a combination of national and regional strategies that ensure sustainability and environmentally sound management (ESM) across the product's lifecycle. The Basel Convention (1989) is a global treaty governing the transboundary movement of hazardous waste, including used lead-acid batteries (ULABs) and many categories of lithium-ion batteries. It aims to prevent the illegal export of hazardous battery waste to developing countries.

In Nigeria, the primary legal instrument enforcing safe battery waste management is the **National Environmental (Battery Control) Regulations**[4]. The Nigerian Federal Government officially launched it in August 2024. It is enforced by the National Environmental Standards and Regulations Enforcement Agency (NESREA), which uses the regulation document as a guiding principle for enforcement.

Its objectives are to prevent and minimise pollution from batteries throughout the value chain. The regulation is based on the Extended Producer Responsibility (EPR) principle, which extends a producer's financial and physical responsibility for a product to all parties involved in battery handling, i.e importers, manufacturers, distributors, collectors and recyclers. It also mandates worker safety throughout the battery value chain.



Strengths of the Battery Control Regulations.

Rigorous Framework for Battery Management: It mandates that key players in the battery waste value chain subscribe to the Extended Producer Responsibility programme. This shifts the responsibilities for end-of-life battery management onto the producers, requiring them to fund and organise systems for safe collection, treatment, transportation, and disposal. The 'Polluter Pays Principle (PPP)' ensures the safety of citizens by ensuring stakeholders within the battery waste value chain 'pay the price' when mismanagement of batteries impacts the socio-economic and health status of citizens.

[4]NATIONAL ENVIRONMENTAL (BATTERY CONTROL) REGULATIONS, STATUTORY INSTRUMENT NO. 11 OF 2024. | UNEP LAW AND ENVIRONMENT ASSISTANCE PLATFORM (INTERNET). (CITED 2025 DEC 18). AVAILABLE FROM: HTTPS://LEAP.UNEP.ORG/EN/COUNTRIES/NG/NATIONAL-LEGISLATION/NATIONAL-ENVIRONMENTAL-BATTERY-CONTROL-REGULATIONS-STATUTORY



Strong Data Collection Framework: The regulation establishes a framework for the periodic collection and tracking of batteries nationwide. It requires regulated entities to submit up-to-date records, including an Environmental Impact Statement (EIS) for new projects and an Environmental Audit Report (EAR) every 3 years. It also mandates that recycling and storage centre operators be transparent about the quantities of used and recycled batteries they receive quarterly. It also requires producers and distributors to provide all batteries with a unique serial number or individual identification code for tracking products at the EoL.

Robust Mandates on Social Protection: NESREA has the power to issue enforcement and suspension notices, with or without a court order, if the site poses a danger to the environment and the health of residents in the vicinity. The regulation also enforces mandatory safety requirements for all persons involved, including scavengers, collectors, transporters, and technicians. All personnel must wear appropriate Personal Protective Equipment (PPE), and recycling plant operators must conduct blood lead tests on facility workers at least twice per year

Public Inclusion: In addition to ensuring Extended Producer Responsibility for producers, the regulation requires producers to create awareness programmes and systems through publications and advertisements to sensitise end-users about hazardous constituents, the dangers of improper handling, and the process for taking back used batteries. Citizens are expected to comply with proper disposal procedures and utilise registered battery collection centres. They can also report instances of illegal disposal or "fly tipping" of used batteries.

Weaknesses of the Battery Control Regulations.

No Mandates on the Minimum Amount for Recycled/Refurbished Content: In comparison to the EU regulation concerning batteries and waste batteries, which mandates the minimum percentage share of recovered critical material from some battery manufacturing waste as of 18 August 2031, the regulation does not mandate minimum recycled content levels for new batteries, EVs, or solar systems.

Lack of Recycling plants in geopolitical zones: Although the regulation mandates that producers establish treatment facilities and that there be at least one facility in each of the six geopolitical zones, the current landscape shows that most recycling plants are Used Lead-Acid Battery (ULAB) facilities and are located in the South-west geopolitical zone.

Weighty Standards and Strategies: Interviews revealed that several international companies are actively involved in the battery waste value chain in Nigeria. While their presence brings technical expertise and can aid the sector's development, it also introduces complex, capital-intensive standards and operational strategies that are often difficult for local players and small businesses to meet.

