UNITED NATIONS

UNEP

BC

UNEP/CHW.15/INF/51/Rev.1

Distr.: General
22 July 2022

English only

BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Fifteenth meeting
Geneva, 26–30 July 2021 and 6–17 June 2022*
Agenda item 4 (b) (iii)

Matters related to the implementation of the Convention: scientific and technical matters: national reporting

Practical guidance on the development of inventories of waste batteries containing lithium

Note by the Secretariat

At its fifteenth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal took note of, in decision BC-15/13 on national reporting, the practical guidance on the development of inventories of waste batteries containing lithium, on the basis of the draft guidance contained in document UNEP/CHW.15/INF/51. The text of the final version of the practical guidance, as taken note of by the Conference of the Parties, is set out in the annex to the present note. The present note, including its annex, has not been formally edited.

* In accordance with decisions BC-15/1, RC-10/2 and SC-10/2 of the conferences of the Parties to the Basel, Rotterdam and Stockholm conventions, the 2021/2022 meetings of the conferences of the Parties are being held in two segments: an online segment held from 26 to 30 July 2021 and a face-to-face segment to be held from 6 to 17 June 2022 in Geneva.

250722

Annex

Practical guidance on the development of inventories of waste batteries containing lithium

Contents

1 Introduction

1. Parties to the Basel Convention are required under Article 13, paragraph 3, of the Convention to annually transmit to the Conference of the Parties a national report on information related to the measures taken towards its implementation. Undertaking inventories can be an effective way of gathering information on the generation, transboundary movements and management of hazardous wastes and other wastes for the purpose of national reporting. Such information, and other relevant information, should be submitted, through the Secretariat of the Convention, using the national reporting format.[1]

2. This guidance aims to provide practical instructions to assist Parties and others in developing an inventory of waste batteries containing lithium. It is meant to be used in conjunction with the Methodological guide for the development of inventories of hazardous wastes under the Basel Convention[i] which provides complementary guidance on the methods of developing national inventories for the preparation of national reports. Accordingly, this guidance proposes an approach for developing an inventory that is consistent with the one contained in the Methodological guide.

3. The main objective of developing an inventory of waste batteries containing lithium is to obtain information on the amount of such waste generated in a country, its disposal and transboundary movements. Knowledge of the amount of waste generated provides a sound basis for their environmentally sound management (ESM)[ii]. This information can be used to develop appropriate policies and strategies for the collection and disposal of waste batteries containing lithium and is an important input into the planning of recycling facilities that require substantial financial investment and regular throughputs of wastes. In addition, the development of the inventory can provide insight into the effectiveness of the system in place in a country to control the transboundary movements of waste batteries containing lithium. The conducting of inventories should be streamlined with the process of developing national policies, legislation, planning and implementation of environmentally sound management of hazardous wastes and other wastes.

3bis. The focus of this guidance is on the inventory of waste rechargeable lithium-ion batteries (see further details in paragraph 6bis).

2 Description of batteries containing lithium and their wastes

2.1 Classification of waste batteries containing lithium

4. For developing the inventory, establishing a classification of wastes that is used consistently will help ensure comparability of inventory information collected from various sources and over the years. Wastes should also be classified in a way that serves the objectives of developing the inventory, such as for the planning of disposal facilities. The format for national reporting under the Basel Convention requires that some of the information provided be categorized according to Annex I, II or Annex VIII codes. Therefore, in developing the inventory, using a classification of waste batteries containing lithium that is harmonized with the annexes of the Basel Convention will make it easier to integrate the outputs of the inventory into the national report.

5. Batteries containing lithium can be categorized into two main groups of batteries that have different properties, applications and market shares. There are non-rechargeable (primary) lithium batteries and rechargeable lithium-ion batteries (LIB):

(a) Primary non-rechargeable lithium batteries use lithium in the anode (negative electrode) and a variety of oxidizing agents in the cathode (positive electrode). Total production volumes of non-rechargeable primary lithium batteries are significantly lower than volumes of rechargeable lithium-ion batteries. Non-rechargeable lithium batteries are used mainly in the following applications: Consumer electronics, such as cameras, watches, back-up batteries for mainboards or medical devices such as pacemakers and other implantable electronic devices;

(b) Rechargeable lithium-ion batteries represent the vast majority of all batteries containing lithium. Lithium-ion batteries typically use graphite in the anode and a variety of lithium containing compounds in the cathode. Therefore, different types of lithium-ion batteries generally are distinguished by the cathode materials. The most commonly used cathode materials are Lithium-cobalt-oxide ($LiCoO_2$ or LCO), lithium-iron-phosphate ($LiFePO_4$ or LFP), lithium-manganese-oxide ($LiMn_2O_4$ or LMO), and lithium-nickel- cobalt- manganese-oxide ($LiNiCoMnO_2$ or NCM). Another

[1] UNEP/CHW.12/INF/16/Rev.1; available at: http://www.basel.int/Countries/NationalReporting/Formatandmanualsfornationalreporting/tabid/8754/Default.aspx.

