2.6. Annexe 4

Lithium-ion battery end-of-life management and recycling in Mauritius

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1 Introduction

The 2020 Circular Economy Action Plan of Mauritius established the need for a policy framework and regional coordination for lithium-ion battery end-of-life management. The CE Action Plan recognizes the need to "devise efficient waste management schemes for end-of-life vehicles, wasta batteries, and waste tires" (Policy P40) as well as the need to "enhance regional and international cooperation on the circular economy (Policy P61). This study looks at the treatment of End-of-Life Lithium-Ion Batteries (LIB), which means after the repurposing and reusing of such batteries in potential second life applications such as stationary storage and EV charging.

Over the next 10 years, the Government of Mauritius expects a large increase in the volume of LIBs entering the waste stream. The number of Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) has been increasing strongly in the last decade, growing from less than 100 cumulative units in 2018 to more than 1000 newly registered vehicles in 2023 alone. In total, until 2023, 2000 new BEVs and PHEVS have been registered in Mauritius. This is in addition to the more than 25000 registered used and new Hybrid Electric Vehicles (HEV) that are currently on the roads. At the same time, the volume of each battery in battery electric vehicles and pluy-in hybrids are becoming bigger.

This waste stream will only accelerate in the 2030s as BEVs, PHEVs, and energy storage systems ramp up in Mauritius. The base case scenario in the EV-Integration Roadmap for Mauritius foresees for 26,000 BEVs and PHEVs by 2030. Experts that have worked with Mauritius Renewable Energy Agency on the development of an Action Plan for the Recycling and Disposal of Used Solar Photovoltaic Panels and EV Batteries in Republic of Mauritius have estimated that around 2000 batteries from BEVs and PHEVs will reach end-of-life by 2030. This number will increase to 30,000 by 2040. In addition, many procurers are now planning for solar + battery storage, so in the medium term this will also drastically increase the number of end-of-life batteries.

Mauritius has already been confronted with the possible impacts of a lack of end-of-life management of lithium-ion batteries. Stakeholders and surveys have confirmed that end-of-life vehicles have been dumped, abandoned roadside, or disposed of in landfills. This poses considerable risks for battery-related fires as well as the leaching of toxic chemicals into the environment. Battery-related fires have already happened, and it is feared this could impact the tourism economy.

The management of end-of-life lithium-ion batteries requires innovations in regulations and trade policy. As Section 3 outlines, recycling lithium-ion batteries in Mauritius will be very difficult given the technical and economies-of-scale challenges. As a result, exportation of end-of-life batteries will be required, at least in the short-term. Given the lack of national recycling facilities for EV batteries, Mauritius' challenge as a small island developing state is to reach the economies of scale for recycling and reuse efforts. Through regional collaboration, the country could potentially reach economies of scale while furthering the region's circularity efforts and thereby realizing ambitious climate action.

2 Technical options for end-of-life lithium-ion battery recycling

The recycling of lithium-ion batteries takes place in four main stages, each with its own challenges and opportunities. There is generally an inverse relationship between capital requirements to set up subsequent stages of battery recycling and the costs associated with the export of the recycled material. Whereas earlier stages do not need a lot of capital, the export is much more expensive. Similarly, there is an inverse relationship between local value add and capital and technology requirements. Basic processes like battery discharge and dismantling offer modest local value addition but require relatively low technology and capital investment. Subsequent stages increase local value add but are also more expensive and technologically complex.

Stage 1 involves discharging the battery to eliminate any residual charge. Residual charges can be responsible for fires, explosions, or shocks during handling, transportation, and dismantling. This is a safety requirement for domestic workers as well as for the exportation of batteries. Stage 1 requires discharging infrastructure which is relatively inexpensive compared to other infrastructure and equipment needed down the recycling supply chain. Stage 1 results in discharged lithium-ion battery packs, which are bulky and expensive to store and export.

Stage 2 involves the dismantling of batteries and the separation of hazardous and non-hazardous materials. After discharging, batteries are first dismantled, which is a labor-intensive process given the lack of standardization of battery packs. Dismantling separates the battery modules or cells from elements that are less complex to handle and pose less environmental or safety risks. These can include the battery casings, wires and connectors, cooling systems, insulation materials, and electrolyte residue. Stage 2 results in separated lithium-ion battery cells or modules, which are still expensive to transport but less so than full battery packs.

Stage 3 involves the treatment of battery cells into black mass. Battery cells are shredded – sometimes after thermal pre-treatment, to create black mass. This black mass is a valuable commodity as it is a high density of critical minerals and can be directly used by reprocessing plants to create new cathode or anode active materials that can are the foundation of new battery cells. The capital requirements to set up a production line to create black mass are high, but the resulting product is valuable and incurs lower export costs. That said, black mass is often still considered as a hazardous material because of its potential for thermal runaway and residual reactivity.