GLIMPSE FROM INTERNATIONAL POLICIES, REGULTIONS AND PROGRAMMES

Mandating Measurable, Material Specific Targets: Nigeria's domestic policies lack specific, critical targets for material recovery. In contrast, the UK Battery Strategy, heavily influenced by European regulations that set mandatory minimum levels of recycled content for batteries sold (e.g., 16% cobalt, 6% lithium, and 6% nickel from recycled materials by 2031), with these percentages increasing over time[5]. Another internal programme, called the B-cycle 2.0 (Australia)[6], defines its collection rate targets as a percentage of batteries Available for Recycling (AfR). It is calculated based on the projected life cycle of specific battery types and importation data. This metric could be adopted in policy development procedures for the battery value chain.

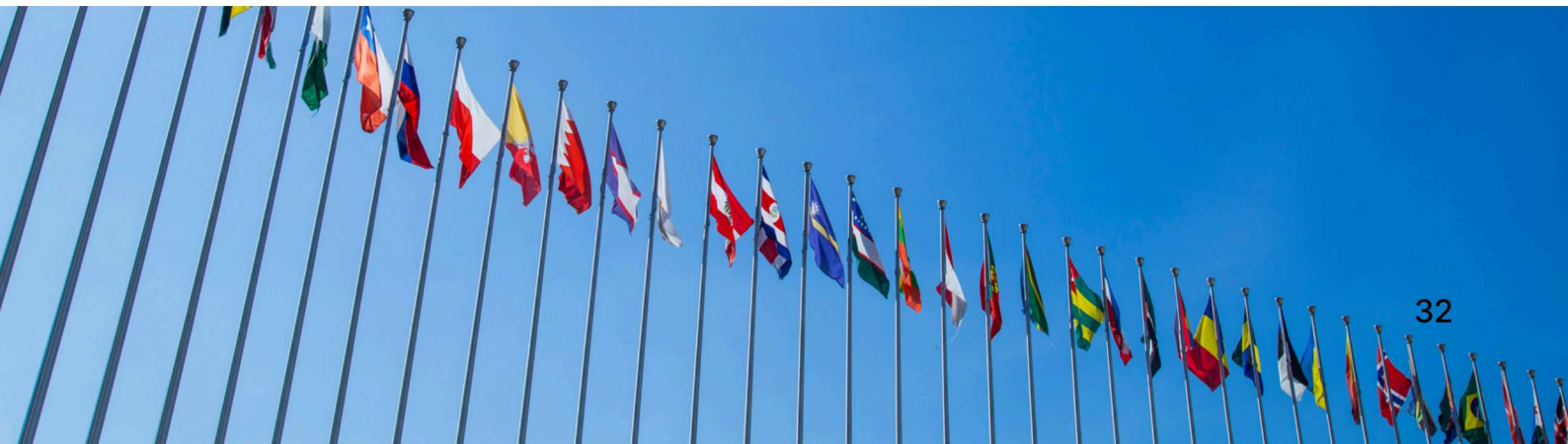
Periodic Review Processes: The B-cycle 2.0 model defines long-term financial security by enabling the funding model to adapt annually[6]. It also conducts an annual review using a framework to ensure accurate measures are taken to adapt and grow within a changing market.

Methods to integrate Social and Workforce Formalisation: The NPSWM mandates efforts to "mobilise, train and formalise the informal sector", but does not specify methods to support workforce associations or gender-specific initiatives in the waste value chain. Rwanda's E-Waste Policy focuses on skills training in TVET schools to address the required skill gap. From a young age, children are informed about the hazards of unsafe handling.

Incentivised Strategies: The EU regulation on batteries and waste batteries requires producers' fees to be modulated based on environmental factors, such as the level of recycled content or the battery's carbon footprint[7]. Nigeria's current EPR fee structure, based on fixed, mandatory fees and penalties, is necessary to ensure citizens' safety, but it might deter new entrants from establishing plants.

Enabling Inclusion in the Informal Sector: South Africa’s battery regulations require producers to support small businesses and entrepreneurs, with special attention to women, youth and persons with disabilities[8]. The rules also ensure that registered informal waste collectors and pickers are paid for their collection services and environmental contributions through a collection service fee. Nigeria could adopt similar measures to accelerate the adoption of safer battery practices while also improving the livelihoods and social protection of informal battery waste workers.