two components are necessary for the battery to work which is the electrolyte and the separator. The separator keeps the anode and cathode apart, while the electrolyte enables the movement of lithium-ions between cathode and anode. The separator typically consists of polyethylene (PE) and polypropylene (PP). The electrolyte consists of a mixture of salts, solvents and additives. Typically, the salt is lithium hexafluorophosphate.[iii]

6. In this guidance document, batteries containing lithium refer to all rechargeable LIB that represent the vast majority of all batteries containing lithium. The lifetime of a battery is the period of time during which a battery is capable of being discharged and recharged, and retains the charge applied. Once the battery is no longer capable of being recharged or cannot retain its charge or is no longer capable of fulfilling its requirements of the application, it has reached the end of its useful lifetime and becomes waste. Such a battery may also become waste before the end of its useful lifetime. Such batteries, after becoming waste, are referred to as waste-lithium-ion batteries (waste-LIB) in this guidance.

7. There are several factors that make it difficult to undertake an inventory of primary lithium batteries. First, primary lithium batteries are produced in significantly lower volumes than LIB. This trend will also prevail in the future as many portable applications, such as cameras or toys, shift from using non-rechargeable batteries to LIB. LIB are used in an increasing number of applications such as e-bikes, vacuum cleaners and notably electric vehicles. Second, information on volumes of primary lithium batteries placed on the market is very scarce, although limited information could be gathered looking at trade statistics. Information on applications that use primary lithium batteries cannot be used to estimate volumes of batteries used, since other types of batteries (such as alkaline batteries) can be used to power them. As a result, a significant amount of research would be needed to cover a small proportion of the total amount of waste batteries containing lithium. Given that the main aim of developing an inventory of waste batteries containing lithium is to obtain information on the amount of such waste generated in a country, a disproportionate amount of resource would be needed to account for primary lithium batteries.

8. Waste-LIB are not explicitly listed in Annexes I and VIII to the Basel Convention while some substances contained in LIB (e.g., the electrolyte consists of hexafluorophosphate) are listed. An indicative list of entries of Annexes I, II and VIII to the Basel Convention relevant to waste-LIB is provided below:

(a) Annex I:

(i) Y32: Inorganic fluorine compounds excluding calcium fluoride;

(ii) Y34: Acidic solutions or acids in solid form;

(b) Annex II: Y46: Wastes collected from households;

(c) Annex VIII:

(i) A1170: Unsorted waste batteries excluding mixtures of only list B batteries. Waste batteries not specified on list B containing Annex I constituents to an extent to render them hazardous;

(ii) A1180: Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B B1110).

9. LIB are often contained in electrical and electronic equipment (EEE). Further guidance on hazardous components or substances that may be contained in e-waste is provided in the technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste, under the Basel Convention.[iv]

10. LIB are used in a very large set of applications. This diversity complicates the classification of waste-LIB for the purpose of developing an inventory. In an attempt to harmonize the collection and compilation of statistics on certain applications, categories based on similar function, similar use of cell chemistry and average lifetime are used in this guidance document. For example, laptops and tablets would be in one category due to their similarities regarding LIB size and lifetime.

11. For the development of an inventory and the assessment of its results, it is helpful to identify the main actors involved and understand their role in the waste management system, how they are organized and their impact on the flow of waste-LIB. Figure 1 provides an example of a scheme of the flows in the value-chain of waste-LIB.