Stage 4 involves the reprocessing of black mass into battery salts. Reprocessing happens through pyro- and hydro-metallurgical processes to eventually generate metal salts that can be used again by battery component producers. The capital requirements and technological know-how for this reprocessing are very high, but the resulting mineral salts are valuable and the easiest to store and export. This is because they become chemically stable and non-flammable.

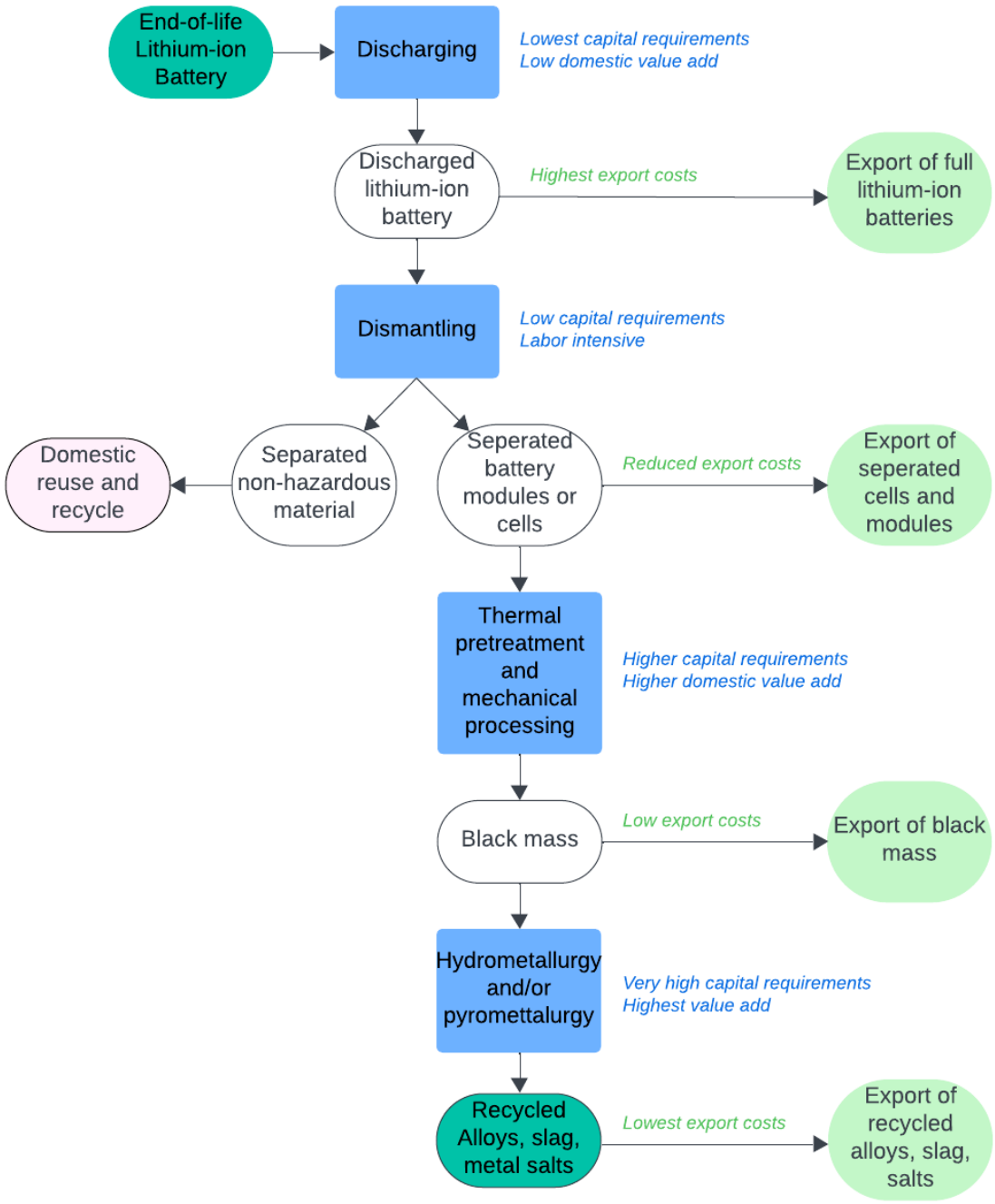

Figure X: Macro lithium-ion battery recycling flowchart
Source: Author

To summarize, these four stages are associated with four end-of-life treatment options. End-of-life treatment is considered the final step before recycling. Before EOL, reusing and repurposing can bring additional secondary value to the battery, and such options should be more thoroughly considered in Mauritius and elsewhere. The four end-of-life options that will be discussed throughout this report are:

1. The export of full lithium-ion battery packs, which requires only minimal domestic processing—primarily discharging—and is the most expensive to transport due to the bulk and safety risks involved.
2. The export of separated battery cells and modules after dismantling, which slightly reduces transport costs while adding some domestic labor value through sorting and handling.
3. The export of black mass after shredding battery cells, which significantly lowers transport costs due to its higher material density and involves more complex domestic processing which requires greater capital investment.
4. The export of refined battery salts, which adds the highest domestic value through advanced hydrometallurgical or pyrometallurgical processing, but which also requires substantial technological capabilities and capital outlay.

3 State of play of lithium-ion battery recycling in Mauritius

3.1 Lithium-ion battery collection, discharge, and storage

The first stage of end-of-life treatment needs a country-wide lithium-ion battery collection and discharging framework, which is currently lacking in Mauritius because of the remaining absence of extended producer responsibility regulations. While there are logistical challenges of safely collecting and transporting batteries across dispersed areas, the main challenge in terms of collection and discharging is the lack of a unified policy of the Government of Mauritius. Today, importers such as LEAL Group make an explicit effort in recollecting and storing the batteries used in their battery electric, hybrid, and plug-in hybrid vehicles. On the recycling end, only B.E.M. is currently collecting and storing lithium-ion batteries. It is important to note that while Mauritius is very experienced in recycling lead acid batteries, this is not at all the same as recycling lithium-ion batteries.

	Involved in EOL lead acid battery management	**Involved in EOL lithium-ion battery management**
Amrita Steels Ltd	Yes	No
BEM Enterprises Ltd	Yes	Yes
Éclair Batteries Ltd	Yes	No

Edasich Metals Ltd	Yes	No
Fiveways Ltd	Yes	No
Getraco Ltd	Yes	No
Grap Stella Steel Ltd	Yes	No
J. Jokhoo Steels Ltd	Yes	No
Metal Processing Ltd	Yes	No
Neelu Steel Trading Ltd	Yes	No
Steel scrap Ltd	Yes	No
Shiv Mahashaktishali Steels Ltd	Yes	No
Tradeway International Ltd	Yes	No
Vivas Tradelink Ltd	Yes	No

Source: Author

Note: As deducted from interviews; final check to be done in Mauritius

Many lithium-ion batteries are expected to come to end-of-life status in the coming years without a plan to safely collect and discharge them. Large battery users such as fleet operators do not yet have plans for end-of-life batteries. They consider a battery's state-of-health of 70% as the cut-off between being able to use the battery on busses and not. This means that in the coming years, we will have more EOL batteries. Medium battery users like those in EVs often dispose of vehicles in junkyards, but this poses significant risks for negative environmental and health impacts. Small battery users like those with electric mopeds and bikes sometimes abandon them when they no longer function.

The fact that batteries are not tracked and stored upon end-of-life is creating huge environmental and health risks. Damaged or deteriorating lithium-ion batteries can become unstable and lead to thermal runaway, which is the process that creates fires or explosions that are both difficult to control and release toxic gases. This can be a threat to the tourism economy. Improperly stored batteries also carry the risk of contaminating soil and water with toxic heavy metals. From a public safety perspective, exposed or corroded battery components can increase the risk of electric shocks or short circuits. These risks are especially substantial in areas that are prone to flooding, which many areas in Mauritius are at risk of during cyclone season. While the country is relatively strongly prepared in terms of early warning systems and flood management infrastructure, this means nothing for battery risks of abandoned vehicles or those in junkyards.

While companies have tried to repurpose end-of-life batteries, this has not always worked, putting them firmly in end-of-life status and in need of end-of-life treatment. Companies like LEAL group are working with local universities to investigate options and methods to reuse batteries. This type of collaboration is encouraged as it could open new repurposing options for batteries, specifically to use them as a backup battery for solar PV

installations. However, they also have more and more end-of-life batteries that need to be dealt with. Current attempts to export those batteries have fallen through because of a lack of scale. Other exporters have been requested by battery offtakers to pay for transport.

There is no universal lithium-ion discharging infrastructure available in Mauritius. Because battery packs are designed and assembled in various ways and using various chemistries, discharging batteries is complicated as such packs have been designed for operational efficiency rather than discharging efficiency. Some companies in Mauritius have discharging equipment specific to the brand of vehicle, but no universal discharging equipment exists.

Some companies have the knowledge to dismantle batteries, but this again depends on specific brands and specific models of EVs. For example, LEAL group has the know-how from their suppliers on how to dismantle batteries. This is in part to replace specific modules to fix cars, but this know-how is key in dealing with end-of-life battery packs as well.

A very small minority of companies have invested in appropriate storage and safety measures, but there is no national standard on how to deal with end-of-life batteries. Some companies like LEAL group have invested a lot of money in proper storage and safety equipment, such as specialized fire extinguishers manufactured in the U.K. that are then installed in their storage locations as well as their stores. Most companies, however, do not yet have standards in place, mostly because of a lack of guidance from national policymakers.

3.2 Lithium-ion battery export

There is insufficient scale from individual companies to export end-of-life lithium-ion batteries today. The volume of batteries today from individual companies does not fill a 120-foot, which is the main limitation to being able to export batteries at a reasonable cost. One company completed all the necessary steps to export end-of-life battery modules to the recycling plants of the car brand they came from, but ultimately the car brand backed down because of the shipping, discharging, and storing costs associated to the batteries that did not even fill up half a container. Transport costs are one of the main contributors of overall recycling cost[i], so it is critical for Mauritius to find recycling facilities nearby in the short-term.

All batteries combined on the island are estimated to fill at least 1, maybe 2 containers, if they would be collected at a recycling hub. This means that an appropriate battery end-

of-life policy could boost the total end-of-life batteries collected, which can then be exported because costs become less prohibitive. This is the scale needed in the short-term to unlock the export of full lithium-ion batteries (option 1). B.E.M. in combination with some of the major car dealers would already fill one container and allow end-of-life batteries to leave Mauritius in the short term.

3.3 Lithium-ion battery black mass production and recycled metal salts production

There is currently no black mass production capacity in Mauritius. The challenges of lithium-ion battery recycling in Mauritius need to be viewed through several interconnected technical, economic, and infrastructural lenses. A major challenge lies in the availability and collection of sufficient feedstock of end-of-life lithium-ion batteries. The profitability of LIB recycling operations depends strongly on a steady stream of used batteries, but Mauritius, like other smaller developing economies, has limited EV adoption (for end-of-life batteries) and lacks significant local battery manufacturing (for LIB scrap). This low domestic supply of end-of-life batteries necessitates regional initiatives.

Moving beyond black mass production into recycled metal salts products pose technological hurdles and is not conceivable in the medium-term. Reprocessing black mass requires advanced pyrometallurgical and hydrometallurgical processes, which demand specialized equipment and expertise. Many of these technologies are not yet readily accessible in Mauritius due to high costs and limited industrial capabilities. The lack of standardization in battery design (a problem in most countries around the world) further complicates recycling processes, as varying chemistries and configurations require tailored recycling approaches. This reduces overall efficiency.

4 Next technical steps for end-of-life lithium-ion battery management in Mauritius

4.1 Lithium-ion battery collection, discharge, and storage

B.E.M. has made inroads to purchase and install a fast and universal discharger. Besides flexibility, speed is also key as discharging infrastructure can be slow, which poses a problem once more end-of-life feedstock becomes available. B.E.M. has explored the acquisition of a fast, universal discharger. They have done price assessments and have come up with quotes for discharging equipment that appear to be very competitive to the global average.

B.E.M. is planning for major lithium-ion storage investments. Right now, B.E.M. is storing most lithium-ion batteries, mostly smaller batteries from laptops and other consumer electronics, in plastic drums with glass protection blankets. They are also expanding to solar PV batteries and are pursuing MOUs with automobile importers, so they have a more reliable feedstock pipeline. Securing those will justify investments in advanced discharging and safety equipment, which are necessary for bigger batteries.

4.2 Lithium-ion battery export

There is a need for one single Interim Hazardous Waste Facility for Lithium-Ion Batteries to be processed before they are treated and/or exported. Several consulted experts and companies believe that a one-stop shop that deals with all collection, discharging, storage, recycling, and exportation is needed to achieve the economies of scale to deal with batteries in the short-term. This one-stop shop will likely be a company, and given the state of the sector today, B.E.M. appears to be the best candidate.

In the medium-term, as end-of-life volumes increase and competition is possible, the Interim Hazardous Waste Facility could seize to exist. The goal of the interim facility is to create scale in the short-term so that economics of collection, discharge, storage, and transport/recycling are improved. This is necessary to avoid the negative environmental impacts of improper handling of end-of-life lithium-ion batteries. A national decision on an interim facility should stipulate the period during which it will be mandated to use the interim facility for the collection of end-of-use batteries, and a target date for reevaluation of the system. This time frame is important to create a reliable investment environment. Ideally, this is tied into regional discussions on a regional platform for battery recycling (see below).

The candidate Interim Hazardous Waste Facility should demonstrate a flow chart that considers shipping fees. Shipping agencies are reluctant to transport waste lithium-ion batteries due to fire risks. When they do, they often require strict safety measures such as embedding the cargo in sand. As a result, a shipping container that could typically carry a certain volume of material is limited to a much more limited volume of waste batteries (in some cases, it has been quoted that a normal carry capacity of 20 metric tons is reduced to 5 metric tons)[ii]. Several industry players in Africa have tested the feasibility of exporting batteries for recycling, but these trials have demonstrated that the costs far exceed the financial returns from material recovery, making the model unsustainable[iii]. This demonstrates the necessity for a well-structured flowchart that underlines the ability to export at a certain volume at a certain cost.

