International Economic Law Clinic

LEVERAGING ASEAN TO ESTABLISH A REGIONAL RECYCLING HUB FOR USED BATTERIES

February 2025, Geneva

Submitted by

Jiaying Zheng, Advaita Lonkar, Sabrina Obianuju Wigwe-Chizindu

To: United Nations Conference on Trade and Development (UNCTAD)
E-9042 Palais des Nations 1211 Geneva 10, Switzerland

and at any time, bind, or lead to any form of liability or responsibility for the clinic participants, participating academic institutions, or TradeLab.

TradeLab

International rules on cross-border trade and investment are increasingly complex. There is the WTO, World Bank and UNCTAD, but also hundreds of bilateral investment treaties (BITs) and free trade arrangements ranging from GSP, EU EPAs and COMESA to ASEAN, CAFTA and TPP. Each has its own negotiation, implementation and dispute settlement system. Everyone is affected but few have the time and resources to fully engage.
TradeLab aims to empower countries and smaller stakeholders to reap the full development benefits of global trade and investment rules. Through pro bono legal clinics and practica, TradeLab connects students and experienced legal professionals to public officials especially in developing countries, small and medium-sized enterprises and civil society to build lasting legal capacity. Through 'learning by doing' we want to train and promote the next generation of trade and investment lawyers. By providing information and support on negotiations, compliance and litigation, we strive to make WTO, preferential trade and bilateral investment treaties work for everyone.

More at: https://www.tradelab.org

What are Legal Practica

Legal practica are composed of small groups of highly qualified and carefully selected students. Faculty and other professionals with longstanding experience in the field act as Academic Supervisors and Mentors for the Practica and closely supervise the work. Practica are win-win for all involved: beneficiaries get expert work done for free and build capacity; students learn by doing, obtain academic credits and expand their network; faculty and expert mentors share their knowledge on cutting-edge issues and are able to attract or hire top students with proven skills.
Practicum projects are selected on the basis of need, available resources and practical relevance. Two to four students are assigned to each project. Students are teamed up with expert mentors from law firms or other organizations and carefully prepped and supervised by Academic Supervisors and Teaching Assistants. Students benefit from skills and expert sessions, do detailed legal research and work on several drafts shared with supervisors, mentors and the beneficiary for comments and feedback. The Practicum culminates in a polished legal memorandum, brief, draft law or treaty text or other output tailored to the project's needs. Practica deliver in three to four months. Work and output can be public or fully confidential, for example, when preparing legislative or treaty proposals or briefs in actual disputes.

Centre for Trade and Economic Integration (CTEI)

The Centre for Trade and Economic Integration (CTEI) CTEI is the Graduate Institute's Centre of Excellence for research on international trade. The Centre brings together the research activities of eminent professors of economics, law and political science in the area of trade, economic integration and globalization. The Centre provides a forum for discussion and dialogue between the global research community, including the Institute's student body and research centres in the developing world, and the international business community, as well as international organisations and NGOs. The Centre runs research projects and organises events. A core goal of the Centre is to foster genuine, interdisciplinary research and to work across discipline to foster solutions that address the major societal issues of today. The Centre for Trade and Economic Integration fosters world-class multidisciplinary scholarship aimed at developing solutions to problems facing the international trade system and economic integration more generally. It works in association with public sector and private sector actors, giving special prominence to Geneva-based International Organisations such as the WTO and UNCTAD. The Centre also bridges gaps between the scholarly and policymaking communities through outreach and training activities in Geneva.

More at: www.graduateinstitute.ch/ctei

Table of Contents

Acronyms

ACIA	ASEAN Comprehensive Investment Agreement
AFTA	ASEAN Free Trade Area
AGBD	Global Burden of Disease
AHTN	ASEAN Harmonized Tariff Nomenclature
ATIGA	ASEAN Trade in Goods Agreement
CEPTs	Common Effective Preferential Tariff Scheme
DENR	Department of Environment and Natural Resources
EV	Electric Vehicle
EPR	Extended Producer Responsibility
FDI	Foreign Direct Investment
FPI	Federation of Philippine Industries
GBD	Global Burden of Disease
GIIW	Green, Inclusive, Innovative, and Well-Managed
ISO	International Standards Organization
IEC	International Electrotechnical Commission
LIBs	Lithium-ion Batteries
MRA	Mutual Recognized Arrangement
OSIC	One-Stop Investment Center
POs	Professional Organizations
PIC	Prior Informed Consent
PRAs	Professional Regulatory Authority
SMEPP	Sustainable Manufacturing and Environmental Pollution Programme
UNCTAD	United Nations Conference on Trade and Development

UNEP	United Nations Environment Programme
WCO	World Customs Organization
WEF	World Economic Forum
WHO	World Health Organization
WTO	World Trade Organization
ULABs	Used Lead-acid Batteries
ULIBs	Used Lithium-ion Batteries
LABs	Lead-acid Batteries

Executive Summary

The significant popularity and growing demand for lead-acid batteries (LABs) in Southeast Asia, particularly in Bangladesh, where three-wheelers dominate the local transportation, combined with the region's vision for lithium-ion batteries (LIBs), underscores the critical need for efficient recycling infrastructure to manage end-of-life batteries due to their limited lifespan. This report reviews the current situation of Used Lead Acid Batteries (ULABs) recycling in Bangladesh and ASEAN countries. It explores the possibility of establishing a recycling hub in ASEAN countries to make use of the economic value of batteries and promote a circular economy while reducing the negative environmental and health impact. It also examines the potential of adapting ULAB recycling experiences to Used Lithium Batteries (ULIBs). However, given that ULABs are classified as hazardous waste subject to the Basel Convention's Prior Informed Consent (PIC) procedure, enhancing trade in ULABs within the ASEAN region and beyond requires navigating various regulatory requirements and ASEAN trade agreements. At the same time, the technical differences between ULIBs and ULABs present challenges to fully leveraging the shared benefits of a regional ULAB recycling hub.

The study's key findings are as follows:

Key Findings:

- The establishment of a recycling hub is subject to countries' export and import regulations on ULABs. In this case, countries that do not have import bans on ULABs in place in ASEAN are Vietnam, the Philippines, Cambodia, and Brunei.
- he PIC procedure needs to be streamlined and, where possible, digitalized to minimize trade-related costs and delays. Article 11 of the Basel Convention could be possibly leveraged by signing special regional or multilateral agreements to enhance efficiency, reduce administrative burdens, and facilitate smoother trade flows for ULABs. Specifying the Harmonized System (HS) code for ULABs and ULIBs will improve the recycling efficiency at the recycling facility and easier to monitor its transportation in an ESM way.
- Continuous efforts are needed to encourage investment and trade in both goods and services related to battery recycling. Leveraging ASEAN trade agreements can help ensure the smooth circulation of used batteries, strengthen technological capabilities, and build human resource capacity to support the sustainable operation of recycling hubs.
- Designing and implementing an Extended Producer Responsibility (EPR)--based Battery Take-Back System for ULABs and ULIBs can enhance public awareness of recycling practices. Such a system would shift the responsibility for end-of-life battery management from local governments and taxpayers to producers, fostering accountability and promoting a circular economy approach.

- Bangladesh can benefit from the regional battery recycling hub in ASEAN by either joining ASEAN as a member state or signing special agreement with ASEAN with regard to the Basel Convention Article 11.

Conclusions:

The findings indicate that establishing a ULAB recycling hub, or ULIB recycling in the future, among ASEAN countries is theoretically feasible; however, successful implementation requires more coordinated efforts, policy alignment and trade facilitation from all stakeholders.

Introduction

Lead-acid batteries (LABs) are the most widely used rechargeable batteries globally, accounting for 72% of the world's rechargeable battery capacity (in GWh) as of 2018 (WEF, 2019). Their simplicity and affordability make them a more practical and accessible energy solution compared with the expensive and technologically demanding lithium-ion batteries (LIBs). This makes them a particularly attractive option in developing countries where stable and cost-effective power is essential. A prime example is Bangladesh, where the LAB industry has expanded three to four times over the past decade (Shah Jalal, 2024). This sharp growth is fueled by the country's increasing reliance on LAB-featured 3-wheelers, notably e-rickshaws.[1]

LABs typically have a relatively short lifespan, lasting only a few years before they reach the end of their functional life, at which point they become used lead-acid batteries (ULABs). LABs in EZ bikes and E-rickshaws can only last a few months, especially in the hot climate in Southeast Asian countries (SMEP, 2021). The absence of a robust regulatory framework and inadequate quality control measures also contribute to the reduced lifespan of these batteries. For instance, in Bangladesh, the electric three-wheeler industry is not officially recognized by the Bangladesh Road Transport Authority (BRTA) or the National Electric Vehicle (EV) Policy, limiting the enforcement of sound quality standards for batteries used in this sector (SMEP, 2024a).

At the same time, importing LABs is often expensive, as they are subject to high tariffs (e.g., Bangladesh has a 30% tariff on lead). These factors combined have given rise to a booming informal recycling industry of ULABs in Bangladesh, with starter batteries and e-rickshaw batteries comprising 80% of total lead recycling in Bangladesh (Pure Earth, 2020). These informal recycling processes lack the necessary processes and technologies to control lead emissions and worker's exposure, coupled with the absence of adequate regulations (UNEP, 2010; Manhart et al., 2016). As a result, significant amounts of lead particles and fumes are released into the air and settle on soil, water sources, and various other surfaces.

Indeed, lead is a well-documented cumulative toxicant. According to the World Health Organization (WHO), no level of exposure has been proven to be safe for children or adults. Even minimal exposure can result in chronic and debilitating health effects across all age groups, with children and women particularly vulnerable (WHO, 2024). Moreover, ULABs are considered hazardous waste under the Basel Convention, necessitating careful documentation during import, transit, or export due to their negative environmental and health impacts.

[1] Currently, e-rickshaws have taken over the local transportation market in Bangladesh. The number of e-rickshaws in the country is estimated to range between 1.5 and 4 million, with the inconsistency stemming from their largely informal operations (Rahman, 2023; The Daily Star, 2024).

Bangladesh is not the only Asian country facing ULAB recycling challenges. Other major markets for LAB-powered e-rickshaws, such as Nepal, Vietnam, Thailand, Malaysia, Indonesia, and the Philippines, are also struggling with the growing need to manage ULAB disposal (Saxena, 2019). The rapid expansion of electric rickshaws in these countries has sharply increased the demand for efficient recycling systems, yet many still face infrastructural and regulatory obstacles.

LABs are an excellent example of a closed-loop product, with an exceptionally high recycling rate and considerable economic benefits. Given the significant economic value of ULABs and the potential environmental and health hazards associated with their improper disposal; this report examines the potential of establishing a regional recycling hub in ASEAN to facilitate systematic ULABs recycling. Doing so will require the facilitation of cross-border trade of LABs, ULABs and recycled lead, which is not necessarily straightforward and may require adjustments to existing domestic laws and trade tariffs.

This report also explores the recycling potential of LIBs, a sector that is rapidly gaining momentum across ASEAN countries. Compared with LABs, LIBs are more costly and technology-demanding but have higher energy density and longer battery performance. The current increasing demand for and manufacturing of LIBs will escalate the future need of recycling ULIBs. Some ASEAN countries have already raised concerns about their national ULIB recycling capacity. For instance, in Indonesia, with the rising popularity of e-mopeds and the government actively promoting electric vehicle adoption, experts are voicing significant concerns about the country's ability to manage the resulting battery waste (Recessary, 2024). In this sense, the future recycling of ULIBs may need to draw inspiration from the ULAB recycling model.

The report is divided into five sections. First, it will explore the economic possibilities of establishing a regional recycling hub within ASEAN countries, emphasizing the need for scalability and cost-effectiveness. Second, it examines key inputs and requirements for the hub, considering the technical aspects of LABs. Third, it provides tools and considerations from the trade perspective that may address the feasibility issue and implementation challenges of establishing a regional recycling hub. Fourth, it will discuss how Bangladesh can benefit from the recycling hub in ASEAN countries. Fifth and finally, it provides recommendations.