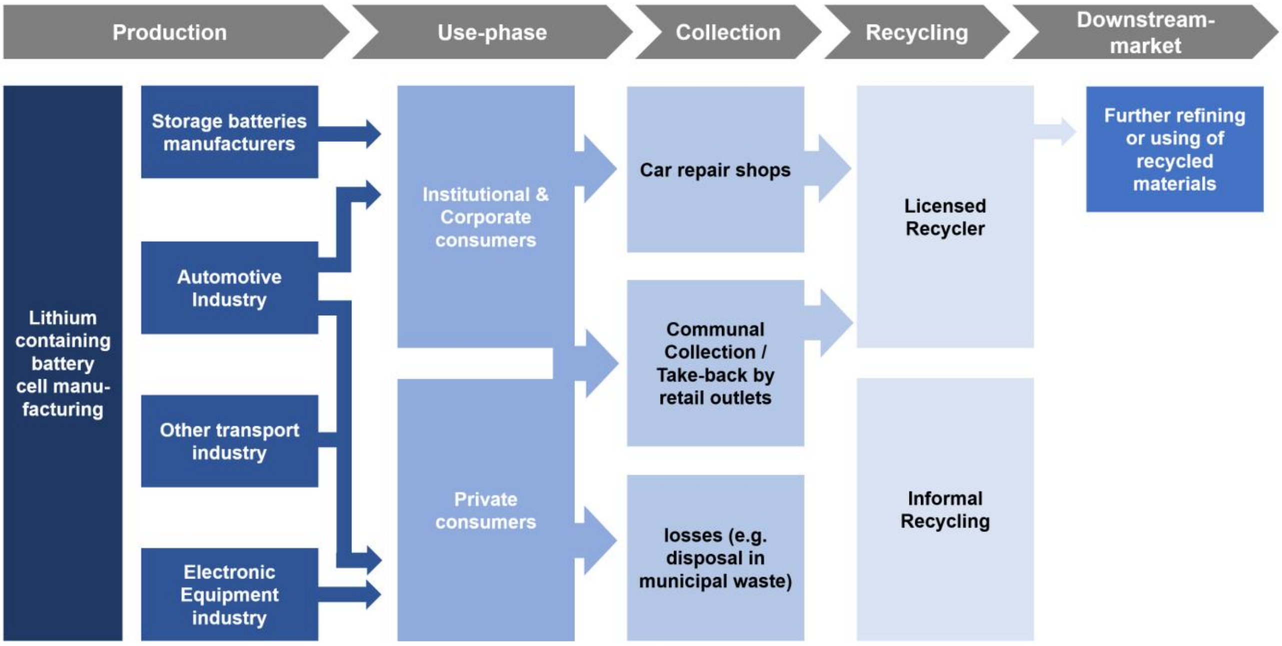

Figure 1: Scheme of LIB from production to the end of use[2]

2.2 Lithium-ion batteries and their application

12. Understanding of the patterns of use of batteries containing lithium helps to determine the potential generators of waste-LIB (Figure 1**)**.

13. LIB have a wide variety of applications that can be classified in the following main categories that will be used in this guidance document:

(a) Automotive traction battery powering the electric motor in battery-electric vehicles (BEV), in plug-in hybrid electric vehicles (PHEV) and hybrid electric vehicles (HEV);

(b) Other transport equipment such as e-bikes and e-scooters;

(c) Portable applications: e.g., in notebooks, cell phones, tablets, portable speakers, vacuum cleaners, power tools, drones etc.;

(d) Industrial applications: e.g., Li-ion batteries used to power forklifts;

(e) Stationary storage applications in the industrial and commercial sectors: used for energy storage in an industrial and commercial setting and typically not meant to be mobile;

(f) Stationary storage applications in the domestic sector: used for energy storage in a home or office setting and typically not meant to be mobile.

14. LIB used in powering electric vehicles may have a second use in other applications such as stationary storage applications (also known as echelon use) when they no longer have their full capacity.

15. Over the last years, the production of LIB has become significantly more cost efficient. Currently they represent the most efficient commercial rechargeable battery option with the highest energy density. Accordingly, many applications that have been depending on energy from a socket are now cordless relying on Li-ion batteries. An overview of the main categories of LIB, their applications and users is provided in Table 1.

[2] Informal recycling of lead acid batteries is a major problem in many developing countries and emerging economies. In many urban areas collection and recycling is often conducted with little regard to emission control and impacts on human and environmental health. Similar issues might occur with Li-ion batteries with issues particularly regarding human health due to inadequate work safety measures.

Table 1: Main applications of LIB

Category	LIB Applications	Main users
Traction batteries for the automotive sector	BEV, PHEV and HEV[3] such as cars, trucks, buses, motorcycles, etc.	Individuals, businesses, public transport sector
Other Transport	e-bikes, segways, e-scooters	Individuals, businesses
Portable Applications	Notebooks, cell phones, tablets, portable speakers, vacuum cleaners, power tools	Individuals, businesses
Industrial Applications	Forklifts, tools, other vehicles	Businesses
Stationary storage applications: industrial and commercial	Electricity supply: back-up power systems and load levelling for grid supply networks	Electricity supply companies
	Renewable energy storage (solar, hydro and wind) systems	Electricity supply companies
	Emergency services: back-up power systems to supply electric power in the event of power outage for critical services	Police, hospitals and government institutions
	Large-scale Uninterrupted Power Supply (UPS) systems: back-up power to protect against power outage	Banks, shops, hotels, factories, providers of IT and financial services
	Telecommunications systems: back-up power systems for mobile phone towers and field facilities	Mobile phone / telecommunications providers
	Energy storage for street lighting systems powered by solar panels	Urban agglomerations, towns, villages.
Stationary storage application: domestic	Desktop UPS systems	Houses and small businesses
	Renewable energy storage systems (solar, hydro and wind) supplying voltages 110- 220 volts	Houses and small businesses in remote areas
	Back-up power systems (usually consisting of a battery connected to an inverter/charger and is connected to the electric grid for recharging): provides electrical power when grid fails	Houses and small businesses
	Back-up power for security systems	Houses, businesses

3 Defining the scope of the inventory

16. Important considerations in defining the scope of the inventory include: its purpose (including for completing the national report under the Basel Convention), desired outcomes, category of applications of LIB to be included (see Table 2 and section 4.1), geographical area to be covered and specific exclusions and limitations due to e.g. access to information sources. When data will be collected from a defined geographic area, the results of the inventory can be extrapolated to the entire country to compute a national estimate.

4 Methodologies for developing the inventory

17. This guidance provides a methodology for developing a first-generation inventory of waste-LIB. This methodology is appropriate for the early stages of development of a national system for the environmentally sound management of waste-LIB when a national system for collecting data from waste generators is not yet fully developed.

[3] BEV = Battery Electric Vehicle, PHEV = Plug-In Hybrid Electric Vehicle, HEV = Hybrid Electric Vehicle.

18. The methodology for developing the inventory relies on readily available statistics on the use of LIB and estimates of other key parameters needed for calculating the amount of LIB generated. A more detailed and comprehensive inventory will require data collected from waste generators and other stakeholders through surveys and field visits. Progressing towards a more detailed inventory requires a larger investment of resources but also results in more accurate outputs.

19. The inventory of waste-LIB is developed in two steps. First, data is collected on the amount of LIB in use for each LIB application (section 4.1). In the second step, the amount of LIB generated is estimated based on the average lifespan of the LIB in their specific application and their respective weight (section 4.2). A more advanced method calculating waste-rates of LIB by age is described in section 4.3.

4.1 Collecting information on LIB use

20. A cost-effective way to gather data on LIB use is to request information from stakeholders using standard questionnaires. These should be designed to obtain data in a consistent manner that will allow the waste-LIB amount to be estimated for certain LIB applications. Questionnaires should contain an explanation of how the data should be entered. The annex to this guidance contains an example of a questionnaire for collecting information on LIB use for energy storage applications in the industrial and commercial sectors. It can be adapted for other categories of LIB. Questionnaires should be send to relevant national authorities, e.g., Ministry of Transport in relation to electric vehicle (EV) registrations. Particularly producers of LIB applications need to be surveyed. In this context producer means any person that, irrespective of the selling technique used, places LIB, including those incorporated into appliances or vehicles, on the market for the first time within the territory of the country on a professional basis. Follow-up phone calls to stakeholders after they receive the questionnaires can help ensure a high response rate.

21. Likely sources of information for various applications of LIB and the information that could be requested are provided in Table 2. The information collected for the inventory can be recorded in a database that will set a baseline for future updates. Table 3 provides an example of a format for such a database. This format can also be used to compute the total amount of waste-LIB generated.

22. When developing a strategy for data collection, the following considerations are helpful:

(a) In many countries, for the first-generation inventory, data on the use of some applications of LIB can be obtained indirectly from national or local authorities rather than from LIB users. For example, in most countries cars, trucks, buses and motorcycles that use the public roads must be registered with a designated government agency that can be contacted to obtain data on the total number of vehicle registrations. Depending on the country, information related to the propulsion type is also available. Based on this information an estimation on the total number of LIB units used in the transport sector can be estimated;

(b) For some applications, it will be necessary to contact a number of different sources. If information is lacking from one source, such as the number of electric vehicle registrations from the ministry of transport, the information may be available from another source, such as the finance ministry, which should have records of vehicle imports and domestic sales in order to collect tax revenues. Also, publicly available import and export statistics, such as UN Comtrade[4] can help to gather data;

(c) In some countries without a LIB manufacturing industry, for certain applications such as renewable energy storage systems for domestic use, there may be only a few importers/suppliers of LIB who can be asked to provide sales data;

(d) In countries without an electronics manufacturing industry, LIB portable applications can be estimated based on import data from UN Comtrade. Using the appropriate Harmonized System (HS) codes, statistics for relevant LIB applications can be derived (compare Table 3);

(e) The applications listed in Table 3 may not be important for all countries. For example, there may be very few solar street lights that use LIB for energy storage in a given country or geographic area. Also, electric vehicles are dependent on the charging infrastructure which can differ significantly between countries and make them unsuitable for use in the country.

23. When possible, the following information should also be collected from LIB users, importers, producers or manufacturers, either through the questionnaire or interviews:

[4] https://comtrade.un.org/data/.

(a) **Average weight of each LIB**: Table 3 provides information about the average weights of LIB units for various applications. For most LIB applications, however, there is a range of weights depending on the cell chemistry and requirements for the battery in the application. For example, a battery electric vehicle can have a lithium-ion battery as light as 200 kg and go up to 600 kg and higher. The information provided in Table 3 can serve as a guide for an initial inventory but more precise information on the weight of LIB used in a country should be collected from users, importers and manufacturers of LIB in the course of the inventory;

(b) **Share of battery in total weight:** Table 3 provides information about average share of LIB in the applications. If data for LIB placed on the market refers to total volume of the application, the share of the battery weight can be used to determine LIB volumes placed on the market;

(c) **Useful life factor (ULF):** This is the average useful life that the users obtain from the LIB and is calculated as the inverse of the lifespan of the LIB. It provides the proportion of LIB that has the probability of becoming waste in any period of 12 months. For example, for a type of LIB application that reaches its the end of its useful life in five years on average, the ULF will be 0.2, implying that 20% of this type of LIB will reach the end of its useful life in any 12-month period. Because of wide variations in the ULF depending on battery quality and use pattern, country-specific information should be obtained from users of LIB in the course of the inventory.

