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EUROPEAN BENCHMARK OF THE BATTERIES AND ACCUMULATORS EPR SCHEME

Methods for determining the average unit weights of portable batteries and accumulators
Management of used electric mobility batteries

REPORT

EXPERTISES

Direction de la supervision des filières REP

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ABSTRACT

The Extended Producer Responsibility (EPR) scheme for batteries and accumulators is one of the first European EPR schemes, established in Europe in 1991. Several Member States have fulfilled the targets set by Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators. The new EU Battery Regulation currently being negotiated between the European Commission, Parliament, and Council, which repeals the latter, is about to set new ambitious targets, including collection rates and management of mobility batteries.

ADEME commissioned RDC Environment to carry out a benchmark concerning the management of this scheme in the various EU Member States, focusing on two subjects:

- The methods / standards for calculating the average unit weight of portable batteries and accumulators, which impact the calculation of the collection rate that is reported to the European Commission;
- The management of batteries used for light and heavy electric mobility.

After an appropriation of the French situation on these two points, 5 standards (BATBASE, ECOBATTERIEN's method, RESCSER OY assistance to producers' declarations , CDCNPA Guidelines, ECOBAT assistance to producers' declarations) and 5 countries (Germany, Belgium, Spain, Norway, Netherlands) were chosen for the in-depth analysis. Subsequently, a cross-sectional analysis led to conclusions and recommendations for the French scheme.
Concerning the method for determining the average unit weights of portable batteries and accumulators, the study recommends working with a harmonised and prescriptive standard of average unit weights for the key references at the French level. This concerns the two Producer Responsibility Organisations (PRO) COREPILE and SCRELEC which are officially approved by public authorities. In addition, in the medium term, it is desirable to harmonise methods at European level. The French public authorities could take this debate to the European level.

At the national level, it is recommended to use a Pareto approach to draw up a harmonised French standard per battery reference for a selection of priority standard references. The study defines the key stages for the development of such a reference system. The PROs should be free to impose or suggest their own reference weights for additional references or to suggest reference weights per device.

The main issues of battery waste management are different for light and heavy mobility. An analysis of the specificities observed per country studied is included in the report.

For light mobility, the scheme operates in a very similar way to the portable battery scheme in Europe in general, including France. Indeed, the operators and operating modes are very similar. The main elements to be considered in the design of the scheme are the regulatory obligation for this category of batteries, the management of the safety of collection points, the supervision of the repair and second life activities under development, and the creation of a specific category for light mobility in the regulations to have specific collection targets for this category.

For heavy mobility, there are two main issues for the scheme in Europe. The first is the choice between a "pay-as-you-sell" or a "pay-as-you-collect" fee scale. The second issue is the expectation of some car manufacturers to individually control the operational management of heavy mobility batteries in view of the objectives expected in the European Battery Regulation regarding the incorporation of recycled materials and second life projects, while on the contrary, other actors prefer a collective system. The different options chosen by the Member States studied to meet these expectations are detailed in the study: fee scale, financial guarantees, individual, collective or hybrid system, etc.

RÉSUMÉ

La filière à responsabilité élargie du producteur Piles et Accumulateurs (PA) est l'une des premières filières REP européennes, instaurée en Europe en 1991. Un certain nombre d'États membres ont atteint les objectifs fixés par la Directive 2006/66/CE relative aux piles et accumulateurs ainsi qu'aux déchets de piles et d'accumulateurs. Le nouveau Règlement européen sur les batteries en cours de négociation entre la Commission européenne, le Parlement et le Conseil de l'UE, abrogeant cette dernière, prévoit de nouveaux objectifs ambitieux, notamment de taux de collecte et de gestion des batteries de mobilité.

L'ADEME a missionné RDC Environment pour réaliser un benchmark concernant la gestion de cette filière dans les différents États membres de l'Union européenne, autour de deux sujets :

- Les méthodes d'élaboration des poids moyens unitaires des piles et accumulateurs de catégorie portable, qui influent sur le calcul du taux de collecte rapporté à l'UE ;
- La gestion des batteries de mobilité électrique légère et lourde.