[5]. UK BATTERY STRATEGY
[6] CHAPLIN L. PROPOSED B-CYCLE 2.0 FINAL SCHEME DESIGN.
[7]REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 12 JULY 2023 (INTERNET). (CITED 2025 DEC 18)
[8]CREECY BD. AMENDMENTS TO THE REGULATIONS AND NOTICES REGARDING EXTENDED PRODUCER RESPONSIBILITY, 2020



OPPORTUNITIES FOR GROWTH WITHIN THE BATTERY WASTE VALUE CHAIN

1. Job Creation and Inclusive Economic Growth

The BWVC offers strong potential to create green jobs across collection, aggregation, testing, refurbishment, logistics, and recycling. Formalizing and upskilling the informal waste sector can improve worker safety, incomes, and productivity, while strengthening national waste management systems.

2. Second-Life Battery Applications for Energy Access

Used batteries from solar and e-mobility systems can be repurposed for second-life applications such as:

- Off-grid and mini-grid energy storage
- Backup power for SMEs, clinics, and schools
- Community energy hubs

Second-life use extends battery lifespan, reduces costs, and supports energy access goals, particularly in underserved areas.

3. Development of Local Refurbishment and Recycling Hubs

Establishing regional battery aggregation, testing, and refurbishment hubs can:

- Reduce environmental risks
- Create skilled technical employment
- Retain value locally
- Lower dependence on imported energy storage solutions

Such hubs can serve both lead-acid and lithium-ion batteries and support future scaling.

4. Recovery of Critical Minerals

Battery recycling enables the recovery of critical minerals such as lithium, cobalt, nickel, and lead. As global demand for these materials grows, Nigeria can position itself within emerging clean-energy supply chains while reducing reliance on raw material imports.

5. Private Sector and Investment Opportunities

The BWVC presents opportunities for:

- Startups focused on collection, refurbishment, and second-life solutions
- Public-private partnerships for recycling infrastructure
- Impact investors seeking climate-aligned and circular economy investments

Clear policy signals and pilot projects can unlock private capital.

6. Strengthening Extended Producer Responsibility (EPR) Systems

Well-designed EPR schemes can:

- Shift end-of-life responsibility to producers and importers
- Create sustainable financing for collection and recycling
- Improve traceability and accountability across the value chain

This reduces the burden on municipalities and communities.



Recommendations

Recommendations to Manufacturers, Importers, and Suppliers

Integrate end-of-life responsibility into product and import strategies, recognising the growing future volume of battery waste.

Establish or support battery take-back mechanisms, even where formal recycling infrastructure is still emerging.

Engage recyclers and refurbishers early to prepare for future compliance and operational requirements.

Advocate for clearer, enforceable regulations that provide certainty and reduce ambiguity regarding battery waste responsibilities.

Begin internal planning for circular business models, including refurbishment, reuse, and second-life applications.

Recommendations to E-mobility and Solar Energy Operators and Businesses

I**ncorporate battery lifecycle planning into core operations**, including tracking, replacement, and end-of-life management.

Collaborate with recycling and refurbishment actors to explore viable second-life pathways, particularly for solar batteries.

Share operational insights and data to support broader forecasting of battery waste generation.

Engage policymakers proactively to ensure energy and mobility policies reflect battery demand and waste realities.

Pilot circular economy initiatives alongside business growth to reduce long-term operational and regulatory risk.

Recommendations to Donors and Investors

Support early-stage investments in battery recycling, refurbishment, and collection infrastructure.

Fund pilot projects and demonstration initiatives to test business models before waste volumes peak.

Invest in data generation and feasibility studies to reduce uncertainty and perceived market risk.

Engage in blended finance and public-private partnerships to de-risk entry into the sector.

Focus capital on high-impact segments of the battery waste value chain, particularly collection and second-life applications.

Recommendations to Researchers and Policy Advocates

Prioritise evidence generation on battery demand, usage, and end-of-life outcomes in Nigeria, particularly for solar and e-mobility systems where future waste volumes are expected to rise.

Move beyond policy advocacy to implementation support, focusing on how existing regulations can be operationalised, monitored, and enforced.

Direct short-term advocacy efforts toward gaps, including data availability, collection systems, and institutional coordination across governmental MDAs

Use research and public engagement to elevate conversations on battery waste management within the national energy, climate, and circular economy.