Table 2: Information that could be requested for developing the inventory and their likely sources

Category of LIB	LIB Applications	Information requested	Possible information sources
Traction batteries for the automotive sector	BEV, PHEV and HEV[5] such as cars, trucks, buses, motorcycles, etc.	• Numbers of vehicles registered differentiated by propulsion type • Battery weights	Ministry of transport (or other vehicle registration agency) Import-statistics (UN Comtrade)
Other Transport	E-bikes, e-scooters, towing truck on airports	• Number of units produced or imported • Weight of battery • Tons of equipment PoM • Share of battery in total weight • Lifespan of battery	Importers, vendors, producers Import-statistics (UN Comtrade)
Portable Applications	Notebooks, cell phones, tablets, portable speakers, vacuum cleaners, power tools etc.	• Number of units produced or imported • Weight of battery • Tons of equipment PoM • Share of battery in total weight • Lifespan of battery	Importers and / or manufacturers of portable applications, producers Import-statistics (UN Comtrade)
Industrial applications	Forklift	• Number of units produced or imported • Weight of battery • Tons of equipment PoM • Share of battery in total weight • Lifespan of battery	Importers and / or manufacturers of portable applications, producers Import-statistics (UN Comtrade), industry businesses
Stationary storage applications: industrial and commercial	Electricity supply: back-up power systems and load levelling for grid supply networks	• Number of LIB storage systems • Lifespan and weight of LIB systems	Electricity supply companies; ministry of energy or natural resources
	Renewable energy storage	• Number of LIB storage systems • Lifespan and weight of LIB systems	Electricity supply companies
	Emergency services: back-up power systems	• Number of LIB storage systems • Lifespan and weight of LIB systems	Ministries and local authorities responsible for education, health care and emergency services.

[5] BEV = Battery Electric Vehicle, PHEV = Plug-In Hybrid Electric Vehicle, HEV = Hybrid Electric Vehicle.

Category of LIB	LIB Applications	Information requested	Possible information sources
	Large-scale Uninterrupted Power Supply (UPS) systems	• Number of LIB per system • Lifespan and weight of LCB	Ministries and local authorities responsible for education, health care and emergency services.
	Telecommunications systems:	• Number of LIB storage systems • Lifespan and weight of LIB systems	Telecommunications and mobile phone companies
	Street Lighting	• Number of street lights in operation, and share of LIB used • Lifespan and weight of LIB	Municipal authorities in charge of maintenance
Stationary storage application: domestic	Desktop UPS systems	• Number of LIB storage systems • Lifespan and weight of LIB systems	Major suppliers of computer equipment, producers
	Renewable energy storage systems	• Number of LIB storage systems • Lifespan and weight of LIB systems	Ministries of energy, environment and natural resources, renewable energy systems suppliers, producers
	Back-up power systems	• Number of LIB storage systems • Lifespan and weight of LIB systems	Ministries of energy, environment and natural resources, home power systems suppliers, producers
	Back-up power for security systems	• Number of LIB storage systems • Lifespan and weight of LIB systems	Ministries of energy, environment and natural resources, home power systems suppliers, producers

4.2 Estimating the amount of waste-LIB by using Useful life factor

24. For each application of LIB listed in the database, the amount of waste-LIB generated per year is calculated according to the following formula:

When amount is provided in units, e.g., for cars:

Step 1: Amount of LIB in use [kg]= Number of LIB in use x average weight of LIB unit [kg]

Step 2: Amount of waste-LIB generated [kg] = Amount of LIB in use [kg] x Useful life factor

Step 3: Amount of waste-LIB generated [metric tons] = Amount of waste-LIB generated [kg] x 0.001

When amount is provided in metric tons, e.g. when data is derived from UN Comtrade:

Step 1: Tons of LIB in use = Tons of application in use x average share of LIB weight

Step 2: Amount of waste-LIB generated [metric tons] = Tons of LIB in use [kg] x Useful life factor

Step 3: Amount of waste-LIB generated [metric tons] = Amount of waste-LIB generated [kg] x 0.001

25. Example calculation:

In a country with 3 telecommunications stations, each using 1 back-up system with a lifespan of 10 years (i.e., a ULF of 0.1). Assuming an average weight of 40 kg for each LIB (see Table 3), the amount of waste-LIB generated annually will be calculated as follows:

(a) Amount of LIB in use = 3 x 40 = 120 kg

(b) Amount of waste-LIB generated annually [kg] = 120 x 0.1 = 12 kg

(c) Amount of waste-LIB generated annually [metric tons] = 12 x 0.001 = 0.012 tons

26. After the quantities of waste-LIB generated have been calculated for each category and application of LIB listed in the database, they are summed up to provide the total amount of waste-LIB generated.