Après une appropriation de la filière française sur ces deux points, 5 référentiels (BATBASE, Méthode d'ECOBATTERIEN, Aide à la déclaration de RESCSER OY, Lignes directrices du CDCNPA, Aide à la déclaration d'ECOBAT) et 5 pays (Allemagne, Belgique, Espagne, Norvège, Pays-Bas) ont été choisis pour l'analyse approfondie. Par la suite, une analyse transversale a permis d'aboutir à des conclusions et des recommandations pour la filière française.
Pour la méthode d'élaboration des poids moyens unitaires des piles et accumulateurs de catégorie portable, l'étude recommande de travailler avec un référentiel harmonisé et prescriptif de poids unitaires moyens au niveau français, pour les deux éco-organismes agréés Corepile et Screlec, et pour les références clés. Par ailleurs, à moyen terme, il est souhaitable d'harmoniser les méthodes au niveau européen. Les pouvoirs publics français pourraient porter ce débat au niveau européen.

Au niveau national, il est recommandé de s'appuyer sur une approche Pareto pour l'élaboration d'un référentiel harmonisé au niveau français par référence de batterie pour une sélection de références standards prioritaires. L'étude définit les étapes clés pour l'élaboration d'un tel référentiel. Les éco-organismes devraient pouvoir imposer ou proposer leurs propres poids de référence pour des références complémentaires ou proposer des poids de référence par appareil.

Les enjeux de la gestion des déchets de batteries sont différents pour la mobilité légère et pour la mobilité lourde. Une analyse des spécificités observées par pays étudié est reprise dans le rapport.

Pour la mobilité légère, la filière fonctionne de manière très similaire à la filière des batteries portables en Europe en général, y compris en France. En effet, les opérateurs et les modes de fonctionnement sont très semblables. Les éléments principaux à prévoir dans la conception de la filière sont l'obligation réglementaire pour cette catégorie de batteries, la gestion de la sécurité des points de reprise, l'encadrement des activités de réparation et de seconde vie en cours de développement et l'établissement d'une catégorie spécifique à la mobilité légère dans la réglementation en vue d'un calcul des objectifs de collecte.

Pour la mobilité lourde, il y a deux enjeux principaux pour la filière en Europe. Le premier est le choix du type de barème en « pay as you sell » ou en « pay as you collect ». Le deuxième enjeu est l'attente de certains constructeurs automobiles de maîtriser de manière individuelle la gestion opérationnelle des batteries de mobilité lourde en vue des objectifs attendus dans le Règlement européen Batteries relatifs à l'incorporation de matières recyclées et des projets de seconde vie, sachant que d'autres acteurs préfèrent un système collectif. Les différentes options retenues par les Etats Membres étudiés pour répondre à ces attentes sont détaillées dans l'étude : barème, garanties financières, système individuel. collectif, ou hybride…

1. Background and objectives of the study

The Extended Producer Responsibility (EPR) scheme for batteries and accumulators is one of the first European EPR schemes. Introduced in Europe in 1991 and implemented in France in 2009, it is an EPR scheme that is now well established. Several Member States have achieved the targets set by Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators. The new EU Batteries Regulation currently being negotiated by the European Commission, Parliament, and Council, which repeals the latter, sets new ambitious targets.

However, due to market developments (increase in the number of electric vehicles and personal mobility equipment placed on the market) and with a view to homogenising and improving the performance of the French scheme, ADEME wishes to study two specific points concerning the management of this scheme in the various EU Member States:

- The methods / standards for calculating the average unit weight of portable batteries and accumulators (BA), which impact the calculation of the collection rate that is reported to the European Commission;
- The management of batteries used for electric mobility (light and heavy) and the creation of EPR schemes for these categories of batteries.

1.1. Determination of average unit weights

Like all other EU Member States, France must meet the collection targets of 45% by 2016 as it is set out in Directive 2006/66/EC. The 45% collection rate has been set out in the obligations imposed on Producer Responsibility Organisations (PRO) in charge of portable batteries and accumulators[1], which are officially approved by public authorities.

The collection rate is calculated as follows, considering the average of products placed on the market during the last three years':

$$Collection\ rate = \frac{3\ \times quantities\ collected\ during\ year\ N}{(quantities\ placed\ on\ the\ market\ during\ years\ (N) + (N-1) + (N-2))}$$

This is one of the key indicators of the scheme's performance, calculated annually by ADEME using the producers' declarations on SYDEREP via the PROs (website dedicated to the EPR scheme declaration system). This calculation is based on the use of an average unit weight for each type of battery and accumulator (electrochemistry) to convert the number of batteries and accumulators placed on the market into tonnage.

However, the European Commission has not imposed a methodology or reference system for defining these unit weights. In general, there are several methods for converting numbers of units into tonnages, including internal measurement campaigns on a sample and the use of a standard, such as the European BATBASE standard[2] . The unit/weight conversion methods have an impact on the determination of the collection rate: underestimated tonnages placed on the market can thus lead to an artificial increase in the collection rate. To date, the two French PROs COREPILE and SCRELEC do not use the same method, the former using the BATBASE standard while the latter relies on unit weight declarations from its members.

To harmonise and compare data between the different actors, and in view of the limited information previously available on the subject, ADEME wants to study the different methodologies and data used in France and in the EU Member States to determine the average unit weight of BAs and therefore the tonnages placed on the market.

This work will enable ADEME:

- To outline a position regarding the BATBASE standard for average unit weight calculation, in the context of both the re-accreditation of French Producer Responsibility Organisations, and of the negotiations on the future European regulation on batteries, repealing Directive 2006/66/EC;
- To define a French method for determining these unit weights;
- To harmonise the data reported annually to the European Commission in the context of mandatory reporting.

[1] A portable battery or accumulator is any battery, button cell, battery pack or accumulator that is sealed and can be carried by hand and is not otherwise an industrial battery or accumulator or an automotive battery or accumulator.

[2] The European BATBASE standard provides minimum and maximum unit weight values for each type of battery and accumulator and can be consulted online: https://mybatbase.bebat.be/fr/faq/faq-listenumerosnomenclature/ . The French PRO COREPILE has been using this standard since 2016, in contrast to SCRELEC.

1.2. Management of electric mobility batteries

Electric mobility is growing rapidly in France and Europe, in all market segments.

- In terms of heavy mobility, while fewer than 1,000 electric and hybrid vehicles (including utility vehicles) were on the road in France in 2010, this figure has risen to 310,000 vehicles in 2020, including 246,000 electric vehicles[3]. The European Commission's plan to ban new thermal cars by 2035 (including plug-in hybrids), voted by the European Parliament in June 2022, will reinforce this trend. The electric propulsion of heavy-duty vehicles (lorries) is still marginal[4] .
- In terms of individual light mobility (electric bikes, e-scooters, gyropods, etc.), there are more than 2 million users of electric scooters, with very high growth rates (+34% between 2019 and 2020) and sales of 640,000 units in 2020[5] . Similarly, the growth in sales of electric bikes was 29% in 2020, with 514,000 units sold. The penetration rate of electric bikes is 19% in France, while it is almost 40% in Germany and 50% in Belgium and the Netherlands, indicating a potential of residual growth for this sector[6] .
- Electric motorised two- and three-wheelers and quadricycles have also been enjoying a rapid growth since their arrival on the market in 2014, with a market share in new vehicle registrations rising from 1% in 2015 to 6% in 2020 in France, reaching 18,793 units according to the same reference from the Ministry of Ecological Transition.

Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators places used electric mobility batteries in the category of industrial batteries and accumulators, regardless of the market segment[7] . However, while the Directive requires the setting up of collection systems financed by producers for portable batteries (Articles 8 and 16), it only foresees a take-back obligation for industrial batteries and refers the financing of collection systems to agreements between producers and users of batteries and accumulators[8]. The European Regulation in preparation provides for various revisions which aim at better managing electric mobility batteries, notably by including specific categories for heavy electric mobility batteries and for light electric mobility batteries (used in Light Means of Transport) whose obligations should be similar to those of the portable battery category.

The French regulations governing industrial batteries and accumulators and transposing the current European Directive are no longer appropriate for managing the growing quantity of mobility batteries for several reasons:

- Light mobility batteries (electric bikes, scooters, etc.) are not subject to a collection system financed by producers, even though they are largely owned by private individuals, and can, by analogy, enter the collection points and schemes of the portable battery and accumulator scheme without any associated financing;
- The interface with the WEEE and ELV EPRs (funding for the logistics of batteries from devices) and with other categories of batteries (industrial outside of mobility, automotive, portable) has not been specifically planned[9].

ADEME wanted to carry out a European benchmark of electric mobility battery management methods to understand different elements:

- How did other EU Member States organise themselves to articulate the EPR schemes for BA with the other EPR schemes concerned by the mobility sector (WEEE for individual mobility and ELV for heavier motorised vehicles), and the extended producer responsibility for the different categories of batteries and accumulators? ;
- How has the regulatory framework evolved (obligations of the scheme, specific objectives, etc.)? ;
- How are the scheme operations and financing organised in the different Member States?

This work will provide public authorities with elements enabling them to observe the evolution applicable to the French scheme.

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[3] https://www.ecologie.gouv.fr/developper-lautomobile-propre-et-voitures-electriques

[4] SoeS, 2020 https://www.statistiques.developpement-durable.gouv.fr/le-parc-de-poids-lourds-en-circulation-est-stable-au-1er-janvier-2020?rubrique=58&dossier=1347

[5] PF2M Smart Mobility Lab (2021) Micro Mobility Barometer 2020

[6] "The electric bike is driving a fast-growing cycle market in 2020", Les numériques, April 2021 https://www.lesnumeriques.com/velo-electrique/le-velo-electrique-dynamise-un-marche-du-cycle-en-forte-croissance-sur-2020-n162397.html

[7] Industrial battery or accumulator: any battery or accumulator designed for exclusively industrial or professional purposes or used in any type of electric vehicle;

[8] Article 8: "Member States shall ensure that producers of industrial batteries and accumulators, or third parties acting on their behalf, do not refuse to take back waste industrial batteries and accumulators, regardless of their chemical composition and origin, from end-users. Independent third parties may also collect industrial batteries and accumulators." Article 16: "Producers and users of industrial and automotive batteries and accumulators may conclude agreements setting out financing methods other than those referred to in paragraph 1.

[9] It should be noted, however, that European regulations do require the removal of batteries from ELVs and WEEE.

2. Methodology

This chapter defines the methodology that was applied in this study.

2.1. Average unit weight standards

2.1.1. Appropriation of the French situation

COREPILE and SCRELEC were interviewed to identify the characteristics of the methods used and their objectives.

The average weight standards per battery reference used by the two PROs were obtained to make statistical comparisons between the average unit weights used by these two organisations, and with the standards identified abroad.

Direct contacts with the main primary cell manufacturers did not allow us to obtain feedback from users on the methods applied in France. A survey was sent to 67 members of the two PROs via the contact details available on SYDEREP. Only about 30 members received the survey (the contact details were not up to date for many companies), and 4 responses were received.

2.1.2. European benchmark on unit weight standards

The research aimed to be exhaustive on the methods used at European level. 25 countries were thus contacted (via one or more of their PROs) as part of the study to establish a state of play of methods and standards used, to determine the unit weights of batteries and accumulators:

- Germany
- Austria
- Belgium
- Bulgaria
- Cyprus
- Croatia
- Denmark
- Spain
- Estonia
- Finland
- Greece
- Hungary
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- Netherlands
- Poland
- Portugal
- Czech Republic
- Romania
- Slovakia
- Slovenia
- