



**CLOSING
THE LOOP**

MAKING A BUSINESS CASE FOR AFRICAN BATTERY RECYCLING



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FAIRPHONE

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Call2Recycle, Inc.

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1 INTRODUCTION

Over the last few years, a lot of attention has been given to the problem of e-waste. But there has been a distinct lack of focus on the opportunities that it offers. This paper aims to present a pilot and unique business model as a viable solution for one of the most challenging e-waste categories: end-of-life phone batteries. The pilot aimed to look into the opportunity for urban mining (sourcing valuable raw materials from waste) when looking at this specific waste stream, and at how a new circular business model can facilitate this. The ability to source materials from old electronics can have immense impacts, including a reduced need for mining minerals, particularly conflict minerals. The main learnings presented in this paper involve the development of a collection network, incentive creation, and collaboration. The results of the pilot project are important learning for the whole industry.

1.1 BACKGROUND

It is impossible to deny that electronic waste (e-waste) is a major challenge – in fact, it is the fastest growing waste stream worldwide. While consumer electronics have become abundant, at the moment, the infrastructure and capacity required to properly collect and recycle these products at the end of their useful lives is only present in the most industrialized and higher income countries.

The [Global E-waste Monitor 2020](#) reveals that this issue is only getting worse. In low- and middle-income countries, increasing incomes, urbanization, and industrialization are driving more widespread use of electrical and electronic equipment (EEE), which in turn results in larger amounts of e-waste. The report predicts that global e-waste generation will reach 74 million metric tons a year by 2030 – double what it was in 2014. The rapid increase is attributed to higher consumption rates, shorter lifespans, and limited repair options.

Closing the Loop (CTL) believes in pragmatic, scalable solutions for sustainability challenges with a focus on sustainable electronics. The Amsterdam-based company with e-waste collection networks throughout Africa developed a proven waste compensation model for ICT hardware. In CTL's "one for one" model, one scrap phone (or other device) is collected to compensate the waste generated by a new one sold. Its customers use this service to reach their sustainability goals. This way, collecting waste becomes a commercial proposition instead of a burden. With their business model, they have collected more than three million e-waste devices for safe recycling since 2012. For CTL, the logical next step was to begin collecting other types of devices and parts, starting with mobile phone batteries.

Partnering in the battery collection pilot project is the sustainable phone producer Fairphone, another Dutch social enterprise. Fairphone sees e-waste as one of the most serious issues in the electronics industry and addresses it with a number of different approaches. Their ultimate goal is to recover the same amount of recycled material as they use in the production of their phones, while working on strategies for improving lifetime extension and reparability of smartphones in parallel.

In Europe, Fairphone has developed a free recycling program. Anyone can send in their old phone for safe reuse or recycling, no matter what condition it is in. Over the past year, the company has increased the success of this program, recovering more than 25% of the number of units put into the market. As part of the program, devices that can get a second life are refurbished and resold, while devices that are beyond repair are safely recycled.

Another aspect of Fairphone's e-waste approach includes engaging with parties such as CTL to recover phones from countries where recycling support is needed most. The two companies have collaborated on several projects since 2013 and decided to partner once again for this battery collection pilot.

As with previous projects, the geographical focus for the pilot was West Africa. According to the latest Global E-waste Monitor, the African continent has an extremely low rate of electronics recycling, with only 0.9% of the total amount sold making it to a formally documented end-of-life process – a clearly acknowledged problem for African countries. The majority is sent to landfill or recycled using rudimentary methods and highly informal handling of batteries which are particularly harmful for humans and the environment, since there is not sufficient recycling infrastructure in many countries.

However, at the same time, this informality in the e-waste sector offers opportunities for efficient collection. Working with the informal sector adds extra value to an e-waste project, because in addition to the environmental benefits, the social returns in terms of job creation, stable working conditions, income, and opportunities for coaching can be very significant. This e-waste also represents untapped potential for local economies – estimates are that more than \$3.2 billion in value is trapped in e-waste across Africa. Inefficient end-of-life practices mean that very little of this value is being recovered.

One short-term solution – to bridge the gap until local recycling infrastructure is in place – is to create business models that divert this e-waste to countries where it can be properly processed. This is what CTL has already done with mobile phones. Until now, batteries were excluded from the collection and shipment, because of the extra care that needs to be taken due to their hazardous nature.

Due to recent progress in e-waste legislation and the availability of scrap batteries, CTL saw Nigeria as the ideal location for a battery collection pilot. Nigeria has high demand for both new and secondhand electronics. (The secondhand ones are often imported after a relatively short period of use in higher income countries.) They are reused for as long as possible, but eventually these devices (and batteries) reach their end of life there.

Finally, Nigeria has recently taken some important legislative steps. One example is the creation of the E-waste Producer Responsibility Organization of Nigeria (EPRON), the first of its kind in the country. Though enforcement is still lacking, CTL is looking forward to the next steps as the company continues to work in the country.

2 THE PILOT

2.1 SUMMARY

2.1.1 Aim of the Pilot Project

There were a few things that were important to determine by starting the collection and shipping of a new type of waste, in this case lithium-ion (Li-ion) batteries:

- The ability to source scrap Li-ion batteries from a country like Nigeria
- The ability to safely store, ship, and recycle these batteries
- The difference in permitting and other documentation for these batteries, compared to mobile phones
- The possibility to make the resources contained in batteries available for reuse
- Whether CTL's business model, already functional for mobile phones, also works for other types of waste such as batteries, which are considered a much more challenging and expensive waste to manage than mobile phones.

2.1.2 Expected Challenges

Though CTL has extensive experience with mobile phones, it was expected that repeating the process for their batteries would present unique challenges:

- Collecting enough batteries for a reasonable pilot
- Batteries were not being traded (even illegally) in the market, so there was no existing trade to tap into
- Batteries can be very dangerous to store and ship, making logistics more challenging
- Due to their hazardous nature, batteries have to be shipped following Basel Convention notification procedures
- The pilot was expected to be very expensive for the aforementioned reasons.

2.1.3 Results

At a high level, the pilot project reached many of its initial goals, and it proved the feasibility of collecting batteries in Nigeria and shipping them to Europe for recycling in a safe, compliant way. Here are a few of the project's most important achievements:

- A total of **5,000 kg** of batteries were sourced and shipped from Nigeria to the port of Antwerp, Belgium.
- The batteries are estimated to contain at least 1,250 kg of cobalt.

- The batteries were received by the recycler, and the **recycled materials will be sold back onto the market** to be used for new batteries.
- Fairphone has investigated and confirmed the **feasibility of a closed-loop supply of this cobalt for its own batteries**, though it didn't pursue implementation due to insufficient volume at the moment.
- There was significant **involvement of the informal sector in Nigeria** in the collection process, leading to income generation for the local community.
- **Three of CTL's customers** were eager to be involved and contributed to covering the costs of this pilot.
- Though technically possible, the required administration and documentation for a shipment such as this is extremely costly and complicated. Agreements such as the **Basel Convention**, though passed with good intentions, in this case obstruct improvements in the recycling of electronic waste from countries like Nigeria.

2.2 PROJECT DETAILS

The pilot project was initiated in late 2017. The collection started in 2018 and ended in April 2020 when the batteries were received by the recycler. The rest of this paper highlights the key challenges and outcomes of this pilot project.

2.2.1 Building a market for scrap phone batteries in Nigeria

At the beginning of the pilot, CTL's collection network faced difficulties obtaining batteries directly from residents and shops. In Nigeria, batteries are commonly thrown away in landfills, as people are not informed of the value and potential environmental hazard they represent. When CTL started showing an interest in buying scrap batteries, the organization learned that they would need to create a market for scrap phone batteries themselves. CTL did so by building a collection network and slowly increasing the price paid for scrap batteries until they could generate a steady supply.

Eventually, they reached the price required to ensure a stable supply of scrap batteries. The resulting market value in Nigeria is based on the perceived value by those collecting the batteries and not the actual material value after recycling.

2.2.2 Local partners

The collection of batteries was facilitated by Verde Impacto, a Nigerian environmental service company. They are one of CTL's long-term collection partners who formerly focused on collecting mobile phones, and have extensive experience in building connections to the informal sector. After learning that phone collectors in CTL's network had scrap batteries they didn't know what to do with, CTL started discussing possible solutions with Verde Impacto. In the end, they decided to

pilot a collection scheme for batteries in Nigeria, and Verde Impacto set up a collection network with the informal sector in Nigeria to supply the batteries.

In order to comply with local permits and regulations, CTL also worked with Hinckley Recycling, a Nigerian firm specialized in e-waste management and Nigeria's first government-approved e-waste recycler. For this project, Hinckley oversaw the safe storage and transportation of the batteries, as well as the administration needed for legal compliance in Nigeria. Finally, they ensured that the shipping complied with international regulations.