Table 3: An example of a format for the database on waste-LIB

LIB Category	LIB Applications	Tons of application in use	No. applications in use	Share of LIB in total weight	Average LIB weight [kg] (c)	Lifespan (years)	ULF (d)	Amount of waste-LIB generated [metric tons]	HS Code
Automotive	BEV cars				350	12			870380
	BEV buses & trucks				1000	10			870420
	BEV motorcycles				50	8			
	PHEV cars				150	12			870350, 870360
	PHEV buses & trucks				300	10			
	HEV cars				10	12			870340, 870360
Other Transport	E-bikes				3,4	5			
	Scooters				3,4	2-4 years			
Portables	Notebooks			25%	0,35	5			
	Cell phones				0,04	4			851712
	Cameras				0,03	5			
	Tablets				0,15	4			
	Power tools				0,5	6			
	Power Banks				0,2	5			
Industrial	Forklift								870911
Stationary storage applications: industrial and commercial	Electricity supply: back-up power systems and load levelling for grid supply networks				…				850760
	Renewable energy storage				…				850760
	Emergency services: back-up power systems				…				850760
	Large-scale Uninterrupted Power Supply (UPS) systems				…				850760
	Telecommunications systems:				40	10	0.1		850760
	Street Lighting				…				850760
Stationary storage application: domestic	Desktop UPS systems				…				850760

LIB Category	LIB Applications	Tons of application in use	No. applications in use	Share of LIB in total weight	Average LIB weight [kg] (c)	Lifespan (years)	ULF (d)	Amount of waste-LIB generated [metric tons]	HS Code
	Renewable energy storage systems				10 – 60				850760
	Back-up power systems								850760
	Back-up power for security systems								850760
	Security systems								850760

4.3 Estimating amounts of waste-LIB by using probability distributions

27. A more accurate approach to calculate amounts of waste-LIB generated per year can be achieved by using probability distributions for the end of the useful life of applications. For example, laptops can have an average use phase of ca. 5 years, however some will reach the end of their useful life in the first year, while others might be in use for much longer than 5 years. This can be reflected in a probability distribution. This method takes into account products that have been put on the market in the past that are still in use and that may become waste in the year of the inventory.

28. A similar approach is used by Member States of the EU to report Waste Electrical & Electronic Equipment (WEEE) to the European Commission.[6] This approach is particularly interesting when detailed data regarding batteries placed on the market or applications containing batteries placed on the market is available.

29. The following example is meant to illustrate the methodology how to determine waste volumes by applying a probability distribution:

(a) Step 1: Estimate amount of LIB Placed on the Market (PoM) for the last 5-10 years for each application in each year (compare Table 2 & Table 3) in either units or metric tons

(b) Step 1.1: If the amount is provided in units multiply with the weight of the battery for the application, e.g. 1000 Laptops PoM in 2019 x 0.35 kg battery per unit = 350 kg or 0.35 tons of LIB PoM:

(c) Step 1.2: If the amount is provided in tons multiply with share of battery in total weight for the application, e.g., 2000 tons of Laptops PoM in 2019 x 25% = 500 kg or 0.5 tons of LIB PoM;

(d) Step 2: To calculate the amount of waste-LIB for a given year: Multiply the tons of LIB PoM in the years before with the probabilities according to the age of the product in the given year (for probabilities by age see Table 6).

30. For example, assuming data are available for LIB PoM for Laptops from 2011 to 2013, the waste-LIB from laptops generated in 2013 is calculated as shown in Table 4.

Table 4: Example of waste-LIB calculation example the year 2013

Application	2011	2012	2013
Laptops PoM each year [metric tons]	10	11	12
Share of battery in total weight	25%	25%	25%
LIB in Laptops PoM [metric tons]	2.5	2.75	3
Age of LIB in 2013	3 years	2 years	1 year
Waste Probability by age	11%	6%	2%
waste-LIB in 2013 for each year	0.275	0.165	0.06

[6] https://ec.europa.eu/environment/waste/weee/data_en.htm.

Application	2011	2012	2013
TOTAL waste-LIB in 2013	0.275 + 0.165 + 0.06 = **0.5 tons**		

Step 3: Add up the results for each year to get an estimation on the amount of waste-LIB for a given year

31. Tables 5-7 provide a more detailed example of the methodology described above:

Table 5: LIB Placed on the market in different applications (metric tons)

Application	2011	2012	2013	2014	2015	2016	2017	2018	2019
Laptops	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Cell phones	…	…	…	…	…	…	…	…	…
Tablets	…	…	…	…	…	…	…	…	…
…									

Table 6: End of useful life probability distribution for each application shown in table 5

Age	1	2	3	4	5	6	7	8	9
Laptops	**2%**	**6%**	**11%**	**14%**	**16%**	**15%**	**13%**	**10%**	**6%**
Cell phones	…	…	…	…	…	…	…	…	…
Tablets	…	…	…	…	…	…	…	…	…

32. To calculate the among of waste-LIB from laptops for the year 2019, the quantity of LIB placed on the market for the application in that year (Table 5) is multiplied by probability distribution for that application (Table 6), as shown in table 7.