1. The Strategic Importance of Establishing a Regional Recycling Hub

Before examining the feasibility of setting up a regional recycling hub for ULABs, it is crucial to first understand the rationale to develop a regional hub. This section does so by focusing on the economic, environmental and health benefits associated with establishing a regional ULAB recycling hub.

1.1 Economic Considerations of Closed Loop Recycling for ULABs

In theory, ULABs are an ideal product of closed-loop recycling (Basel Convention, 2004). Lead-based products are relatively easy to identify and recycle due to their distinct physical and chemical properties, and product design. Nearly all materials recovered from ULAB can be reused to manufacture new batteries (Alistair et al., 2016). Moreover, the sulphuric acid in ULABs, and even the plastic carcasses of ULABs, are also recyclable. The ease of ULAB recycling can be contrasted, for instance, with the difficulty associated with recycling ULIBs, which are larger, heavier, and much more complex than ULABs. It is estimated that the recycling of ULIBs costs more than mining more lithium to make new ones (BBC, 2022).

ULAB recycling rates are extremely high in some countries. In the United States for instance, where a comprehensive network of high-quality collection and recycling systems exists, the ULAB recycling rate is as high as 99% (BCI, 2023). In Europe, the end-of-life collection and recycling rates for lead-based products, such as automotive and industrial batteries as well as lead sheets, are estimated to reach as high as 99% and 95%, respectively (Alistair et al., 2016). In Bangladesh, about 97% of the LABs come from recycled ULABs and scrap metal (The Daily Star, 2021).

However, it is difficult to make ULAB recycling profitable. This is, in part, because of the high costs associated with the developing and managing ULAB recycling facilities, as well as expenses related to land acquisition and preparation, construction, regulatory compliance, hiring and training personnel, purchasing ULABs, and ongoing maintenance and repairs, as set out in Chart 1 below. Indeed, as further elaborated upon in Box 1 below, a ULAB recycling plant in Singapore never get off the ground, due to prohibitive costs.

Key steps	Estimate Costs
Battery-breaking machine	$500,000 to 2 million
Separation equipment	$1 million to $5 million
Smelting	$1 million to $5 million
Emission treatment equipment	$500,000 to $2 million
Control Systems	$500,000 to $2 million

Chart 1: Estimate Machinery and Equipment Costs for ULAB Recycling Facilities (GME, n.d.)

Box 1: Establishment of ULAB Recycling Facility in Singapore

Atlus Asia Group Pte Ltd signed an agreement to develop a lead-acid battery recycling plant in Singapore, projected to handle 10,000MT annually for ULABs, lead, metallics, plastics, gypsum, and water recovery (Atlus Group, n.d.) However, the project has stalled due to high costs associated with land, labor, and energy, as well as difficulties in sourcing ULABs from the domestic market. Since the ULAB recycling business in Singapore is already well-established, with much of the material being exported to other countries, overall speaking, the project has become less economically viable at this time.

Moreover, establishing formal ULAB recycling facilities is challenging due to the prevalence of low-cost informal recycling operations in ASEAN and Bangladesh. Several reasons contributed to the prevalence of the informal sector (Figure 1). The existence of these informal practices often diverts the flow of ULABs to the informal sector. It also makes developing formal ULAB recycling comparatively more expensive and challenging.

Figure 1: Reasons for the existence of Informal Recycling (Environment and Social Development Organization (ESDO), 2021)

Due to the high costs associated with establishing formal ULAB recycling plants, however, it would be more cost-effective to establish a regional ULAB recycling hub, as opposed to numerous national recycling hubs. A case can be made to establish a regional ULAB recycling hub within ASEAN, given that the ASEAN region is the third largest market for the LAB-powered three-wheeler e-rickshaws (SMEP, 2024). The widespread use of 3-wheeler e-rickshaws across ASEAN and other developing Asian countries, especially in Bangladesh where they make up 77% of total LAB usage, can ensure a steady and reliable supply of ULABs for recycling (SMEP, 2024). Meanwhile, it can help countries without existing recycling technologies and backup infrastructure like Bangladesh, to ease the recycling pressure and generate economic revenues by

exporting the ULABs. Therefore, there is a case to be made to establish a regional recycling hub for ULABs in ASEAN.

1.2 Health and Environmental Implications of Informal ULAB Recycling

The toxic nature of lead and sulfuric acid in LABs requires putting in place adequate safeguards to ensure that the recycling process and management of ULABs do not result in serious environmental and health risks. Informal recycling practices can lead to soil and water contamination by lead, as well as harmful exposure of workers and nearby communities to toxic substances. Suboptimal procedures result in lower recovery rates, dangerous exposure to the environment, and adverse health risks.

In the case of Bangladesh, informal and unsound ULAB recycling is a significant contributor to lead exposure across the country and the primary contributor to lead pollution hotspots. Lead exposure accounts for approximately 3.62% of the death rate (IHEM, 2019). The Global Burden of Disease study indicates that lead exposure causes around 30,000 deaths annually in the country (IHME, 2022). The high death rate of lead exposure in Bangladesh is caused, in part, by the widespread practice of informal ULAB recycling (Figure 2). Bangladesh has more than 1,100 informal and illegal ULAB recycling operations across the country (SMEP, 2024). These sites are believed to be a significant contributor to lead exposures across the country and the primary contributor to lead pollution hotspots. It is common in Bangladesh to see roadside mechanics who conduct the refurbishment of ULABs on open streets with their bare hands.

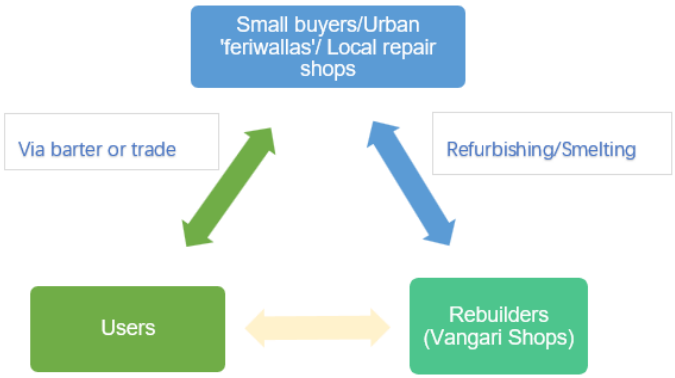


Figure 2: Graphical Representation of Informal Recycling in Bangladesh (UNCTAD, 2024)

The negative health and environmental impact of improper ULAB not only have health and environmental implications but also have economic consequences. It is estimated that Bangladesh loses US $15.9 billion in GDP from reduced lifetime earning potential among the exposed population (Attina and Trasande, 2013). This figure includes only lost earning potential due to IQ decreases, and does not include healthcare costs, lost earnings from premature death, or lost taxes from illegal ULAB recycling operations.

Lead exposure is not an isolated issue in Bangladesh but a regional concern. According to the GBD Study, South Asia and East Asia recorded the highest numbers of lead exposure-related deaths in 2019 with China, India, Bangladesh, Indonesia, and Pakistan ranking as the top five with the highest lead exposure death rates. India alone is home to 275 million children affected by lead poisoning —this amounts to half of all India's children and one-third of the children affected by lead globally. (Larsen, B., & Sánchez-Triana, 2023; Lu et al., 2024). In Indonesia, more than 8 million children are estimated to have high blood lead levels (Pure Earth, 2020). In the Philippines, the Expanded National Nutrition Survey shows that over a million Filipino children ages 6-9 years have elevated blood lead levels between 2021 and 2022 (Asian Development Bank, 2024).

To address the risk associated with the informal and illegal recycling of ULABs, the Ministry of Environment, Forest and Climate Change in 2021 prohibited the dismantling and burning of batteries for recycling without prior approval from the Department of the Environment. In addition, it is important to consider developing a regional recycling hub with proper lead disposal for ULABs. Given that ASEAN is the most robust regional cooperation mechanism among Asian countries, it could potentially serve as a strategic starting point and example to amplify regional efforts in advancing proper recycling practices of ULABs. This regional approach aligns with the principle of inclusivity, preventing any ASEAN member state or neighboring nations like Bangladesh from being left behind or excluded from these critical sustainability initiatives.

1.3 The rationale for establishing a ULAB recycling hub in ASEAN

Various factors need to be considered to identify the exact location of a ULAB recycling hub, including existing infrastructure, costs, and the presence of import bans (or export) bans on ULABs, as well as tariffs. Establishing a hub in ASEAN would enable companies to more leverage the various trade agreements that seek to facilitate intra-ASEAN trade, including the ASEAN Trade in Goods Agreement (ATIGA), which requires member states committed to eliminating import duties on intra-ASEAN trade for all products by 2010 for the ASEAN-6 countries (Brunei, Indonesia, Malaysia, the Philippines, Singapore, and Thailand) and by 2015, with flexibility up to 2018, for the CLMV countries (Cambodia, Laos, Myanmar, and Vietnam) (ASEAN, 2009).

ASEAN Member States currently have a 0% tariff on ULABs, as seen in their tariff schedules. However, to qualify for the preferential 0% tariff rates, products must meet the "ASEAN Value Content" of at least 40% calculated using the formula set out in Article 29 (ASEAN, 2009). In the case of ULABs, determining the origin can be complex, particularly if components have been replaced or modified. This is especially relevant given that some informal battery repair shops may change parts of the batteries, potentially affecting their qualification for preferential tariffs. The extent to which rules of origin could create an obstacle to inter-ASEAN trade in ULABs must be further examined.

However, the zero ULAB tariffs applicable for the trade of ULABs between ASEAN Members make the ASEAN region an ideal location for the hub. Indeed, this can be contrasted with Bangladesh, not an ASEAN Member, for which the current total tax incidence (TTI) for ULABs could be as high as 58.6%, of which 25% is Customs Duty (CD) (Government of the People's Republic of Bangladesh, 2024). The high import taxes and tariffs make Bangladesh less favorable for establishing a regional recycling hub. The high importing costs increase the expense of sourcing ULABs, reducing business profitability.

To identify the best location within ASEAN, it would be important to choose a country that does not have in place import bans on ULABs. As set out in Table XX below, the countries that do not have import bans on ULABs in place in ASEAN are Vietnam, the Philippines, Cambodia, and Brunei. Thus, from a regulatory and trade perspective, these four ASEAN countries could be well-positioned to develop the ULAB recycling plant. However, ULABs are considered "hazardous waste" under the Basel Convention, which means that their export is heavily regulated. This is further explored in section 3.2 below.

Countries	ULAB import	ULAB export
Thailand	Ban	No ban
Singapore	Ban, unless with the written permission of the Director-General	No ban
LAO PDR**	Ban	/
Viet Nam	No ban	No ban
Indonesia	Ban	No ban
Philippines	No ban	Ban
Myanmar	Ban	No ban
Cambodia	No ban	No ban
Brunei	No ban	No ban
Bangladesh	No ban	No ban
Malaysia	Ban	

Chart 2: Overview of Countries Import and Export Bans in ASEAN Members and Bangladesh[2]*

[2] Information gathered from: Basel Convention, n.d.; Philippines Pollution Control Department, 2017; Singapore, 2022; Lao People's Democratic Republic, 2021; Vietnam Customs, 2024; Indonesian Ministry of Environment, 2004; Philippines Bureau of Customs, 2021; Volza Philippines Import Data, 2021; Ministry of Natural Resources and Environmental Conservation, Myanmar, 2024; Kingdom of Cambodia, 2020; Brunei Darussalam National Single Window, n.d.
* The data from Lao PDR is not accessible.
**No ban does not mean there are no regulations or restrictions (eg. licensing, on the transboundary movement of ULABs and ULIBs.

1.4 Establishing a ULAB recycling hub in the context of increased demand for lithium-ion batteries

Despite LABs still accounting for the largest share of the overall global battery market, the demand for LIBs is growing significantly. In ASEAN countries, the demand for LIBs is projected to grow by 33% by 2030 (McKinsey & Company, 2023). Most ASEAN countries have ambitious goals regarding developing the electric vehicle (EV) market. For instance, Indonesia is advancing the localization of the EV supply chain and projects to become one of the world's top three producers of EV batteries by 2027 (ASEAN, 2024). Thailand, current largest car producer and exporter in Southeast Asia, is planning to convert about 30% of its annual vehicle production into EVs by 2030 (Reuters, 2024).

More ULIBs are yet to be generated in the near future. It should be recognized that ULIB recycling is more technologically demanding and costly compared to ULABs. Generally, instead of directly going into the recycling process like ULABs, ULIBs have more options to continue their lifespan based on remaining energy capacity (Figure X).

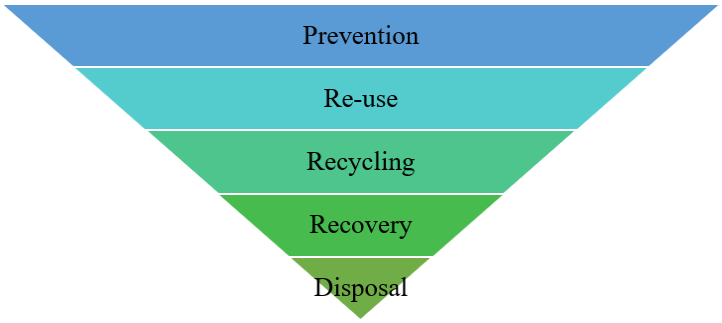


Figure 6: Management hierarchy of ULIBs (Dobo et al., 2023)

Among all the options, reuse is widely applied to ULIBs in EVs, which involves two key strategies: and repurposing. Remanufacturing refers to refurbishing ULIBs in their original applications, restoring them to a like-new condition. Repurposing, on the other hand, allows ULIBs to be utilized in non-vehicle applications, such as stationary energy storage systems. (Chen et al., 2019). Reuse is preferable to recycling in the market because it can maximize the value of the batteries and minimize emissions and energy consumption (Dobó et al., 2023; WEF, 2024). Also, it is estimated that the recycling of ULIBs costs more than mining more lithium to make new ones (BBC, 2022).

On the other hand, while LIBs are observed to have fewer environmental impacts than LABs and are not yet listed in the Basel Convention as hazardous waste in Annex I or VIII of the Basel Convention, this does not imply the absence of negative effects (Yudhistira et al., 2022). Some substances commonly contained in LIBs, such as inorganic fluorine compounds excluding calcium fluoride are listed as toxic waste (Basel Convention, 2023). ULIBs have both combustible material and an oxidizing agent, which has the risk of runaway reactions resulting in fires or

explosions (UNEP, n.d.). If disposed of improperly, it has the danger of exploding or setting fire (US EPA, 2021). There are more recent cases indicating that the fire and explosion of LIBs employed in EVs and commercial/industrial battery energy storage systems (BESS) could create hazards (Conzen et al., 2022).Therefore, the technical complexity of LIBs and potential management risks underscore the urgent need for large-scale formal recycling systems to offset high costs and ensure safe operations. The practice of establishing a recycling hub for ULABs may thus potentially offer a good recycling model for ULIBs.

2. Processes to Establish a Formal ULAB Regional Recycling Hub

Having made the case for the importance of establishing a formal ULAB recycling hub, this section highlights the process that must be followed to do so. According to UNEP's Technical Guidelines for the Environmentally Sound Management of Waste Lead-Acid Batteries, the formal recycling of ULABs should follow a comprehensive mechanism, with each step conducted in accordance with Environmentally Sound Management (ESM) principles.

The first part of the process focuses on the collection and transport of ULABs - either domestically or internationally. The ULAB collection process, which can be done from various sources such as households, vehicle owners, battery shops, telecom companies, and NGOs, must be carried out in a systematic and environmentally friendly manner. Once collected, batteries should be carefully transported to designated facilities, in this case, the recycling hub, where they undergo essential storage and drainage processes. The storage and drainage of ULABs involves classifying the collected ULABs and preparing them for formal recycling. Standardizing ULAB drainage practices is crucial. Different measures should be implemented to distinguish complete ULABs and damaged ULABs, such as those with cracked cases or missing caps, commonly referred to as spent lead-acid batteries, which may be prone to leakage or are already leaking. This has been highlighted in the latest working document under revision for updating technical guidelines by the Small Intersessional Working Group (UNEP, 2024) Also, it is extremely important to distinguish ULAB from other used batteries such as ULIBs to prevent them from entering the ULAB recycling streams (UNEP, 2022).

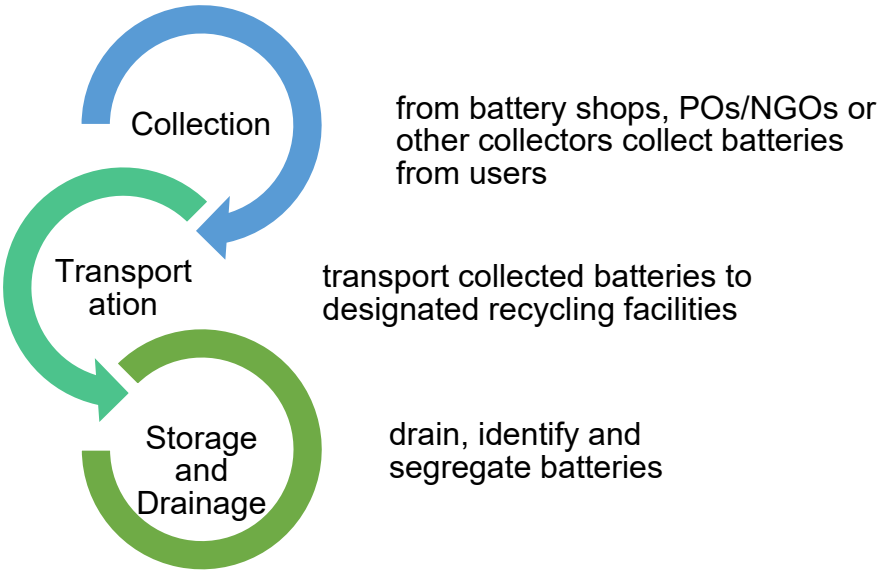


Figure 4: Pre-recycling Steps of ULABs (UNEP, 2003)

Once the pathways for ULAB collection, transportation and segregation are cleared, it is time to consider the relevant necessary facilities and systems for effective recycling. When looking solely at the steps involved in ULAB recycling, both formal and informal recycling follow a similar approach (see Figure 5). However, the key distinction lies in the fact that formal recycling facilities have a comprehensive infrastructure in place that extends beyond the physical recycling process. To date, putting in place the necessary infrastructure remains a key obstacle for the regional recycling hub for ASEAN countries. Leveraging trade agreements and successful practices is therefore essential to secure the resources and support the proper recycling process.

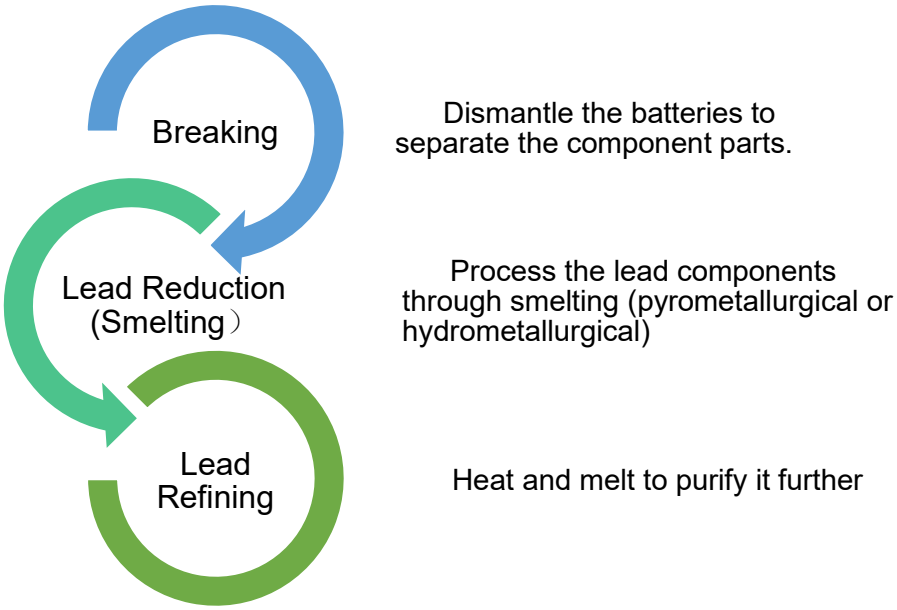


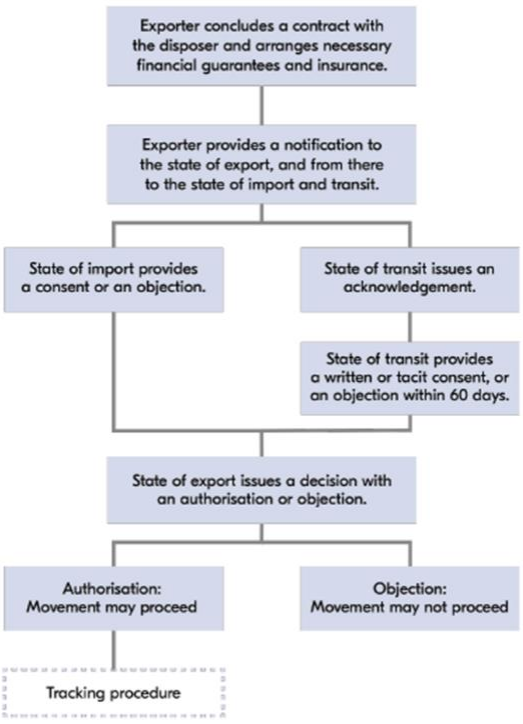
Figure 5: Key steps in ULAB recycling

3. Navigating International Trade and Environmental Agreements to establish a Regional ULAB Recycling Hub

Establishing a regional recycling hub for ULABs requires cross-border trade in ULABs, as a first step. This, in turn, triggers the applicability of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention, 2024). Moreover, cross-border trade requires the clear, consistent, and efficient implementation of HS codes, as well as efforts to address existing border capacity gaps. This section examines these and other trade barriers, while identifying how various provisions in ASEAN can be leveraged to facilitate ULAB trade.

3.1 Navigating the rules of the Basel Convention

All ASEAN countries, and Bangladesh, have signed the Basel Convention. As highlighted earlier, the Basel Convention sets international rules for the movement and management of hazardous wastes, including ULABs. These are classified as hazardous waste under List A of Annex VIII of the Basel Convention, given that they contain lead and sulfuric acid, which can cause significant environmental damage as well as health risks.[3] As a result, cross-border trade of ULABs can happen only if (i) the exporting country does not have the technical capacity and necessary facilities, capacity or suitable disposal sites to dispose of in an ESM way; and (ii) the prior and informed consent procedure (PIC) is followed, which various steps, as illustrated in Chart 3 below; (iii) both parties are members of the convention, unless a separate



[3] On the other hand, the Basel Convention is still in the process of data collection for the recycling of ULIBs due to its only recent emergence in popularity (UNEP, 2022).

agreement is made; (iv) hazardous waste is packaged, labelled and transported in conformity with generally accepted rules and standards (Basel Convention, 2023a).

Chart 3: Main stages of the PIC Procedure (Singapore National Environment Agency, 2024)

Implementing the PIC procedure is time-consuming and costly for companies involved. For instance, in the EU, arranging new PIC notifications can take from 2 months up to 5 years, and the costs often come with administration costs, ranging from free to several thousand euros. The highest cost of a single notification costs EUR 20,000

Prevent Waste Alliance, 2022). Moreover, implementing the PIC process can be very challenging. The Prevent Waste Alliance found that among the national reports submitted to the Secretariat of the Basel Convention, only 56% of shipments were processed, meaning 105 out of 188 reports were received (Prevent Waste Alliance, 2023). So far, the Small Intersessional Working Group on improving the functioning of the PIC First meeting of the Basel Convention is identifying key challenges in implementation (Box 2).

- Difficulty contacting other Competent Authority (CA)
- Failure to communicate receipt, lack of response from CA(s) or slow response from CA(s)
- Different documentation requirements from other CA(s)
- Use of hardcopy forms and post
- Interpretation of the term of “transit”
- Lack of harmonized timelines for decision
- Disagreements on waste classification
- Variation in approaches to financial guarantees
- Confusion over waste definitions/national restrictions
- Notification forms requires updating
- Varying consent dates on approvals
- Transit countries waiting for a decision by CA on import before making a decision
- Having to wait 30 days for tacit consent from transit CAs after the CA of import has approved
- Capacity and resources of some CAs

Box 2: Challenges in the Implementation of the PIC Procedure (Basel Convention, 2024)[4]

In the case of ASEAN and Bangladesh, the limited capacity of some local authorities poses additional challenges for the regional ULAB recycling hub in ASEAN. The implementation of the PIC procedure typically involves several authorities. There are instances where economic operators pay bribes “at the border to conduct the transboundary movement illegally” to ease the process (Prevent Waste Alliance, 2023). Therefore, the lengthy and unpredictable process makes securing a stable supply of ULABs more difficult and could add up to additional operational costs. Currently, the

[4] UNEP/CHW/PIC_SIWG.1/2 is a working document.

Basel Convention UNEP/CHW.16/INF/17 is exploring electronic approaches to the notification and movement of documents under the Basel Convention (Basel Convention, 2023b). This progress will bring new opportunities for establishing a ULAB recycling hub.

At the same time, the distinction between used batteries remains vague and unclear. Unlike the classification of waste plastics into hazardous, easy-to-recycle, and hard-to-recycle plastic waste, the Basel Convention lacks detailed criteria for classifying ULABs (Basel Convention, 2019). This results in ULABs with varying efficiency and conditions being categorized and processed under the same procedures. To establish a more effective recycling framework, it is crucial to develop clear and standardized criteria for the classification of ULABs and link this classification with the WCO Harmonized System. It is already listed as a prioritization area by the Basel Convention, which will be discussed in a later section.

Although the Prior Informed Consent (PIC) procedure and requirements under the Basel Convention may complicate the trade of ULABs, Article 11 of the Basel Convention provides opportunities for trade facilitation within its framework. Specifically, under Article 11, the Basel Convention allows parties to establish bilateral, multilateral, or regional agreements for the transboundary movement of hazardous or other wastes. These agreements can be made with both Parties and non-parties, provided they uphold the ESM of hazardous and other wastes (Basel Convention, 2023a).[5]

Leveraging Article 11 could also apply to ASEAN countries and Bangladesh to sign either bilateral or regional agreements in the trade of hazardous waste, or specifically for ULABs and ULIBs. An Article 11 arrangement could be used to classify end-of-life products, including waste, scrap and secondary materials, harmonize or mutually recognize regulations or standards, or working practices with regards to implementing the PIC procedure; and/or a list of pre-consented facilities where the parties to the agreement have ensured that waste is delivered to, and processed, in a proper manner. Moreover, it could set out a fast-track procedure for the shipment of waste destined for vetted facilities. Such agreements could streamline the implementation of the PIC procedure, enhance consistency in waste management practices, and facilitate the secure supply of used batteries to the recycling hub.

[5] For example, this approach has been used by countries or regions seeking more cost-effective and simplified trade in waste. For example, the countries of the Organisation for Economic Co-operation and Development (OECD) adopted the *Decision concerning the Control of Transboundary Movements of Wastes Destined for Recovery Operations* in 2001 (OECD, 2001). This decision established a controlled system to facilitate trade in recyclables in an ESM manner using simplified procedures and a risk-based approach. Similarly, the U.S. has developed a series of bilateral agreements for the transboundary movement of hazardous waste with countries such as Canada, Mexico, Costa Rica, Malaysia, and the Philippines. These agreements offer safe, low-cost solutions for managing waste where domestic capacity or appropriate technology is lacking (US EPA, 2024).

3.2 Harmonization and Specification of the HS Code

To facilitate trade of ULABs for a regional recycling plant, it would be important to be able to identify and differentiate ULABs from spent LABs, which pose a higher risk of lead exposure compared to intact ULABs to their damaged or broken condition. Therefore, it is crucial to distinguish spent LABs from ULABs, particularly during the battery storage and drainage stage in the pre-recycling process. It will increase the efficiency of recycling at recycling plants while also ensuring that each step is conducted in an ESM way.

However, spent LABs and ULABs are within the category of the Harmonized Commodity Description and Coding System, generally referred to as Harmonized System (HS). [6] Indeed, ASEAN countries use the ASEAN Harmonized Tariff Nomenclature (AHTN) which is a regional adaptation of the WCO HS. Similar to the WCO-HS, the AHTN classifies ULABs under code-8549.11, which corresponds to "waste and scrap of lead-acid accumulators; spent lead-acid accumulators" as further detailed in Figure XX below.[7]

Heading	H.S. Code	
85.48	8548.00	**Electrical parts of machinery or apparatus, not specified or included elsewhere in this Chapter.**
85.49		**Electrical and electronic waste and scrap.**
		- Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators :
	8549.11	-- Waste and scrap of lead-acid accumulators; spent lead-acid accumulators
	8549.12	-- Other, containing lead, cadmium or mercury
	8549.13	-- Sorted by chemical type and not containing lead, cadmium or mercury
	8549.14	-- Unsorted and not containing lead, cadmium or mercury
	8549.19	-- Other
		- Of a kind used principally for the recovery of precious metal :
	8549.21	-- Containing primary cells, primary batteries, electric accumulators, mercury-switches, glass from cathode-ray tubes or other activated glass, or electrical or electronic components containing cadmium, mercury, lead or polychlorinated biphenyls (PCBs)
	8549.29	-- Other
		- Other electrical and electronic assemblies and printed circuit boards :
	8549.31	-- Containing primary cells, primary batteries, electric accumulators, mercury-switches, glass from cathode-ray tubes or other activated glass, or electrical or electronic components containing cadmium, mercury, lead or polychlorinated biphenyls (PCBs)

Figure 7: ULABS Classification under WCO-HS

[6] It is a multipurpose international product nomenclature developed by the World Customs Organization (WCO). The HS ensures consistency and simplicity in international trade. It is essential for customs procedures, trade facilitation, negotiations, and the collection of vital trade statistics (WCO, n.d.).

[7] For the purposes of subheadings 8549.11 to 8549.19, "spent primary cells, spent primary batteries and spent electric accumulators" are those which are neither usable as such because of breakage, cutting-up, wear or other reasons, nor capable of being recharged."

Hdg. No.	AHTN 2022 Code	Description	MFN Rates of Duty (%)					
			2024		2025	2026	2027	2028
			01 Jan – 21 Jul	22 Jul – 31 Dec	Starting 01 Jan			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
85.46		**Electrical insulators of any material.**						
	8546.10.00	- Of glass	3	3	3	3	3	3
	8546.20	- Of ceramics :						
	8546.20.10	- - Transformer bushings and circuit breaker insulators	10	10	10	10	10	10
	8546.20.90	- - Other	10	10	10	10	10	10
	8546.90.00	- Other	1	1	1	1	1	1
85.47		**Insulating fittings for electrical machines, appliances or equipment, being fittings wholly of insulating material apart from any minor components of metal (for example, threaded sockets) incorporated during moulding solely for purposes of assembly, other than insulators of heading 85.46; electrical conduit tubing and joints therefor, of base metal lined with insulating material.**						
	8547.10.00	- Insulating fittings of ceramics	7	7	7	7	7	7
	8547.20.00	- Insulating fittings of plastics	10	10	10	10	10	10
	8547.90	- Other :						
	8547.90.10	- - Electrical conduit tubing and joints therefor, of base metal lined with insulating material	7	7	7	7	7	7
	8547.90.90	- - Other	7	7	7	7	7	7
85.48	8548.00.00	**Electrical parts of machinery or apparatus, not specified or included elsewhere in this Chapter.**	5	5	5	5	5	5
85.49		**Electrical and electronic waste and scrap.**						
		- Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators :						
	8549.11	- - Waste and scrap of lead-acid accumulators; spent lead-acid accumulators :						
		- - - Lead-acid scrap storage batteries, drained or undrained :						
	8549.11.11	- - - - Of a kind used in aircraft	3	3	3	3	3	3
	8549.11.12	- - - - Other, of subheading 8507.10.92, 8507.10.95, 8507.20.94 or 8507.20.95	3	3	3	3	3	3
	8549.11.19	- - - - Other	3	3	3	3	3	3
	8549.11.20	- - - Waste and scrap containing mainly iron	10	10	10	10	10	10
	8549.11.30	- - - Waste and scrap containing mainly copper	10	10	10	10	10	10
		- - - Other :						
	8549.11.91	- - - - Of a kind used in aircraft	10	10	10	10	10	10
	8549.11.92	- - - - Other, of subheading 8507.10.92, 8507.10.95, 8507.20.94 or 8507.20.95	10	10	10	10	10	10

Figure 8: Classification of ULABs under AHTN

In order to make a clear differentiation between ULABs and spent batteries, it is recommended that the ULABs should have a separate classification under both WCO-HS as well as AHTN codes. The AHTN system already permits further classification up to 10 digits for facilitating trade which can be leveraged in this case. The WCO also gives a high priority to periodic updating of the HS codes system to be in harmony with technological developments and changes in trade patterns (WCO, n.d.). The WCO can manage this process through the Harmonized System Committee (representing the Contracting Parties to the HS Convention), which examines policy matters, takes decisions on classification questions, settles disputes and prepares amendments to the Explanatory Notes. The HS Committee can prepare amendments updating the HS every 5 – 6 years.

Therefore, in terms of procedure, the proposal for a separate classification for ULAB, which is recyclable, could be made possible both at the WCO as well as AHTN. However, for this to happen, there must be a shared understanding between the

ASEAN countries about the interpretation of spent batteries as per notes under Chapter 85, which is distinguishable from ULABs. This may take a considerable amount of time and could be further prolonged due to the technical difficulty in distinguishing ULABs. Theoretically, given that spent LABs are damaged batteries due to wear and tear or other reasons, there is a possibility that spent batteries will be physically different from ULABs. However, it would be hard sometimes to distinguish when the package remains intact, but the inside electrodes are broken. No matter how challenging the classification process may be, countries should bring it into the discussion and support it with additional technological inputs over time.

With regard to LIBs, the HS code system classifies them under the 6-digit code- 8507.60 (WCO, n.d.). Currently, there is no distinct categorization for ULIBs, let alone specific subcategories differentiating between ULIBs intended for repurposing and those designated for recycling. The absence of such classification will generate energy loss and inefficiency. However, there is still significant uncertainty regarding how to effectively categorize ULIBs for repurposing or recycling. The Basel Convention is currently working on the inventories of waste batteries containing lithium, which involves ULIBs (Basel Convention, 2022). More scientific information is important for establishing clear and standardized assessment criteria to direct the ULIBs to appropriate end-of-life pathways in the future.

Box 8: HS code system for LIBs and ULIBs

3.3 Border Capacity Building

Both the requirements under the Basel Convention and the HS require robust border control mechanisms for effective implementation. However, this remains a significant challenge for many ASEAN member states, and even countries in the world (Basel Convention, 2024).

One model that could potentially be applied to alleviate border capacity pressure for the cross-border trade of ULABs and ULIBs is the "Green List" system. This system designates a list of “fast-track” companies at customs, which have a proven good practice of adhering to the PIC procedure and the HS classifications. By streamlining the customs process for these trusted companies, the Green List system helps to reduce common challenges such as lack of planning, poor coordination among sectors and stakeholders, and weak enforcement by local authorities (WEF, 2021).