2.2.3 Shipment quantities

In order to increase shipping efficiency by filling up the container and for the licensing, permitting and export procedures, the final shipment of 5,000 kg of batteries also included Li-ion batteries from laptops. These 450 kg of laptop batteries came from Hinckley's sister company, an authorized HP repair center. These batteries were not paid for but were included in the shipment, as it was the same type of cargo. To this point, the HP laptop repair center does not have an alternative for the handling of the batteries and just stores them.

The batteries were collected over a time span of 18 months. CTL aims to provide stable income through reliable and continuous collection to its supply chain network.

2.3 KEY FINDINGS

2.3.1 Dealing with (new) competition

As the market for used Li-ion batteries began to grow in Nigeria, other players started to enter the game. However, the competitive landscape is opaque, and it is difficult to determine what parties are involved in the purchasing of the batteries and under what conditions they are being recycled. Presumably, considering the prices offered, most of them are not following legal procedures. This was also seemingly confirmed by the lack of permit requests made to local environmental agencies. Some collectors were unable or unwilling to identify the people they were supplying to; they claimed that they always dealt with middlemen. The biggest consequence of this unclear competition situation was a rise in the purchase cost for the batteries.

2.3.2 Working with local regulation

When CTL started operating in Nigeria, legislation for the collection, storage, and shipment of batteries was not readily obtainable or translated into clear processes. After seeking support from the authorities, spending significant time on research, and building a network of people involved in permitting procedures, how to obtain them became clearer although the process of obtaining the required permits was still long and not clear enough. Though NESREA (the local environmental authority) was very helpful in explaining and assisting with the permitting process, the novelty of

this project did make things more complicated. Add to that that other stakeholders like the banks, the logistics companies, and customs authorities were unaccustomed to the procedures. Extensive communications back and forth between these different stakeholders created significant delays in the process.

Working with Hinckley Recycling was essential to overcoming the administrative hurdle. During this pilot project, NESREA and the United Nations Environment Programme (UNEP) started another e-waste-related project in Nigeria. This project improved CTL's ability to receive permits, as there was an increased focus on e-waste from NESREA, in addition to a closer relationship with the organization. In addition, many procedures for the collection, storage, and shipment of e-waste became clearer and more formalized.

The support from NESREA allowed CTL to complete the permitting process, and in return provide valuable experience that will directly contribute to policy development in Nigeria. Active participation in the legislation and regulations not only enabled CTL to steer these developments, it also helped to ensure that the pilot was compliant with the law.

2.3.3 Basel Convention notification process

International waste shipments must be approved by the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, an international treaty designed to reduce the movement of hazardous waste.

The process of getting a shipment of batteries from a country with little or no recycling capacity to a country with proven ability to responsibly recycle the batteries – a process governed by the Basel Convention – was particularly difficult, and required the involvement of all four countries the shipment would pass through on its way to Belgium. The process was especially time-consuming due to the fact that each country had its own approval procedures, and some of the countries did not have clear regulations or processes in place for the related permits. For example, in one country, they demanded a copy of the *Movement Document* as a hard copy for pre-approval, whereas this document is usually only created when the shipment actually leaves. Another example is that some countries accept a bank statement of the existence of a Bank Guarantee, whereas others need the Guarantee Certificate itself.

Complying with the Basel process also required documentation disclosure from many of the agencies involved in the project. This proved challenging due to unclear instructions from the agencies themselves, as well as slow bureaucratic processes in general. A particular challenge is that due to budgetary constraints, most of the government agencies in Africa have only one person who is knowledgeable on the Basel Convention and authorized to assist in the process. This creates very long waiting times due to the caseload within the agencies. With extensive support of NESREA and UNEP, significant improvements were made, and eventually the shipment departed in March 2020.

Key recommendation for peer applicants is thorough project preparation and an open dialogue with local regulators. Key for officials to make the process clearer is the availability of clear instructions and a checklist of needed documents. It would be helpful if the Basel secretariat would develop and implement these procedures throughout its focal points and create one understanding of Basel requirements.

CASE: BASEL CONVENTION PROCESS IN HIGHER-INCOME COUNTRIES

Challenges in transboundary movement of batteries are not limited to lower- or middle-income regions and countries. Call2Recycle, Inc., a North America-based nonprofit that has collected and recycled almost 100 million kg of batteries since its inception in 1994, has similarly struggled to move used batteries, particularly lithium-ion and nickel-cadmium batteries. In order to find available processing capacity, batteries have been processed in six countries on three continents over the last four years. In shipping and processing these battery types of batteries, the two most significant challenges Call2Recycle has encountered are finding willing shipping lines, which are often reluctant to handle the risks associated with batteries, and obtaining the necessary environmental permits, which can take up to one year to finalize. These impediments have increased their battery recycling costs, particularly inventory fees to hold batteries until shipping and permitting are resolved. Until there is greater battery recycling infrastructure worldwide, there will be significant financial hurdles to managing this waste properly.

2.3.4 Government approval and export regulation

Nigeria has strict currency and export controls, which means that all exports have to be authorized by the Central Bank of Nigeria (CBN). Halfway through the process of preparing for the shipment, CBN implemented a new online system for all forms and approvals which required a long onboarding time and caused delays due to problems with the new software.

Once the request did go through, there was additional scrutiny from the bank, which suspected fraud, wondering why any company would spend more than €5,000 to export a container when the contents were worth only half of that amount. “Normal” shipments that leave Nigeria are shipments such as coal, oil, and agricultural products. Multiple times during the shipping process, officials from various organizations asked to see extra documentation. These documents must be requested in costly processes, even though they are not actually required according to the regulations. Each of these requests resulted in a delay of at least a week, as in Nigeria, these types of issues need to be resolved with face-to-face meetings.

It is widely known that bribery and corruption are challenges in many low-income countries. This is especially true when permits and lengthy bureaucratic procedures are involved. The biggest challenge often faced is that doing things the right way is considerably slower than participating in bribery. CTL has a zero-tolerance policy for bribery, no matter the time delay caused. This policy was also strictly adhered to for this pilot. Though no concrete requests for bribes were received, the refusal to entertain any requests for facilitation payments did create delays for the project. The process of preparing the shipment was delayed by 16 weeks due to these lengthy administrative procedures.

2.3.5 Safety compliance during shipping

As outlined above, the shipping of Li-ion batteries has to follow very strict rules. The rules are related to specific battery packing and storing instructions and approval from governments. CTL's partner recycling company in Belgium assisted with preparing the necessary documentation and complying with safety regulations related to the shipment.

None of the possible logistics operators contacted had any experience working with this type of cargo, especially not in their Nigerian locations. This meant that all guidelines and instructions had to be passed from CTL to the logistics operators, with extra checks by the recycling company to ensure legal compliance. It was expected that the responsibility for and knowledge of the shipping regulations would be with the local logistics operators, but instead the effort had to come from CTL. This is not ideal.

A learning for CTL and its partners is to provide clear instructions to the logistics companies early on in the partnership so a common understanding of the requirements for shipping this type of cargo is reached. A further recommendation is to choose a logistics partner with offices in other parts of the world (where they have the required experience) to enable sharing of experience within the logistics partner's organization.

2.3.6 The business model

For CTL, the most innovative and interesting part of this pilot is the business model. The company has already proven the waste compensation model for mobile phones, and the next step was to test a similar model for batteries. More specifically, CTL uses a "one for one" model, which means one scrap phone (or other device) is collected for every one sold. This way, collecting waste becomes a commercial proposition instead of a burden on those producing the waste. CTL makes it possible to create a positive impact on behalf of companies that want to take responsibility for their waste. A key difference between phones and batteries was the extra complication related to shipping batteries, as well as the negative value of the waste.

To prove the feasibility of the business model for batteries, a few things had to happen:

- CTL needed a customer willing to pay for the compensation of batteries
- The cost of collecting, shipping, and processing the batteries had to be less than what companies were willing to pay for the service
- The movement of the batteries had to be verified with a transparent and traceable system.

2.3.7 Customers and income

The costs of this project were covered in part by Fairphone and the Dutch government – two of CTL's existing customers. Fairphone was especially interested in the project due to its strategic focus on cobalt (the primary material that will be obtained from the recycled batteries). Fairphone's goal is to be able to report on the amount of cobalt used in their batteries and how much is recovered through projects like this one with CTL. Besides focusing on recycling, Fairphone is also involved in projects that [source fair cobalt](#) from mines that are working to improve miners' livelihoods.

2.3.8 Costs

The first obvious cost for this pilot was the purchasing of the batteries from the informal sector. Though details cannot be shared, the price that had to be paid per kilo of batteries far exceeded the material value of the batteries after recycling. This was because of the cost required to motivate collectors to make the effort to safely and responsibly collect these batteries. Since the amount needed for this work is not related to (and exceeds) the material value, innovative financing models such as CTL's Waste Compensation model are needed.