4.3 Lithium-ion battery black mass production and recycled metal salts production

B.E.M. has done technical assessment to explore the possibility of investing in a black mass production line and are confident about their ability to do so. B.E.M. has acquired land for e-waste recycling, including for lithium-ion batteries, and more than sufficient land is available to install a black mass production line. B.E.M. estimates the construction costs at a competitive quote compared to international benchmarks. They anticipate a 2-year lead time between an investment decision and production. B.E.M. estimates that if IOC countries combine their EOL LIB stock, a black mass production line could be economically feasible in five years' time. This estimate shows that if no regional integration of end-of-life batteries is achieved, each country will be left with the expensive exportation of lithium-ion batteries for at least the next decade.

Energy infrastructure is a critical bottleneck for battery recycling, and Mauritius has a competitive edge in the region. Recycling processes, including thermal pretreatment before black mass production, are highly energy-intensive, and the reliability and cost of energy and electricity can significantly affect operational viability. According to World Bank Development Indicators, Mauritius and Seychelles have a 100% electricity access rate, compared to 90% for Comoros and 36% for Madagascar[iv].

The government of Mauritius could also use black mass production to boost its renewable energy plans. The Government failed to meets its goal of increasing renewable energy to 35% by 2025 as described in the Renewable Energy Roadmap 2030[v]. In 2022, the share of renewable energy stood at 19%, which was a significant increase from a decade earlier. In the 2022 review of the policy, the Government of Mauritius now targets 60% renewable energy share by 2030[vi]. To accelerate the deployment of solar energy, black mass production can make sense given for two reasons. First, it is expected that black mass buyers will seek more low-carbon black mass over time. Second, more solar energy can be combined with more battery storage infrastructure which can then be a feedstock for domestic black mass production facilities.

Specifically, the Government's Solar PV Scheme for Charging of Electric Vehicles and its objectives for Battery Energy Storage Systems can be a catalyst for recycling operations. The solar scheme of Mauritius would allow PV installation for EV charging and exporting surplus energy to the grid[vii]. This surplus energy from solar can create challenges to provide sufficient capacity during peak demand hours when the sun is down. This situation has created grid operation challenges all over the world and one way to deal with those challenges is to have sufficient battery storage. Similarly, the Budget Speech

2021/2022 also showed an intention to increase battery capacity to 40 MW, with half of that already auctioned. That 20 MW would ultimately lead to a significant volume of end-of-life batteries of around 150-250 metric tons of black mass, depending on battery chemistry used. While the time frame for those volumes to be available for recycling is several years in the future, it shows how a first mover advantage could eventually pay off.

While there is potential, the economic competitiveness from lithium-ion battery recycling in Mauritius is not guaranteed. LIB recycling facilities often struggle to achieve price parity with raw material extraction due to the higher costs of processing and the fluctuating prices of metals like cobalt and nickel. This challenge is exacerbated by competition from established global players in countries like China, the U.S., and the EU, which benefit from economies of scale and more developed recycling ecosystems. Without targeted support and investment, Mauritius, as well as any other regional initiative, may find it challenging to carve out a niche in the global recycling industry.

Any places for lithium-ion battery recycling should take into account the rise of LFP chemistries. Consulted experts agree that for a country like Mauritius, it is conceivable that batteries in the future will depend on other chemistries such as LFP for both EV segments and stationary storage segments. LFP uptake have outpaced other battery chemistries and captured a market share exceeding 50% globally in the final quarter of 2024. It is believed that the ex-China LFP share will double from 14% in 2024 to 30% in 2030[viii]. LFP battery recycling is additionally difficult as the chemistry does not contain nickel and cobalt, which often help the economics of battery recycling.

5 Regional initiatives on battery recycling and end-of-life management, and lessons for Mauritius

Réunion Island already exports batteries back to mainland France. Reunion island has recently installed a facility processing lithium-ion batteries making them stable using a specific process and then sends them to recycle sites which are in mainland France[ix].

In recent years, there has been several initiatives in South Africa with respect to lithium-ion battery recycling. In 2021, a MINTEK study concluded that lithium-ion battery recycling in South Africa was not viable due to low collection rates and a lack of economic feasibility[x]. However, in the years since, investment in recycling has gained momentum, with several companies driving new initiatives. Notably, Cwenga Lib launched its pilot lithium-ion battery recycling operations in Germiston at the end of last year[xi]. Other planned projects include

initiatives by Desco Electronic Recyclers[xii] and a joint venture between ACE Green Recycling (a US/Singapore based company) and Tabono Investments[xiii].

Some initiatives rely strongly on partnerships with global recyclers. For example, Ace Green Recycling has also partnered with Spiro, which is Africa's largest EV company with more than 22000 electric bikes deployed across the continent. Ace is set to recycle lithium-ion battery material, including LFP batteries, from Spiro's end-of-life batteries and waste material from its battery manufacturing in Africa. They will use their proprietary technology to recycle lithium-ion battery material, including all the way to metal salts. The firm has said the process recovers lithium to produce lithium carbonate at battery-grade purities, which will then be fed back into the battery materials value chain. The JV has mentioned that recycling hubs will be co-located near Spiro's collection hubs[xiv]. This recycling to metal salts is one step beyond black mass production and likely not relevant for Mauritius.