It can significantly alleviate the border capacity challenges for companies, especially micro, small, and medium-sized enterprises (MSMEs), which account for between 97.2% and 99.9% of total establishments in ASEAN Member States (ASEAN, n.d.). These MSMEs are also potential candidates for the business of ULAB trade, yet they often face limitations such as a lack of skilled manpower, institutional capacities, and financial resources to comply with international and domestic regulatory requirements

(Department of Economic and Social Affairs (DESA), 2020). Therefore, the “Green List” systems may be applicable to address these challenges.

3.3 Leveraging ASEAN Trade Agreements

3.3.1 Trade in Goods within ASEAN

As discussed before, cross-border trade in ULABs is a complicated matter. How to relieve the barriers to the transboundary movement of used batteries is essential to optimize the recycling process. ATIGA, with its provisions for facilitating the free flow of goods in the region, offers a legal framework to address some of these challenges and establish a cohesive system for ULAB recycling within ASEAN. There are several provisions in the agreement pertaining to trade facilitation that can be leveraged.

To bridge the information gap that exists between different countries with the ASEAN group, Article 47(i) of ATIGA could be used as an instrument. Even with regard to enforcing registration requirements, these provisions can be used to create a centralized system within ASEAN which can help enhance the transboundary movement of ULABs and also the movement of recycled LABs (ATIGA, 2009).

Article 47 (ii) can be leveraged to enhance the involvement of the private sector. The private sector is crucial for enhancing the uptake of recycled ULABs and for significant development towards a circular approach. This provision can be leveraged by bringing together the small business community, including the e-rickshaw drivers across all ASEAN members to spread awareness of the harmful effects of informal recycling and encourage more uptake of ULABs. Also, this provision can ensure the active participation of essential stakeholders while making the process participatory and democratic (ATIGA, 2009).

3.3.2 Investment and Technological Exchanges

At the same time, it is crucial to recognize that the establishment of recycling hubs will not be feasible without sufficient investment. Currently, companies have already expressed frustration in entering the ULAB recycling market. Additionally, inconsistencies in battery recycling legislation across ASEAN member states further exacerbate the challenges for businesses, creating significant barriers to market entry and regulatory compliance. The varying legal frameworks and standards across the region complicate investment decisions, leading to uncertainties regarding operational requirements, environmental obligations, and cross-border trade regulations. Addressing these challenges requires a harmonized regulatory approach and targeted investment incentives to create a more attractive and supporting business environment for battery recycling in ASEAN. To face this challenge, the ASEAN Comprehensive Investment Agreement (ACIA) can play a vital role.

ACIA aims to promote a conducive investment climate across the region. However, it should be noted that the ACIA does not explicitly classify or include recycling within the listed sectors under Article 3 (ASEAN, 2012). However, if the principle of EPR were applied, ULAB recycling—and recycling in general—could be recognized as an extended value chain of manufacturing, aligning it more closely with existing trade and investment structures.

First, ACIA can attract investment as it seeks to simplify investment procedures for companies, including those interested in ULAB or ULIB recycling. Article 25 encourages the establishment of a One-Stop Investment Centre (OSIC). (ASEAN, 2012). This government- or agency-led initiative aims to streamline and centralize investment processes, offering investors a single hub for accessing services, guidance, and information necessary for starting and operating businesses or making investments. By reducing bureaucracy and promoting efficiency and transparency, the OSIC can attract both domestic and Foreign Direct Investment (FDI). In the context of ULAB and ULIB recycling, such a measure is particularly important given the diverse laws and regulations governing ULAB and ULIB manufacturing and recycling across ASEAN member countries.

Moreover, Article 24(c) of ACIA emphasizes organizing missions to promote regional clusters and production networks, which is a key provision for investment promotion and facilitation of establishing regional hubs (ASEAN, 2012). These missions can connect investors with different stakeholders, including automotive companies, waste management firms, NGOs and government agencies. For recycling used batteries, these missions should focus on providing investors with comprehensive information on national investment frameworks, environmental regulations, and legislation relevant to ULAB and ULIB recycling. It is essentially important because recycling plants are usually governed by the Ministry of Economy and Industry, Environment, and Health collaboratively, which is subject to various regulations and involves multiple stakeholders. Additionally, the information-sharing activities, such as seminars and briefings outlined in Article 24(d), can further enhance transparency and support informed decision-making.

Technological capacity presents a significant challenge for recycling plants in some countries, where outdated technology contributes heavily to pollution. In Lao PDR, for example, formal recycling facilities of ULABs rely on older, high-emission processes that negatively impact the environment and surrounding communities. Consequently, the country’s only recycling plant was shut down, with no replacement established so far, underscoring the urgent need for technological upgrades to enable sustainable and safe recycling practices (MONRE, 2023).

To bridge the technology and infrastructure gap, Article 17 of the ATIGA consists of provisions related to capacity building to be provided through the effective implementation of programmes to strengthen individual member states’ domestic capacity, efficiency and competitiveness (ASEAN, 2009). This provision can be

leveraged to enhance capacity building and technical assistance by states within ASEAN that have made significant progress with regard to recycling and waste management of ULABs and ULIBs to countries within ASEAN that do not have the requisite technology or infrastructure.

Also, the ASEAN Infrastructure Fund (AIF) under the Asian Development Bank (ADB) provides a robust platform for mobilizing regional resources and driving sustainable progress within ASEAN. On the one hand, the establishment and management of recycling facilities for ULABs falls directly under the focus of the ASEAN Catalytic Green Finance Facility (ACGF) (ADB, n.d.). The ACGF is a mechanism under AIF dedicated to catalyzing investments in projects that contribute to environmental sustainability and climate resilience, while also enabling ASEAN countries to adopt advanced technologies for greener, more efficient infrastructure (ADB, n.d.). Therefore, countries can solicit funds from the ACGF to access targeted support for ULAB infrastructure construction.

Meanwhile, Green and Inclusive Infrastructure Window (GIIW) another mechanism under AIF, is one of the few external agreements within the ASEAN context that has provisions relating to the promotion of the circular economy. Projects that incorporate renewable energy, energy efficiency, and sustainable resource use are prioritized under GIIW.

ULAB recycling in this case align closely with GIIW’s objectives. Therefore, ASEAN member states can seek concessional financing (i.e., low-interest loans or grants) from GIIW to make ULAB recycling projects green and inclusive projects more attractive and feasible, particularly in countries with limited access to capital. It also promotes public-private partnerships (PPPs) to involve the private sector in financing and implementing green infrastructure projects.

3.3.3 Trade in Services within ASEAN

Another important aspect of ULAB recycling is human capacity building, which means the facilities should be equipped with professional engineers to ensure that the recycling process is conducted in an ESM manner and workers are in a safe condition. It may include environmental, chemical, mechanical, industrial, electrical, safety and quality control engineers.

To get access to the team of engineers and technicians, it is crucial to leverage the ASEAN Mutual Recognised Agreement on Engineering Services (MRA-Engineering). This agreement, pertaining specifically to engineering services, can be leveraged to facilitate smooth access to the talent pool of engineers in ASEAN.

Article 1 of the MRA-Engineering outlines the agreement's objectives to facilitate mobility, share information, and promote best practices in engineering standards and qualifications (ASEAN, 2005). Different ASEAN countries have differing levels of

standards, qualifications and expertise when it comes to engineers. Since ULAB recycling facilities require specialized services, qualified engineers from one ASEAN country could work on ULAB or ULIB-related projects in another without undergoing duplicative registration processes, speeding up the implementation of recycling facilities or compliance programs.

By leveraging Article 5 of MRA-Engineering, environmental engineering can be recognized as a specialization under the Mutual Recognised Arrangement (MRA) to ensure engineers in this domain can benefit from mutual exemptions (ASEAN, 2005). Also, Article 6 can be applied to the assessment at the Professional Regulatory Authority (PRAs). The Assessment can integrate environmental and hazardous waste management skills into the standards they monitor, ensuring engineers involved in ULAB and ULIB projects meet consistent qualifications and experience requirements.

Moreover, to secure investments and technology for ULAB recycling facilities, ASEAN Member States should prioritize liberalization efforts under the ASEAN Framework Agreement on Services (AFAS), the Mutual Recognition Arrangements (MRA), and the ASEAN Comprehensive Investment Agreement (ACIA). These frameworks can facilitate the establishment and expansion of Mode 3 participation (commercial presence) in the recycling sector. In particular, joint ventures, mergers, acquisitions, and cross-border collaborations in professional services for ULAB recycling are effective trade liberalization tools. The formation of ASEAN-wide firms in professional services could pool resources a nd technical expertise to address the region's recycling needs more effectively.

The rationale presented for Used Lead-Acid Batteries (ULABs) in Sections 3.3.1 (Trade in Goods), 3.3.2 (Investment and Technological Exchanges), and 3.3.3 (Trade in Services) is equally applicable to Used Lithium-Ion Batteries (ULIBs). While ULIBs differ in chemical composition and recycling technology, the underlying needs—such as facilitating cross-border trade, attracting sustainable investment, harmonizing regulatory frameworks, and mobilizing qualified engineering and technical expertise—remain the same. Given the growing volume and environmental risks associated with ULIBs, it is essential that ASEAN applies a consistent and integrated approach to both battery types to support the development of a regional circular economy.

Box 9: Unified Rationale for ULAB and ULIB Recycling

3.4 Public Engagement in the Recycling of ULABs

Apart from establishing a cross-border trade framework, a fundamental aspect of supporting the circularity of batteries is ensuring active participation from the general public—particularly the informal sector—throughout the entire battery life cycle. In this context, the concept of Extended Producer Responsibility (EPR) can play a pivotal role in designing effective national take-back systems. “Extended producer responsibility (EPR) is “an environmental policy approach in which a producer’s responsibility for a product is extended to the post-consumer stage of a product (Basel Convention, 2017). In the case of LABs, it means manufacturers and retailers are held accountable for the collection of batteries and channel the collected ULABs to authorized recycling facilities. The cost of environmentally sound collection, sorting, treatment, and disposal of batteries can be reflected in product prices. EPR programmes could potentially alleviate the legislation enforcement pressure in ASEAN and Bangladesh for ULABs and ULIBs recycling because it will shift the responsibility for end-of-life management from local government authorities and taxpayers to producers and can create incentives for producers to incorporate environmental considerations into the lifecycle of batteries.

However, EPR is a concept that is not applied in all ASEAN nations. Some nations have currently initiated pilot EPR projects focused on plastic recycling. However, only a few have developed plans for battery recycling, including Vietnam, Thailand, the Philippines (Box 10) and Singapore.

Therefore, it is crucial for countries to incorporate EPR principles into policymaking. For the design of EPR, countries can draw experiences from plastic or textile recycling, while also bearing in mind that the weight and bulkiness of LAB may impede consumer’s willingness and accessibility to the scheme compared to plastics. It is especially important to consider that in developing countries, sometimes battery retailers or collection points may be far away. A more feasible solution in the case of ASEAN would be to link the retailers, garages, repair shops, or breaker yards with ULAB removal services from scrap vehicles (UNEP, 2004). It is also a way to incorporate the informal sector into the collection process. The successful function of this collection mode needs to ensure that transportation to collection points is managed in an ESM way and is also accessible to the local communities.

Box 10: Philippines EPR Law 2022

An example of EPR regulation within ASEAN, worth examining, is the Extended Producer Responsibility (EPR) Act of 2022 enacted by the Philippines with regard to plastic packaging with the objective of addressing its contribution to global marine plastic pollution and achieving plastic neutrality, which is defined as "a system or its desired outcome where, for every amount of plastic product footprint created, an equivalent amount thereof is recovered or removed from the environment by the product producers through an efficient waste management system" (Congress of Philippines, 2022). Previously, manufacturers were only responsible for the impact of the actual production of their products but consequent to the enactment of the new regulation, product manufacturers will be held responsible for the entire life cycle of their product, i.e. from manufacture, to use, and to end-of-life. Under this law, companies are mandated to register their EPR program with the National Solid Waste Management Commission, and failure to do so incurs penalties for the obligated enterprise (Congress of Philippines, 2022). It is relevant to note that this regulation does not result in added accountability or burden on the local governments units (LGUs), as obligated enterprises enter partnerships with LGUs, communities engaged in waste retrieval. This element is crucial in determining the feasibility of the measure itself. It is worth analysing if this type of regulation can enable local government units within the Philippines to implement EPR regulation in respect of ULABs. It is worth analyzing if a parallel regulation on similar lines can be implemented with respect to ULABs.

The EPR law for ULABs can potentially be designed with the objective of achieving LAB neutrality- by extending the responsibility of producers to recycle a required amount of LABs which are necessary to offset its product footprint. For this reason, it would be essential to calculate the product footprint of LABs which encompass a range of factors, including resource use, energy consumption, emissions, waste generation, and potential environmental and health risks.

To raise public awareness of EPR and increase willingness to participate in the take-back scheme, countries or manufacturers may consider the recommendations from the Basel Convention National Management Plans for ULABs. It suggests two options to encourage proper battery collection schemes: deposit/refund or a percentage discount system. These approaches incentivize consumers to return used batteries responsibly by either providing a refundable deposit when batteries are returned or offering a discount on new battery purchases when old ones are traded in (UNEP, 2004).

Box 11: Complexities of Applying EPR on ULIBs

Implementing EPR for ULIBs presents significant logistical challenges. Unlike lead-acid batteries, ULIBs are often embedded in products such as electric vehicles, scooters, and electronics, making them difficult and sometimes dangerous to dismantle. Their weight, high energy density, and risk of fire or explosion during handling and transport create serious safety and infrastructure concerns. As such, designing EPR schemes for ULIBs requires special attention to safe collection methods, protective packaging, and transport regulations—factors that may limit the feasibility of wide-scale EPR rollouts in certain ASEAN Member States.

4. Bangladesh and ASEAN

As Bangladesh is not an ASEAN Member State and establishing a ULAB recycling hub in ASEAN faces tariff and technology constraints, locating the hub within an ASEAN country may be a more viable option. In this context, exploring how Bangladesh can benefit from this hub is essential, particularly as the country seeks new opportunities for economic growth, geopolitical influence, and strategic connectivity amid recent political uncertainty following the fall of Sheikh Hasina's regime. There are two scenarios that Bangladesh can consider.

Scenario 1: Bangladesh joining ASEAN

One of the compelling options is the proposition of Bangladesh joining ASEAN (The Business Standard, 2024). Recent developments demonstrate that Bangladesh is in the process of considering this option when Chief Advisor Muhammad Yunus sought Indonesia's support in its bid to join ASEAN (DhakaTribune, 2024).

Integrating into ASEAN could provide Bangladesh with access to technology transfer, partnerships, and expertise that could accelerate innovation. Bangladesh is set to graduate from the Least Development Countries (LDC) category to the ‘developing country’ category by the end of 2026 (The Daily Star, 2024). As an LDC, Bangladesh has enjoyed preferential access for its exports to many countries. Graduating from the LDC category may result in Bangladesh losing such preferential treatment, after which Bangladesh will need to attract foreign investment. A UNCTAD study from 2023 projected a potential loss of export earnings as a result of losing the Most Favored Nation (MFN) tariffs and withdrawal of the Duty-free Quota-free (DFQF) facilities (UNCTAD, 2023). To fill this gap, ASEAN membership or deeper economic integration with ASEAN could offer Bangladesh alternative trade and investment opportunities.

Furthermore, ASEAN membership could allow Bangladesh to integrate into regional supply chains, particularly in high-value industries such as electronics, automotive, and advanced manufacturing. For Bangladesh, joining ASEAN could formalize ULAB

recycling by leveraging the trade and investment provisions under AFTA and ACIA. Additionally, Bangladesh currently imposes a 25% import tariff on ULABs, which could be negotiated for reduction or elimination. ACIA's investment facilitation mechanisms, such as one-stop investment centers, could further support Bangladesh in attracting foreign investment and streamlining industrial operations.

Scenario 2: Bangladesh signs special agreement with ASEAN

Another feasible alternative worth exploring is the establishment of a special agreement among ASEAN member states under Article 11 of the Basel Convention, with the specific objective of creating a regional recycling hub. Such an agreement could provide a structured framework to address key aspects, including tariff reduction or elimination for the trade of ULABs, trade facilitation measures, and the development of essential infrastructure for the regional recycling facility specifically between ASEAN and Bangladesh. By leveraging this mechanism, ASEAN countries can also have more harmonized policies that promote efficient and ESM of ULABs, fostering regional cooperation and advancing the circular economy.

5. Summary of recommendations

- **Governmental and Policymakers:**
  - The circularity of ULABs and ULIBs in ASEAN and Bangladesh: Consider easing export and import restrictions and reducing tariffs in the case of Bangladesh. It is a prerequisite for countries that aim to establish themselves as regional recycling hubs and crucial for ensuring a steady and economically viable supply of used batteries to achieve economies of scale.
  - Compliance with International Agreements and Standards: Streamline and simplify procedures and strengthen border capacity building. Countries can consider establishing a "Green List" system for companies with good track records in regulatory compliance or import licensing schemes or digital platforms for companies in the trade of ULABs and/or ULIBs to speed up the import approval and monitoring procedure.
  - EPR and takeback programs: Establish EPR regulations on ULABs and/or explore the possibility of utilizing the already existing regulatory frameworks under EPR laws (like the Philippines' EPR law 2022 on plastic packaging) and applying them to the context of ULABs. The government should also seek to collaborate with the battery industries by providing incentives to establish battery takeback programs to engage the general public, especially individuals from the informal sector.
  - ASEAN Trade Agreements: Continue leveraging trade agreements like ATIGA, ACIA, and MRA-Engineering etc., to reduce trade barriers, attract foreign investment for recycling infrastructure, and foster collaboration on technology and expertise.

- **International Cooperation:**
  - HS Code: Revisit the ASEAN Harmonised Tariff Nomenclature as well as the HS (WCO) system and explore the possibility of creating a distinction between ‘used’ LABs and ‘spent’ LABs, as well as LIBs and ULIBs.
  - Basel Convention and PIC procedure: Promote international collaboration in exploring digital solutions for implementing the PIC procedure, with the ASEAN region potentially serving as a pilot example.
- **Scientists and researchers:**
  - Undertaking the exercise of calculating the product footprint of ULABs and ULIBs which will help in mapping the required amount of ULAB and ULIB recycling to achieve neutrality.
  - Advancing scientific research on ULABs and ULIBs, including tools for battery performance evaluation, classification standards, recycling, and monitoring methods with less environmental impact. Also, researchers should continuously explore the inventories of ULIBs and identify the criteria between recycling and repurposing of ULIBs.

5. Conclusion

To conclude, there are several reasons that justify our proposal for establishing regional recycling hubs within ASEAN (including Bangladesh) to address the adverse environmental and public health effects resulting from the unsafe and informal recycling practices of ULABs, as well as the inadequate and unsustainable recycling and disposal practices of ULIBs. The health issues vary from damage to kidneys, brain, and blood cells leading to anemia, for repeated exposure, bronchitis, emphysema, chronic nosebleeds, and death (ESDO, 2021). With regards to the environment, effects vary from ‘threats to aquatic and terrestrial ecosystems’ and biodiversity. Throughout the value chain, from collection to disposal, there are five to six tools that can be leveraged by utilising trade agreements. The strict adoption of the four key stages of the PIC procedure under the BC; (1) notification in writing, (2) consent and issuance, (3) detailing the transboundary movement and (4) confirmation of disposal of ULABs (Basel Convention, 2024). The PIC procedure holds exporting and importing countries to account by not exempting them from upholding its core obligations and legally binding them to exhaust all likely and achievable avenues to protect human health and the environment (Basel Action Network, 2023).

Aside from the PIC procedure, the BC has an established legal framework, which is another tool that facilitates efforts in establishing regional recycling hubs amongst ASEAN and Bangladesh. Notably, most of the ASEAN countries and Bangladesh have not established dedicated laws to manage ULABs creating inconsistencies and setbacks in the value chain of the recycling process to disposal. Discrepancies vary

from border incapabilities (unskilled CAs/technical assistants), risk of illegal traffic, longer delays, unsafe and unsustainable recycling/repurposing and disposing practices. Regulatory frameworks can outline recycling infrastructures for ULABs and ULIBs, incorporating provisions that consider recycling/repurposing/disposing technologies, as well as financial incentives for recycling facilities and ESM practices. This creates a better platform for international cooperation to standardize appropriate recycling processes and promote global best practices (REECOLLABB, 2024).

The Harmonised System and its classification of goods can make it challenging to establish regional hubs. Indeed, under the HS, it is hard to distinguish batteries intended for recycling from those that do not require it, to when non-recyclable batteries are mistakenly put into the recycling stream which has a knock-on effect such as the additional sorting efforts being strained on resources, operational complexity and unnecessary costs further increases (WEF, 2020).

In light of these challenges, there are other beneficial tools, such as AFTA, AIF, and ACIA, that can enhance cross-border capabilities and provide a robust infrastructure to assist in creating regional recycling hubs. AFTA plays a vital role by reducing the tariff rates to no more than 5%, eliminating all import duties, and aligning national standards with international standards. As AFTA is widely used by companies in ASEAN countries, specifically for exports, we can use this agreement to advocate for more use of formal recycling practices and foster cohesion to build regional recycling hubs. ACIA promotes a conducive investment climate across the region, which can attract investment as it seeks to simplify investment procedures for companies, including those interested in ULAB recycling. This encourages regional clusters and production networks, which is a key provision for investment promotion and facilitation of establishing regional hubs.

In order to meaningfully utilize trade agreements to establish regional recycling hubs, the level of cohesion required amongst ASEAN countries and Bangladesh cannot be underestimated. Collaborative efforts need to infiltrate all levels of government and the necessary stakeholders like the legislators, local authorities, private companies (manufacturers, buyers), workers at the informal battery shops all need to be proactively engaged to make a meaningful impact. This also applies whether Bangladesh decides to join ASEAN or not. There is a stronger case of why Bangladesh should join ASEAN as opposed not being a member. Bangladesh can integrate into regional supply chains, particularly in high-value industries like electronics, automotive, and advanced manufacturing. Recently, Vietnam’s ASEAN membership facilitated its emergence into a global manufacturing hub. Bangladesh can utilize ASEAN’s legal frameworks in formalising the recycling of ULABs by leveraging the innovative provisions in the AFTA and ACIA. As for AIF, the resources pooled can be used to tackle the technological and economic barriers of ULIBs by providing incentives to lower costs of repurposing batteries. Bangladesh currently has an import tariff of 25% on the ULABs which can be brought to zero upon joining ASEAN.

Nevertheless, whether Bangladesh decides or not, any meaningful effort rests upon much needed international cooperation giving effect to the trade agreements such as the PIC procedure, the heart of the Basel Convention control system, reduction of tariffs, harmonization of regulations and investments to establish regional recycling hubs. It is important to note that Informal recycling is exclusive to ULABs. With regards to ULIBs, their recycling process is more intricate therefore the recycling practices are generally formalised and their main challenge lies more in collection than recycling itself. Overall, addressing the trade issues in establishing regional recycling hubs for ULABs and ULIBs is one part of the problem. If we are to have functioning regional recycling hubs that promote circularity, we need to address many aspects like education, technology, economies to make a strong case for establishing regional recycling hubs for ULABs.

Bibliography

Alistair, J., Binks, S., & Gediga, J. (2016). “Lead Industry Life Cycle Studies: Environmental Impact and Life Cycle Assessment of Lead Battery and Architectural Sheet Production”. *The International Journal of Life Cycle Assessment.* Vol.21, 1624-1636. https://doi.org/10.1007/s11367-015-1021-5.

Asian Development Bank (ADB) and ASEAN Green Finance Facility (ACGF) (2021), “ASEAN Catalytic Green Finance Facility 2019-2020”. Retrieved from: https://www.adb.org/sites/default/files/institutional-document/670821/asean-catalytic-green-finance-facility-2019-2020.pdf.