Facilitate cross-stakeholder dialogue to ensure that policy proposals reflect on-the-ground realities faced by businesses, waste workers, and end-users.

Strengthen public awareness efforts by translating research findings into accessible messaging on battery safety, disposal, and environmental risks.

Recommendations to Customers and End-users

Seek information on safe battery disposal and recycling options when purchasing battery-integrated products.

Participate in take-back and collection programmes where available.

Adopt responsible disposal practices, avoiding unsafe dumping or informal handling where possible.

Consider second-life or refurbished batteries for appropriate, non-critical applications.

Engage with awareness campaigns and incentive schemes designed to improve battery return and recycling rates.

Recommendations to Battery Waste Workers

Engage in training and certification opportunities to improve safety and professional recognition.

Adopt safer handling and processing practices where resources and equipment are available.

Collaborate with other recyclers and aggregators to strengthen collection and material recovery systems.

Advocate for incentivised inclusion in formal waste management frameworks

Participate in dialogue on policy and infrastructure development to ensure worker realities are reflected.

Policy and Regulatory Recommendations

Recycling targets and circular content requirements
Nigeria lacks clear recycling targets for batteries. Establishing national collection and recycling goals, alongside phased minimum recycled-content requirements for new batteries and energy storage systems, would improve accountability, attract investment and strengthen end-of-life management. Mandatory annual reporting by producers and recyclers would enhance transparency and benchmarking.

Data and traceability
Reliable, standardised data is essential. A national battery registry with harmonised reporting could enable traceability from import to disposal, support material flow analysis, reduce leakage into informal channels and improve long-term planning through shared, open data systems.

Expansion of recycling infrastructure
Recycling facilities are concentrated in the South West, leaving other regions underserved. Incentives such as tax relief, concessional finance and green guarantees could stimulate private investment in new zones, particularly in the north. Supporting second-life battery applications would extend product lifespans and improve resource efficiency.

Social inclusion and informal sector integration
Informal collectors play a central role in battery recovery but lack recognition and protection. Formalisation through licensing, cooperatives, training and collection service fees could improve safety and livelihoods. Partnerships with vocational institutions would build technical skills and support women's and youth participation.

Incentive-based compliance
Nigeria's largely punitive regulatory approach may deter investment. Introducing performance-based fee differentiation under EPR and fiscal incentives for cleaner technologies would create a more enabling market. Green bonds, innovation funds and recognition schemes could further encourage compliance, eco-design and innovation in second-life and recycling technologies.

Policy review and transparency
Although many strategies call for periodic review, few are updated in practice. Mandatory review cycles every three to five years, supported by annual NESREA implementation reports, would strengthen accountability and policy responsiveness. A multi-stakeholder technical advisory group could guide updates in line with evolving technologies, standards and national priorities.

Public awareness and behavioural change
Policy effectiveness depends on public participation. National awareness campaigns on battery risks and safe disposal, combined with accessible collection points and incentives such as deposit-refund or take-back schemes, would improve compliance and reduce dumping. Integrating battery management into schools and community programmes would help build long-term behavioural change.

Implementation gap
Interview insights highlight that policy success depends less on the existence of frameworks than on consistent, effective implementation.

Policy and Regulatory Recommendations

As one interviewee emphasised when reflecting on battery waste governance in Nigeria:

> ***"The most urgent need is an implementation structure that brings unregulated actors on board, so they can move from unsafe practices to safe, monitored practices."***

This perspective is consistent with the DRIIF findings and reinforces the need for realistic, inclusive implementation frameworks that recognise the current market structure and create credible pathways for behavioural change.

CLOSING REMARKS

Nigeria is approaching a period in which battery consumption will expand rapidly through off-grid electrification, electric mobility, and industrial growth. The existing policy instruments demonstrate intent, yet fall short in terms of circularity, social integration, and market readiness. Implementing the reforms proposed in this section would strengthen environmental protection, create green jobs, and enhance national preparedness for rising end-of-life volumes. With coherent regulation, functional recycling infrastructure, active public participation and implementation structures that genuinely bring informal actors on board, Nigeria has the opportunity to build a resilient, competitive and sustainable battery waste value chain that supports its broader energy transition objectives.

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