Other notable recycling initiatives are going on in Nigeria. In Nigeria, Innovate UK Global Alliance Africa collaborated with Hinckley Recycling in Nigeria to identify effective solutions for end-of-life care for lithium-ion batteries as part of a collaboration with a few stakeholders[xv]. In 2024, it was announced that the Ogun state government had partnered with the UK government's Manufacturing Africa programme to establish a lithium-ion recycling plant. The initial investment will be around $5 million[xvi]. Another example is the cooperation of Romco Group (a UK recycler) and Elemental Group (a Polish recycler) that plan to engage in battery recycling in West Africa, likely in Nigeria[xvii].

Regional initiatives for recycling, until metal salts might open up new markets for black mass producers elsewhere in Africa. It is important to note that the first pilot battery recycling plant in South Africa focuses on recycling all the way to battery grade metal salts[xviii]. Similarly, some of the plans in Nigeria want to do the same. While this is a step beyond what Mauritius could reasonably expect to do, even in the medium term, given it is a small island without a large battery production and consumption market, these initiatives can be investigated as potential offtakers for black mass produced in Mauritius.

Regional initiatives have shown that more re-use of end-of-life batteries is probable, but this needs to be addressed early on as it can change the economics of black mass production. The Rwandan government has been addressing e-waste and battery waste issues for over a decade and mandated extended producer responsibility. Rwanda established an e-waste dismantling facility that is operated by Enviroserve Rwanda, which also works with off-grid solar companies to handle obsolete equipment. It has been reported that Enviroserve has accumulated 11 metric tonnes of lithium-ion batteries. Like in

Mauritius, these end-of-life batteries are currently stockpiled due to the high costs of exporting them for recycling. As an alternative, however, the company is exploring battery repurposing. Initial tests indicate that over 50% of battery cells could be reused[xix]. This is good news from a circularity perspective, but if the same would happen in Mauritius and other Indian Ocean Commission states, it would strongly affect the flow chart and timing of potential black mass production since it would delay a significant amount of feedstock of end-of-life batteries available.

6 Creating a supportive national regulatory environment for lithium-ion battery end-of-life management in Mauritius

6.1 The Draft Action Plan for the Recycling and Disposal of Used Solar Photovoltaic (PV) Panels and EV Batteries and the National Battery Plan

MARENA is currently working on a strategic plan which will incorporate end-of-life aspects of several energy technologies, including batteries. The draft Action Plan acknowledges that currently there is no information available on how batteries are being disposed of. It also sets out the design objectives of a national battery plan for electric vehicles for Mauritius, which essentially underlines the need for EPR legislation as it reiterates (1) that it needs to be compatible with and facilitate a circular economy approach, (2) cover all large batteries in scope and avoid free riders, (3) reflect the costs imposed by appropriately managing batteries through their life cycle.

6.2 Trade policy-related challenges and opportunities

End-of-life lithium-ion batteries are considered as hazardous waste, which complicates their exportation. Mauritius defines hazardous wastes under the Environment Protection Act and lists them under the 2001 Environment Protection Regulations. Hazardous wastes are wastes that have the potential to cause harm or damage to human health and the environment due to their hazardous properties. Used batteries are included as hazardous waste.

Many other countries and trade partners of Mauritius also consider lithium-ion batteries as hazardous wastes. Consulted experts clarified that Madagascar prohibits the import of waste, hazardous waste, and dangerous substances, including materials containing them. Similarly, Comoros prohibits the import, export, and transfer of hazardous wastes on all national territory. Similarly, Seychelles prohibits the import of any hazardous

waste into its territory. This set-up where end-of-life batteries are considered as hazardous waste by all neighboring IOC member states means that economies of scale in dealing with end-of-life batteries, and the ability to monetize them as secondary resources, are effectively blocked.

The system will apply to lithium-ion battery modules and cells, as well as black mass. This means that cross-border trade requires prior informed consent from the exporting country's environmental authority, the importing country's authority, and the transit country authorities. These approvals ensure that the materials are shipped to facilities capable of handling them in an environmentally sound manner. The system also applies to black mass since it is classified as hazardous waste due to its residual reactivity and the presence of toxic heavy metals like cobalt and nickel.

It is estimated that export of hazardous wastes as categorized by the Basel Convention can take an additional 6-12 months to receive the correct permissions. This process is facilitated by a sound working relationship between the country of export and import, and by minimizing transit countries. B.E.M., for example, has working relationships with recyclers in Singapore, which should help with getting the correct permits within a reasonable time frame.