Asian Development Bank (2024, Oct.23), “How strengthened regulations and healthcare can prevent lead poisoning”. Retrieved from: https://blogs.adb.org/blog/how-strengthened-regulations-and-healthcare-can-prevent-lead-poisoning. (Accessed Jan.5, 2025).

Asian Development Bank (ADB) (n.d.), “ASEAN Catalytic Green Finance Facility (ACGF)”. Retrieved from: https://www.adb.org/what-we-do/funds/asean-catalytic-green-finance-facility/overview. (Accessed Jan. 20, 2025).

ASEAN (2005), “ASEAN Mutual Recognition Agreement on Engineering Services”. Retrieved from: https://agreement.asean.org/media/download/20150119180933.pdf.

ASEAN (2009), “ASEAN Trade in Goods Agreement”. Retrieved from: https://asean.org/wp-content/uploads/2021/09/22223.pdf.

ASEAN (2012), “ASEAN Comprehensive Investment Agreement”. Retrieved from: https://agreement.asean.org/media/download/20140119035519.pdf.

ASEAN (n.d.), “Overview: Development of Micro, Small and Medium Enterprises in ASEAN (MSME)”. Retrieved from: https://asean.org/our-communities/economic-community/resilient-and-inclusive-asean/development-of-micro-small-and-medium-enterprises-in-asean-msme/. (Accessed Feb.3, 2025).

ASEAN (2024, Feb.2), “Indonesia’s Electric Battery Industrial Strategy”. Retrieved from: https://www.aseanbriefing.com/news/indonesias-electric-battery-industrial-strategy/.

Attina, T. M., & Trasande, L. (2013). “Economic costs of childhood lead exposure in lowand middle-income countries.” *Environmental Health Perspectives*, 121(9), 1097-1102. DOI: 10.1289/ehp.1206424.

Baars, J., Domenech, T., Bleischwitz, R. et al.(2021), “Circular economy strategies for electric vehicle batteries reduce reliance on raw materials”. *Nat Sustain* 4, 71–79 https://doi.org/10.1038/s41893-020-00607-0.

Bangladesh Customs (n.d.), “Bangladesh Customs Tariff, Chapter 85”. Retrieved from: https://nbr.gov.bd/uploads/tariff_schedule/Chapter-855.pdf. (Accessed Jan. 19, 2025).

Batteiger, Alexander, and Vera Susanne Rotter. (2018), "Material Implications of Rural Electrification—A Methodological Framework to Assess In-Use Stocks of Off-Grid Solar Products and EEE in Rural Households in Bangladesh" *Recycling* 3, No. 1, 7. https://doi.org/10.3390/recycling3010007.

Basel Convention (2004), “Training Manual: National Management Plans for Used Lead Acid Batteries”, https://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/tm-ulab/tm_ulab.pdf.

Basel Convention (2023a), “The original convention on the control of transboundary movements of hazardous wastes and their disposal and Basel Protocol on Liability and Compensation”. Retrieved from: https://www.basel.int/theconvention/overview/textoftheconvention/tabid/1275/default.aspx

Basel Convention (2024b), “Small Intersessional Working Group on improving the functioning of the prior informed consent procedure First meeting: Report on challenges in the implementation of the prior informed consent procedure and best practices, possible approaches and initiatives to improve its functioning, as well as options for possible ways forward”. Retrieved from: https://www.basel.int/Default.aspx?tabid=9753.

Basel Convention (n.d.), “Basel Convention Country Fact Sheet”. Retrieved from: https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-CFS-Thailand-1.English.doc. (Accessed Jan.17, 2025).

Basel Convention (2023b), “Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Sixteenth meeting: Report, including recommendations, on the next steps regarding the work on electronic approaches to the notification and movement documents under the Basel Convention”. Retrieved from:https://www.brsmeas.org/2023COPs/Meetingsdocuments/tabid/9373/language/en-US/Default.aspx.

Basel Convention (2019), “Amendments to Annexes II, VIII and IX to the Basel Convention”. Retrieved from:

https://www.basel.int/Implementation/Plasticwaste/PlasticWasteAmendments/FAQs/tabid/8427/Default.aspx.

Basel Convention (2017), “Open-ended Working Group of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Fourteenth meeting: Technical Guidelines on the environmentally sound management of waste batteries other than waste lead-acid batteries (UNEP/CHW/OEWG.14/INF/10/Rev.1)”. Retrieved from: https://www.basel.int/TheConvention/OpenendedWorkingGroup(OEWG)/Meetings/OEWG14/Overview/tabid/9768/Default.aspx.

Basel Convention (2022), “Open-ended Working Group of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Twelfth meeting: Draft practical guidance on the development of inventories of waste batteries containing lithium”. Retrieved from: https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-OEWG.12-INF-17-Rev.2.English.pdf.

Battery Council International (BCI) (2017), “National Recycling Rate Study”, https://batterycouncil.org/wp-content/uploads/2018/01/BCI_201212-17_RecyclingRate_Study_Reformatted-Version.pdf.

BBC (2022, Jan.6), “Lithium batteries’ big unanswered question”. Retrieved from https://www.bbc.com/future/article/20220105-lithium-batteries-big-unanswered-question. (Accessed Jan 1, 2025).

Brunei Darussalam National Single Window (n.d.), “Prohibited Goods”.Retrieved from: https://bdnsw.mofe.gov.bn/Pages/ImpExpProh-RestictionGoods.aspx. (Accessed Jan 17, 2025).

Casals Lluc Canals, Garcia B. Amante, Canal Camille (2019), “Second life batteries lifespan: Rest of useful life and environmental analysis”, *Journal of Environmental Management*, Vol. 232, 354-363.

Casals, L.C., García, B.A., Aguesse, F. *et al*. (2017) “Second life of electric vehicle batteries: relation between materials degradation and environmental impact”. *Int J Life Cycle Assess* 22, 82–93. https://doi.org/10.1007/s11367-015-0918-3.

Chen Mengyuan, Ma Xiaotu, Chen Bin, Arsenault Renata, Karlson Peter, Simon Nakia, Wang yan (2019), “Recycling End-of-Life Electric Vehicle Lithium-ion batteries, Joule, Vol. 3, No.11, 2622-2646. https://doi.org/10.1016/j.joule.2019.09.014.

Congress of Philippines (2022), “Republic Act No. 11898: Extended Producer Act of 2022”. Retrieved from: https://legacy.senate.gov.ph/republic_acts/ra%2011898.pdf.

Conzen Jens, Lakshmipathy Sunil, Kapahi Anil et al (2022)., “Lithium-ion battery energy storage systems (BESS) hazards”, *Journal of Loss Prevention in the Process Industries*, Vol. 81. https://doi.org/10.1016/j.jlp.2022.104932.

DhakaTribune (2024, November 3), “Chief adviser seeks Indonesia’s support for ASEAN membership”. Retrieved from: https://www.dhakatribune.com/bangladesh/foreign-affairs/364034/yunus-congratulated-indonesia%E2%80%99s-new-president-and?__cf_chl_tk=8mSwwfyv6JKmFoLXh7xVR98hfUjGjFwE0iabx7SQOXc-1734269714-1.0.1.1-iJp5HTnf.RCrtzMwNsxxPUOLTARazImLvv0CUjySBTQ. (Accessed Jan. 20, 2025).

DESA (2020), “Micro-, Small and Medium-sized Enterprises (MSMEs) and their role in achieving the Sustainable Development Goals”. Retrieved from: https://sustainabledevelopment.un.org/content/documents/25851MSMEs_and_SDGs_Final3120.pdf.

Dobo Zsolt, Dinh Truong, Kulcsar Tibor (2023), “A review on recycling of spent lithium-ion batteries”. *Energy Reports*, Vol.9, 6362-6395. https://doi.org/10.1016/j.egyr.2023.05.264.

Doi Naoko, Purtanto Alloysisu Joko, Suehiro Shigeru, Morimoto Soichi, Takamine Akira, Kawada Yasuo, Sasaki Koichi, Matsuo Yuhji (2024), “Reuse of Electric Vehicle Batteries in ASEAN”, *ERIA Research Project Report No.31*, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.eria.org/uploads/Reuse-of-Electric-Vehicle-Batteries-in-ASEAN.pdf.

ESDO (Environment and Social Development Organization). (2021). “National Strategy for Used Lead Acid Battery (ULAB) Recycling in Bangladesh with UNEP” Dhaka: ESDO. For SMEP project.

Fallin Danielle, “Southeast Asia hopes to become the next EV hub”, *Center for Strategic International Studies*, Retrieved from: https://www.csis.org/blogs/new-perspectives-asia/southeast-asia-hopes-become-next-ev-hub. (Accessed Nov. 2024).

Faria Ricardo, Marques Pedro, Garcia Rita et al. (2014), “Primary and secondary use of electric mobility batteries from a life cycle perspective”, *Journal of Power Sources*, Vol. 262, 169-177. https://doi.org/10.1016/j.jpowsour.2014.03.092.

Gianni Mori Engineering (GME) (n.d.), “Battery Recycling Plant for Sale”. Retrieved from: https://www.gme-recycling.com/battery-recycling-plant-for-sale/. (Accessed Oct.29, 2024).

Gottesfeld Perry and Pokhrel Amod K. (2011), “Review: Lead Exposure in Battery Manufacturing and Recycling in Developing Countries and Among Children in Nearby Communities”, *Journal of Occupational and Environmental Hygiene* 8, 520-532. DOI: 10.1080/15459624.2011.601710.

Government of the People’s Republic of Bangladesh (2024), “National Board OF Revenue: National Customs Tariff, FY: 2024-2025).” Retrieved from: https://customs.gov.bd/files/TRF_2024_2025_06062024.pdf.

Hanh Nguyen Minh (March 10, 2022), “Thailand Issues New Incentive Package for Electric Vehicle Industry”, *ASEAN Briefing*, Retrieved from: https://www.aseanbriefing.com/news/thailand-issues-new-incentive-package-for-electric-vehicle-industry/. (Accessed Oct.2024).

International Lead Association (ILA), “Inventory of Lead Acid Batteries and Used Lead Acid Batteries in Bangladesh”. Retrieved from: https://wedocs.unep.org/bitstream/handle/20.500.11822/36335/ULAB4.pdf?sequence=3&isAllowed=y.

Institute for Health Metrics and Evaluation (IHME) (2019). *GBD Compare*. Seattle, WA: University of Washington, https://vizhub.healthdata.org/gbd-compare/. (Accessed, Nov. 23, 2024).

Institute for Health Metrics and Evaluation (IHME) (2022). “GBD 2021 data and tools guide”. Retreived from: https://www.healthdata.org/research-analysis/gbd-data. (Accessed, Nov. 23, 2024).

Indonesian Ministry of Environment (2004), “The Implementation of the Basel Convention in Indonesia”. Retrieved from: /https://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/2004_PDF/indonesia.pdf. (Accessed Jan. 17, 2025).

Indonesian Ministry of Trade (2020), “Ministry of Trade Regulation No. 100/2020”. Retrieved from: http://jdih.kemendag.go.id/peraturan/download/2073/2.

Kingdom of Cambodia (2020), “The enforcement of the list of prohibited and restricted goods”. Retrieved from：https://tools.customs.gov.kh/documents/reader/6091/16376601619761228/Anukrit%2017%20on%20Enforcement%20of%20the%20List%20of%20Prohibited%20and%20Restricted%20Goods.

Lao People’s Democratic Republic (2021), “Decision no.1687/MONRE on Pollution Control”. Retreived from: https://faolex.fao.org/docs/pdf/LAO210602.pdf.

Larsen Bjorn and Sánchez-Triana (2023), “Global health burden and cost of lead exposure in children and adults: a health impact and economic modelling

analysis", *Lancet Planet Health*, Vol.7, No.10, e831-e840. doi: 10.1016/S2542-5196(23)00166-3.