Table 7: Calculating waste-LIB from Laptops for 2019

Age of Application	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	2%	2%	2%	2%	2%	2%	2%	2%	**2%*18**
2	6%	6%	6%	6%	6%	6%	6%	**6%*17**	6%
3	11%	11%	11%	11%	11%	11%	**11%*16**	11%	11%
4	14%	14%	14%	14%	14%	**14%*15**	14%	14%	14%
5	16%	16%	16%	16%	**16%*14**	16%	16%	16%	16%
6	15%	15%	15%	**15%*13**	15%	15%	15%	15%	15%
7	13%	13%	**13%*12**	13%	13%	13%	13%	13%	13%
8	10%	**10%*11**	10%	10%	10%	10%	10%	10%	10%
9	**6%*10**	6%	6%	6%	6%	6%	6%	6%	6%
result	**0.6**	**1.1**	**1.56**	**1.95**	**2.24**	**2.1**	**1.76**	**1.02**	**0.36**
waste-LIB in 2019	0.6 + 1.1 + 1.56 + 1.95 + 2.24 + 2.1 + 1.76 + 1.02 + 0.36= **12.65**								

33. The above example illustrates the principles of the method. To assist Parties in applying the method, an spreadsheet-based tool has been developed and is accessible on the website of the Basel Secretariat.[7] The tool contains probability distributions for all applications listed in Table 1. The useful life of a certain application might be shorter in one country while in another it could be longer and the distributions might differ regionally. The distributions provided in the tool aim at representing average values. In addition, some of the applications include a wide variety of products: e.g., power tools include cordless chainsaws which have a large battery, while drills also included in power tools have significantly smaller batteries. The values provided in the tool attempts to cover a wide range of applications, but adjustments might be needed depending on the market situation in each country.

[7] http://www.basel.int/?tabid=9043.

4.4 Refining the first-generation inventory

34. For an initial inventory, the amount of waste-LIB generated can be estimated for the Portable applications sector only. Since this sector accounts for the largest share of the market for LIB in most countries, the inventory output will provide an estimate of the bulk of waste-LIB generated at present. Countries without an electronics manufacturing industry can estimate the amounts placed on the market based on import statistics (UN Comtrade). However, in the mid to long-term, traction batteries from electric vehicles will likely represent by far the largest volumes of LIB globally. Information on vehicle registration can be obtained directly from government authorities. A small survey of key actors, such as vendors of automobiles and LIB as well as repair shops can provide information on the lifespan of LIB for various types of vehicles (BEV, PHEV, HEV).

35. To refine the first generation inventory, data can be collected from additional sources of information such as those listed in Table 3 if these are relevant for the country. Field visits and interviews to collect more detailed information for the most important applications will also provide a more complete and accurate picture of the amount of waste-LIB generated nationally, particularly regarding stationary applications.

5 Preparing national summaries and forecasts

36. If the inventory has been developed based on information from a limited geographic area, then the estimated amount of waste-LIB generated in that area must be extrapolated to the whole country to obtain a national estimate. If for instance a large city has information on amounts of waste-LIB from portable applications for the area, the number could be divided by the inhabitants of the area resulting in waste-LIB from portables per capita. Multiplying it by the number of inhabitants in a country results in a rough estimate for the whole country based on a relatively small set of data. Forecasting in the early years following the development of an initial inventory of waste-LIB may be difficult. If policies affecting the transport sector, renewable energy generation and telecommunications are well established, then forecasting the changes in LIB use can be performed with a degree of certainty. For instance, some countries have announced that from e.g. 2030 no more passenger vehicles with internal combustion engines will be sold. This will have a significant impact on LIB PoM in electric vehicles. The preparation of a historical database for portables applications for the previous 5 years can help to examine trends in LIB use in this category in order to prepare a forecast.

37. Information on the total amount of hazardous wastes generated is requested in table 6 of the national reporting format. Parties have the option of providing detailed information concerning specific hazardous wastes categorized according to the codes of Annex I or VIII to the Basel Convention or national codes. Further instructions can be found in the Manual for completing the format for national reporting under the Basel Convention.[v]

6 Obtaining data on options for final disposal and recovery

38. Information on options for the final disposal and recovery of hazardous wastes and other wastes available in a country are to be provided in table 2 and table 3 of the national reporting format, respectively. It is therefore important to collect information on existing facilities for the disposal and recycling of waste-LIB in the course of developing the inventory (see e.g. CEC, 2045[vi]). Information on the amount of waste-LIB processed by these facilities can also be cross-checked against the amount of waste-LIB generated to assess the accuracy of the latter (see section 9). When such facilities do not yet exist, information collected on alternative disposal practices will help in devising an appropriate strategy for the ESM of waste-LIB.

7 Obtaining data on the transboundary movements of used lithium ion batteries

39. Parties to the Basel Convention have the obligation to designate one or more authorities (competent authorities) for approving the transboundary movements of hazardous wastes and other wastes. Competent authorities should therefore maintain a record of annual imports and exports of waste-LIB. Parties should provide this information in table 4 (export) and table 5 (import) of their national report.