The greatest cost associated with the pilot project was the time needed to develop the process. All permitting, shipping complications, and extra communication required was very time-consuming and resulted in a total project cost of more than €70,000. This amount is expected to be significantly lower for the second shipment, as the process is now clearer and all parties involved now have experience with following these procedures.

2.3.9 Traceability and transparency

In 2019, CTL implemented Chainpoint, a supply chain tracking system. This system was implemented for all transactions in the company's supply chain, but the battery pilot was the first shipment that was tracked from start to finish with the new system.

CTL was able to track and trace all batches of batteries from the point of purchase up through the recycling process in Belgium. It has shown that this system works and can be used locally in Nigeria by the company's partners.

2.3.10 Recycling

There are only a few companies around the world that can recycle these types of batteries, though it is a constantly evolving industry. For this pilot, a contract was signed with a leading company that has proven to be a responsible and compliant recycler.

Due to the nature of the contracts, various aspects of the agreement may not be disclosed, including the name of the recycler. Determining the exact composition of the shipment in terms of cobalt content is also challenging, especially with shipments smaller than 10 tons, resulting in a lack of transparency. It is therefore not possible to know the exact results of the recycling in terms of materials recovered, other than that the contractual obligations have been met.

In order to improve the image and standing of the lithium-ion battery recycling industry, it is highly recommended to increase the transparency of contractual arrangements.

Nevertheless, this recycler uses some of the best available recycling technologies. According to the recyclability study of Fairphone 2¹, in which recovery rates are calculated, cobalt contained in a smartphone battery can be recovered at a rate of 89%.

CASE: USING RECYCLED COBALT IN NEW BATTERIES

During the course of the project, Fairphone looked into possibilities to directly reuse the cobalt resulting from the recycling of the batteries to create a closed loop from smartphone battery to smartphone battery. As Fairphone has projects in developing livelihoods in the artisanal mining of cobalt in the Democratic Republic of Congo, it was interesting to determine whether this new stream of cobalt could be integrated. Conversations were held with the recyclers and the manufacturers of the cathode, cell, and battery, and it was confirmed that such an integration (and the tracing of the cobalt) would be feasible but at a cost of developing and certifying a completely new cobalt source which was not feasible for Fairphone at this point.

¹ <https://www.fairphone.com/en/2017/02/27/recyclable-fairphone-2/>

3 RECOMMENDATIONS

Based on our experience with the project, CTL can provide recommendations for upscaling this pilot in various ways.

- The first, most important recommendation is that a robust and innovative business model is needed for the sound recycling of batteries from low-income countries. Without a working international financing mechanism for waste such as this, the sheer costs of collection and administration mean that this will not be feasible for just the material content alone any time in the near future.
- In order to reach significant volumes of waste, it is important to involve the informal sector for collection. In the same time it took to collect 4,500 kg of batteries from the informal sector, only 450 kg was received through formal channels.
- Close collaboration with the authorities and other stakeholders is essential during the permitting process. This helps avoid the risk of bribery and corruption as well as making the processes more efficient. It also promotes development of the sector in the country involved which is essential for a long-term sustainable solution.

3.1 NEXT STEPS

While the project took much longer than initially anticipated, both CTL and Fairphone consider it a success. After getting to grips with international regulations and local challenges, a clear system of processes, procedures, and permits has now been established, and it can be replicated for future shipments. CTL is already collecting more batteries in preparation for a second shipment. Going forward, CTL intends to increase the scope of this project by collecting more batteries and involving a greater number of stakeholders from the electronics industry. Fairphone will continue to find the best ways to integrate this cobalt into its batteries.

It is important to note that scaling up and collecting more is not the end goal. In order for a solution to be sustainable in the long run, it is important that it is financially sound. The business model and the financing mechanism behind this work are essential for solutions to last. CTL will be looking into further work to enable sound management of waste such as lithium-ion batteries and other electronics and will partner with others to do so more effectively. Fairphone is also looking forward to working with CTL on these future endeavors.

4 MORE INFORMATION

This whitepaper is a publication by Closing the Loop in collaboration with Fairphone, with contributions from Call2Recycle. Interested parties who want to learn more about the pilot or would like to discuss potential collaboration opportunities can contact the contributors and partners below.

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Figure 1 - Workers with drums of batteries, wrapped and ready for shipment