Lu Yi, Chandan Ambrish Kumar, Mehta Sumi et al. (2024), "Assessment of prevalence of elevated blood lead levels and risk factors among children and pregnant women in Bihar, India", *Environmental Research*, Vol.259. https://doi.org/10.1016/j.envres.2024.119528.

Manhart A, Smera T, Kuepouo G, Mathai D, Mng'anya S, Schleicher T (2016). "The deadly business – findings from the lead recycling Africa project." *Freiburg: Oeko-Institut*, https://www.oeko.de/oekodoc/2549/2016-076-de.pdf.

McKinsey & Company (2023, Jan.16), "Battery 2030: Resilient, sustainable and circular". Retrieved from: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-2030-resilient-sustainable-and-circular. (Accessed Nov.21, 2024).

Ministry of Natural Resource and Environment (MONRE) of Lao PDR (2023), "Workshop 2023 of the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes". Retrieved from: https://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/2023_PDF/Session1/S1_Lao_PDR.pdf. (Accessed Jan. 20, 2025).

Ministry of Natural Resources and Environmental Conservation, Myanmar (2024), "Invitation to provide comments on the draft updated technical guidelines on ESM of WLAB and draft technical guidelines on ESM of other waste batteries, as revised during the fourteenth meeting of the Open-ended Working Group". Retrieved from https://www.basel.int/Implementation/Wastebatteries/DevelopmentofOWBTGs/tabid/9671/ctl/Download/mid/27914/Default.aspx?id=5&ObjID=30959.

OECD (2001), "Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operations". Retrieved from: https://legalinstruments.oecd.org/public/doc/221/221.en.pdf.

Philippines Bureau of Customs (2021), "Memorandum: Export of lead-acid batteries not allowed and prohibited". Retrieved from:https://customs.gov.ph/wp-content/uploads/2023/01/aocg-memo-520-2021-Export_of_Lead-Acid_Batteries_Not_Allowed_and_Prohibited.pdf.

Pollution Control Department (2017), "Updates of National Regulations and Implementation Status of the Basel Convention in Thailand". Retrieved from:: https://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/2017_PDF/Day1_S1/S1_02_Thailand.pdf. (Accessed Dec.4 2024).

Pure Earth (2020), “Assessment of informed lead acid battery recycling and associated impacts in Bangladesh”, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://wedocs.unep.org/bitstream/handle/20.500.11822/36331/AIUL.pdf?sequence=3&isAllowed=y.

Prevent Waste Alliance (2023), “Practical Experiences with the Basel Convention: Challenges, Good Practice and Ways to Improve Transboundary Movements of E-Waste in Low and Middle Income Countries”. Retrieved from: https://prevent-waste.net/wp-content/uploads/2023/05/PREVENT-StEP_Practical_Experiences_Basel-Convention_discussion-paper-2022.pdf.

Rahman,S.(2023), “Vicious toxicleadcycle: Illegal lead battery factories,pollution,and unauthorized. The Business Standard”. Retrieved from https://www.tbsnews.net/features/panorama/ vicious-toxic-lead-cycle-illegal-lead-battery-factories-pollution-and-unauthorised.

Reccessary (2024), “Indonesia’s EV ambitions highlight urgent battery recycling challenge”. Retrieved from: https://www.reccessary.com/en/news/world-environment/indonesia-ev-battery-recycling-challenges. (Accessed Jan. 20, 2025).

Reuters (2024, Jan.25), “Exclusive: Thailand aims for lithium output in two years, boosting EV ambitions”. Retrieved from: https://www.reuters.com/business/autos-transportation/thailand-aims-lithium-output-two-years-boosting-ev-ambitions-2024-01-24/. (Accessed May 1, 2025).

Saxena, S. N. (2019). “Two- and three-wheeler electric vehicles in India—Outlook 2019”. *International Journal of Electrical Engineering and Technology,* Vol.9, No.1, 1-13. http://ripublication.com/ijeet19/ijeetv9n1_01.pdf.

Shah Jalal (2024), “Battery Industry in Bangladesh: Powering up the Nation on the Go”, *IDLC Monthly Business Review*, Vol. 20, Issue 4, 2. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://idlc.com/mbr/images/public/egtD9vMoP4227sAUWGTURc.pdf

Singapore (2022), “Singapore Environmental Public Health Act [Chapter 95, Section 113]: Environmental Public Health (Toxic Industrial Waste) Regulations”. Retrieved from: https://sso.agc.gov.sg/sl/epha1987-rg11?ProvIds=P1V-#pr14-. (Accessed Jan. 17, 2025).

Singapore National Environment Agency (n.d.), “Basel Convention Control Procedure”. Retrieved from: https://www.nea.gov.sg/corporate-functions/resources/legislation-international-law/multilateral-environmental-agreements/chemical-safety/basel-convention/basel-convention-control-procedure. (Accessed Jan.18, 2025).

Sustainable Manufacturing and Environmental Pollution (SMEP) (2021), “GAHP SMEP C-002 Development of detailed designs for future research ITT: Final report, Used Lead Acid Battery Industry in Bangladesh”, https://southsouthnorth.org/wp-content/uploads/2021/10/210901-GAHP-Final-Report-Bangladesh-ULAB.pdf

Sustainable Manufacturing and Environmental Pollution (SMEP) (2024a), “Formalizing Electric Three-wheeler sector: Regulating for growth, preventing lead pollution, and unlocking green investment, SMEP Press Release. Retrieved from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.pureearth.org/wp-content/uploads/2024/04/ENG-Press-Release_SMEP-Workshop-with-Policymakers_Pure-Earth_April032024.pdf.

Sustainable Manufacturing and Environmental Pollution (SMEP) (2024b), “Unified policies, healthier journeys: Addressing the used-lead-acid battery challenge in Bangladesh”, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://unctad.org/system/files/non-official-document/%5B_SMEP_%5D_ULABs_27-03-2024_%281%29.pdf.

Tao Yanqiu, Rahn Chritsopher D., Archer Lynden A. and You Fengqi (2021), “Second life and recycling: Energy and environmental sustainability perspectives for high-performance lithium-ion batteries”, Science Advances, Vol. 7, No.45. DOI:10.1126/sciadv.abi7633.

The Business Standard (2024， November 29), “Should Bangladesh join ASEAN?” Retrieved from: https://www.tbsnews.net/features/panorama/should-bangladesh-join-asean-1005611 (Accessed on Jan. 20, 2025).

The Daily Star. (2021, February 7), “Recycled lead-acid battery putting Bangladesh in danger.” Retrieved from https://www.thedailystar.net/health/news/recycled-lead-acid-battery-putting-bangladesh-danger-2040473.

The Daily Star. (2024, February 8), “'Tesla of Bangla': Nasrul Hamid defends battery-run three-wheelers.” Retrieved from https://www.thedailystar.net/environment/natural-resources/energy/news/tesla-bangla-nasrul-hamid-defends-battery-run-three-wheelers-3539466.

The Daily Star (2024, Feb. 28), “LDC Graduation: Implications for Bangladesh beyond 2026”. Retrieved from https://www.thedailystar.net/anniversary-supplement-2024/readying-the-next-big-leap/news/ldc-graduation-implications-bangladesh-beyond-2026-3554306, (Accessed Jan. 20, 2025).

United Nations Conference on Trade and Development (UNCTAD) (2023), “Key Statistics and Trends in Trade Policy 2023”. Retrieved from: https://unctad.org/system/files/official-document/ditctab2024d2_en.pdf.

United Nations Environment Programme (2010), “Final review of scientific information on lead. Nairobi: United Nations Environment Programme”, http://www.unep.org/chemicalsandwaste/http://www.unep.org/chemicalsandwaste/Portals/9/Lead_Cadmium/docs/Interim_reviews/UNEP_GC26_INF_11_Add_1_Final_UNEP_Lead_review_and_apppendix_Dec_2010.pdf.

United Nations Environment Programme (n.d.), “Alternatives to Lead-acid Batteries”. Retrieved from: https://wedocs.unep.org/bitstream/handle/20.500.11822/27402/ALAB.pdf?sequence=1&isAllowed=y. (Accessed Jan.1, 2025).

United Nations Environment Programme (2024), “Technical guidelines on the environmentally sound management of waste lead-acid batteries (not been formally edited)”, Small Intersessional Working Group on the technical guidelines for waste lead-acid batteries and on other waste batteries, First Meeting. Retrieved from: https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-WB_SIWG.1-2.English.pdf. (Accessed Jan. 16, 2025).

United Nations Environment Programme (2022), “Practical guidance on the development of inventories of waste batteries containing lithium”. Retrieved from: https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-NREP-INVENT-GUID-LithiumBatteriesWaste-2022.English.pdf.

United Nations Environmental Protection Agency (US EPA) (2021), “An Analysis of Lithium-ion battery fires in waste management and recycling”, https://www.epa.gov/system/files/documents/2021-08/lithium-ion-battery-report-update-7.01_508.pdf.

United Nations Children’s Fund (UNICEF) and Pure Earth (2020), “The toxic Truth: Children’s exposure to lead pollution undermines a generation of future potential”. https://www.unicef.org/media/73246/file/The-toxic-truth-children%E2%80%99s-exposure-to-lead-pollution-2020.pdf.

US EPA (2024), “International Agreements on Transboundary Shipments of Hazardous Waste”. Retrieved from: https://www.epa.gov/hwgenerators/international-agreements-transboundary-shipments-hazardous-waste. (Accessed Jan 19, 2025).

Vietnam Customs (2024), “Item Policy”. Retrieved from: https://www.customs.gov.vn/index.jsp?pageId=2281&aid=206343&cid=4132. (Accessed Jan.16, 2025).

Volza Philippines Import Data(2021), “Key Indicators of Used Lithium Battery Imports in Philippines”. Retrieved from: https://www.volza.com/p/used-lithium-battery/import/import-in-philippines/.

World Customs Organization (n.d.), “What is the Harmonized System (HS)?” Retrieved from: https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx. (Accessed Jan. 19, 2025).

WCO HS Code, “Chapter 5: Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles”. Retrieved from: https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/nomenclature/instruments-and-tools/hs-nomenclature-2022/2022/1685_2022e.pdf?la=en. (Accessed Jan. 20, 2025).

World Economic Forum (2019), “Consequences of a Mobile Future: Creating an Environmentally Conscious Life Cycle for Lead-Acid Batteries”, https://www.weforum.org/publications/consequences-of-a-mobile-future-creating-an-environmentally-conscious-life-cycle-for-lead-acid-batteries/.

World Economic Forum (WEF (2021), “Trade and the Circular Economy: A deep dive into plastics action in Ghana”. Retrieved from: https://www3.weforum.org/docs/WEF_Ghana_NPAP_Trade_and_Circular_Economy_2024.pdf.

World Economic Forum (WEF) (2024a, Jun 6), “Jumpstarting lithium battery recycling starts with investing in innovation”. Retrieved from: https://www.weforum.org/stories/2024/06/jumpstarting-lithium-battery-recycling-investing-innovation/. (Accessed, Jan.15, 2025).

World Health Organization (2024), “Lead poisoning”, Retrieved from: https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health. (Accessed Oct.2024).

Weinert, J., Ogden, J., Sperling, D., & Burke, A. (2008). “The future of electric two-wheelers and electric vehicles in China”. *Energy Policy*, Vol. 36, No.7, 2544–2555. https://doi.org/10.1016/j.enpol.2008.03.008.

Xu Jinqiu, Thomas H.R., Francis Rob W., Lum Ken R., Wang Jingwei, Liang bo et al. (2008) ,”A review of processed and technologies for the recycling of lithium-ion secondary batteries”. *Journal of Power Sources*, Vol. 177, No.2, 512-527.

https://doi.org/10.1016/j.jpowsour.2007.11.074.

Yudhistira Ryutaka, Khatiwada Dilip, Sanchez Fernando (2022), “A comparative life cycle assessment of lithium-ion and lead-acid batteries for grid energy storage”, *Journal of Cleaner Production*, Vol. 358. https://doi.org/10.1016/j.jclepro.2022.131999.