The implementation regulations for the Basel Convention should be reviewed to ensure they are still fit for purpose. The company in Mauritius that eventually will export needs to have all the documents ready from the Ministry of Environment. The Customs Authorities of Mauritius just must cross-check whether those papers actually comply with the regulations, including the Basel Convention. The system under which Basel Convention rules are applied could be reviewed to ensure it is still fit for purpose.

The HS system needs innovation. The HS nomenclature is mostly linear from upstream sectors such as material extraction via production to eventually waste. Those waste streams, however, can include valuable secondary sources. Current regulations and trade practices are based on a linear logic, rather than a circular one, also because they rely on the current HS classification system. For example, there is HS code for black mass.

The Government of Mauritius should adopt labeling and information requirements that will assist recycling. The Draft Action Plan recognizes that several features from the EU Battery Regulation can be leaned on when developing a National Battery Plan for Mauritius, specifically with respect to labeling and innovation. Since disassembling batteries has very low automation rates, manual labor would be needed. To ensure both efficiency and safety,

labeling requirements should mandate the disclosure of type of battery, type of battery chemistry, assembly details and disassembly guidelines, material content, quantity of each material, date of manufacture, presence of hazardous substances, change of ownership and other technical documentation.

6.3 Extended producer responsibility

The adoption and implementation of Extended Producer Responsibility (EPR) regulations is long overdue and should be priority number 1. EPR regulations would change the scale of batteries and e-waste available for end-of-life treatment, and as a result, its economic profitability.

Extended Producer Responsibility regulations have been drafted already for several years but have not yet been adopted and implemented. Several stakeholders indicate that EPR policies have been a decade in the making, that draft regulations have been ready for four years, and have now been at the State Low Office for a long time. The draft regulations were tailored after the French model but have not yet been adopted or implemented. Noteworthy recyclers such as B.E.M. have not been consulted on this draft EPR legislation. The immediate start-up of a consultation process with a clear timeline on final EPR adoption is paramount.

6.4 Indian Ocean Commission state cooperation

As a French Department, la Réunion falls under relevant EU policies. These policies include the EU Waste Shipment Directive is relevant having reached political agreement in December 2023, updating Regulation 1013/2006, as well as the Batteries Regulation (Regulation (EU) 2023/1542). The current drafts of Mauritius EPR contain a lot of provisions from the EPR policies that apply to France and Réunion. Reviewing this again to ensure significant overlap can help with the interoperability of EPR schemes of the IOC islands.

End-of-life lithium-ion-batteries should not be considered as waste but as secondary materials so that trade between the islands is possible to achieve economies-of-scale. Right now, for example, Réunion cannot export their end-of-life lithium-ion batteries to Mauritius, and Mauritius cannot import those batteries either, because they are considered as waste.

A regional lithium-ion recycling hub for IOC countries would change economies-of-scale instantly. This would allow for investments in appropriate discharging, storage, and

transport infrastructure to be carried by the private sector. Similarly, the regional hub approach would also allow earlier investment in a shredder and black mass production line.

The draft Circular Economy Action Plan for the African and Indian Ocean Island Countries recognizes the need for a regional approach. Draft 18122024 recognizes the "need to develop a regional approach aimed at improving capacities, facilitating transboundary movement of batteries and promoting investments for more efficient used lithium-ion battery collection, recycling, and reuse. This regional approach is particularly important for countries of limited size that will continue to lack sufficient end-of-life battery volumes to justify investments in their own end-of-life management capacities. The development of a circular economy of Li-ion batteries in the region relies on multi-party collaboration, which requires active engagement from governmental agencies, battery disposal actors, shipment companies, and electric vehicles manufacturers." Action 3.5. in the draft action plan foresees regional cooperation along the following lines:

- An analytical assessment of global and regional practices for the reuse and recycling of used Lithium-ion batteries, with a specific focus on the region.
- A feasibility study for each island on the logistics required and the installation of a processing site (such as in Reunion) for making the batteries inert/stable before export.
- A harmonisation of trade procedures and transport requirements for used Li-ion batteries considering the Basel Convention.
- A pilot export operation from one of the islands by car importers which will allow the industry to learn about the obstacles and evaluate the overall cost of collection, export and recycling of waste batteries, to determine the amount of the eco-contribution that will apply to these materials and that will finance their recycling through an EPR policy.

The draft Circular Economy Action Plan for the African and Indian Ocean Island Countries recognizes the need for a regional battery collection and transport hub. The draft action plan recognizes that reuse and repurpose should take priority. Action 3.6. stipulates that IOC states will engage in a Pre-Feasibility Study that will present the economic, financial, technical, social, institutional, logistical, and environmental assessments of establishing a regional recycling network and hub in the region for specific waste streams. In its second phase, lithium-ion batteries will be considered together with E-wastes, used tyres and plastics. Specifically, the pre-feasibility study will be undertaken for the most favorable option for a regional recycling facility based on technical, environmental, social, financial, and economic assessments (for example a hub for e-wastes/Li-ion batteries in Reunion or in Mauritius and a hub for used tyres in Reunion or Madagascar and

improved collection/storage/pre-processing/compaction in other countries and transshipment). If the setting up of the regional hubs is found feasible, the next phase can be dedicated to a full feasibility study and the implementation of the project by interested private operator and determining funding sources.

Government could rely on ISO 59014 to allow companies in Mauritius to import some end-of-life batteries as secondary materials. ISO 59014:2024 provides principles, requirements, and guidance for organizations to enhance the sustainability and traceability of activities and processes in the recovery of secondary materials. The standard could be used to develop a system of cross-border interoperability so that end-of-life batteries that are currently considered as waste could be traded.

If/when a regional trade system is set up, reducing tariff rates for end-of-life batteries can be a win-win for environmental sustainability and the economics of recycling. Making sure no tariffs apply can facilitate transboundary movement of cross-border trade of end-of-life batteries.

IOC member states can develop a green list system that fast tracks companies with a good track record. This system would recognize and certify businesses that meet strict environmental, safety, and compliance standards. This system can tie into the following specific ISO standards. The benefactors would benefit from a reduction of bureaucratic delays and other facilitation of cross-border trade for end-of-life batteries.

6.5 Government incentives to promote LIB circularity

It is important to make sure that there are no tariff barriers to the import of lithium-ion battery safety, storage, and discharging equipment. Hazardous waste storage containers are needed to store lithium-ion batteries in a safe manner. Currently, consulted companies did not identify any troublesome tariff barriers. The only tax paid is the 15% VAT to get them cleared through customs, which is considered as both normal and fair.

If the government works with recycling fees, those fees should go to recycling. Currently the government collects recycling fees on mobile phones, tires, and so forth, but the collected fees are not earmarked to support the recycling industry. At the very least, the government should use those resources to plan for appropriate regulations, like EPR, that can help the recycling industry invest early on, rather than late in the game when they will have to suffer from second-mover disadvantages.

7 Recommendations

- Establish a multi-disciplinary, multi-ministerial steering committee to finalize EPR regulations and other regulations and initiatives that foresee for end-of-life management and recycling options that are economically feasible, focusing on Option 2 and 3 as laid out.
- Develop a national end-of-life lithium-ion battery collection and discharging framework to safely manage increasing volumes of used batteries and make sure that there is a reliable flow of end-of-life batteries to reach economies of scale. Like in any EPR, this should include clear guidelines on the roles and responsibilities of importers, users, and recyclers, as well as designated collection points to prevent unsafe storage and disposal.
- Develop a national end-of-life lithium-ion battery collection and discharging framework to safely manage increasing volumes of used batteries. This should include clear guidelines on the roles and responsibilities of importers, users, and recyclers, as well as designated collection points to prevent unsafe storage and disposal.
- Create an interim hazardous waste facility to centralize battery collection, storage, and discharge. This is required to achieve economies of scale necessary for cost-effective export and processing. This facility would serve as a temporary solution and should be managed by a qualified operator that is able to manage storage and transport, and, eventually, recycling.
- Support regional cooperation within Indian Ocean Commission member states to establish a regional recycling hub. This would further facilitate trade and economies of scale for battery recycling while ensuring compliance with Basel Convention rules. A regional approach would allow the trade of end-of-life lithium-ion batteries as secondary resources rather than waste, whose trade is currently prohibited.
- Introduce a Green List System to fast-track responsible companies in the trade of end-of-life batteries. This would reducing regulatory delays and promote circular economy principles. Companies with proven compliance and environmental responsibility should be granted preferential access to export and repurposing channels.
- Ensure that end-of-life batteries are classified as secondary materials, not waste, to facilitate trade and reuse while preventing unnecessary restrictions under hazardous waste regulations. This can be done by aligning with ISO 59014:2024 standards.

- Promote battery repurposing initiatives through collaborations between industry and academia, while engaging in a technical analysis of how that could affect EOL LIB feedstock for exporters and recyclers.
- Encourage investments in black mass production by supporting the private sector in setting up processing infrastructure, particularly if regional battery flows can be secured. With sufficient volume, Mauritius could process batteries into black mass, making exports much more cost-effective and adding local value and jobs.
- Establish clear labeling and tracking requirements for imported batteries, including unique identifiers that persist through second-life applications and final recycling. This would enhance traceability and enable better management of used batteries, alongside the likely upcoming traceability requirements from metal salts producers using EOL LIB.
- Align national trade policies with the need for revised HS classifications for secondary battery materials. This includes ensuring that black mass and repurposed batteries are recognized as valuable secondary resources rather than hazardous waste.
- Provide government incentives for lithium-ion battery safety, storage, and discharging infrastructure, specifically by ensuring that there are no tariff barriers on essential equipment for battery recycling operations.

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