8 Updating the inventory

40. Applying the methodology described in section 4 provides an estimate of the amount of waste-LIB generated in a given year. To monitor the amount of waste-LIB generated every year it is

recommended to establish a procedure for collecting the needed information from sources on a regular basis so that the inventory can be updated. For instance, a procedure could be established to send out the questionnaires to the data sources at a given date each year. Similarly, since information on the import and export of waste-LIB will likely vary from year to year, the data can be updated by obtaining it from the competent authorities or UN Comtrade on an annual basis.

9 Assessment of results and conclusions

41. It is important to assess the results of the inventory to identify measures that can make it more complete. Key elements to be assessed include the reliability of the data collected and the accuracy of the results. The assessment may also identify potential gaps in the control system for the implementation of the Basel Convention.

42. One approach to assessing the accuracy of the waste-LIB inventory is to compare the amount of waste-LIB generated to independent information on the flows of the waste-LIB in the country. For a country where waste-LIB recycling facilities exist, assuming that all waste-LIB are recycled by these facilities, the amount of waste-LIB processed by the recyclers should be equal to the sum of the amount imported and generated domestically minus the amount exported, if any. If a country exports all the domestically generated waste-LIB for disposal (recycling), the amount of waste-LIB generated should be close to the amount exported.

43. Licensed waste-LIB recyclers should keep records of the amount of waste-LIB recycled. Depending on how waste-LIB are classified and notified to the competent authorities, the information provided may not be easily translated into quantities of waste-LIB (in tons) and directly compared to the amount of waste-LIB generated. Furthermore, if waste-LIB are shipped together with other wastes, the competent authority may record the weight of the consignment but not of each waste within.

44. Discrepancies between the amount of waste-LIB generated and the amount disposed/recycled domestically and/or exported could be due to a number of reasons that are worth investigating. They could indicate inaccuracies in the data collected, poor record keeping, differences in classification, missing data, etc. In some cases, consulting other sources of information may also help to resolve discrepancies; for instance, information on the transboundary flows of waste-LIB could also be obtained from customs authorities and the UN Comtrade database.

45. Discrepancies could also point to potential gaps in the control system for the transboundary movements of waste-LIB and areas where measures are needed to ensure the environmentally sound management of this waste. For example, deficits in the export of waste-LIB could be an indication that some waste-LIB is exported illegally, without notification to the competent authorities. In some countries, a proportion of waste-LIB generated could be disposed of through informal recycling rather than licensed recycling facilities.

10 References

[i] ICC (Committee for Administering the Mechanism for Promoting Implementation and Compliance of the Basel Convention). 2014. Methodological guide for the development of inventories of hazardous wastes and other wastes under the Basel Convention. Available at: http://www.basel.int/portals/4/download.aspx?d=UNEP-CHW.12-9-Add.1.English.pdf

[ii] UNEP. 2013. Framework for the environmentally sound management of hazardous wastes and other wastes. UNEP/CHW.11/3/Add.1/Rev.1

[iii] Lightning Global. 2019. Lithium-ion Batteries Part I: General Overview and 2019 Update. Available at: https://www.lightingglobal.org/wp-content/uploads/2019/06/Lithium-Ion_TechNote-2019_update.pdf

[iv] Technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention. UNEP/CHW.12/5/Add.1/Rev.1.

[v] UNEP. 2019. Manual for completing the format for national reporting under the Basel Convention. Available at http://www.basel.int/Countries/NationalReporting/tabid/8754/Default.aspx

[vi] CEC. 2015. Environmentally Sound Management of End-of-Life Batteries from Electric-Drive Vehicles in North America. Montreal, Canada: Commission for Environmental Cooperation. 103 pp. Available at www3.cec.org/islandora/en/item/11637-environmentally-sound-management-end-life-batteries-from-electric-drive-vehicles-en.pdf

Annex

Example of a questionnaire for the survey of LIB use in stationary storage applications

Dear Sir/Madam,

This questionnaire is for collecting data on lithium-ion batteries (LIB) to determine the amount of waste that results from their use. The information you provide will only be used for the purpose of developing an inventory of waste lithium-ion batteries. Thank you for your cooperation.

Section A: Respondent information

Name	
Role/title	
Organization	
Address	
Telephone	
E-mail	
Date of completion	

Section B: Information on the use of LIB

1. Please check the application for which LIB are used in your organization. For each application, indicate the number of systems/equipment /plant that use LIB.

Applications	Check if applicable	Number of systems/equipment
Electricity supply: back-up power and/or load levelling systems		
Solar energy storage systems		
Telecommunication and mobile phone facilities		

2. For each system/equipment reported above, please provide answers to the following questions in the table below:

a) What is the average capacity (in kWh) or weight (in kilograms) of a LIB system?

b) What is the type of LIB in the system? Please indicate if the LIB used in the system is new or used?

c) What is the lifespan of the LIB system used? (The lifespan is the number of years between the time of first use of the LIB to the time of its disposal)

System/equipment	(a) Number of LIB systems	(b) Types of LIB	(c) Is LIB new or used?	(d) Average capacity of LIB systems (kWh)	(b) Average weight of LIB (kg)	(c) Lifespan (years)
1						
2						
3						

____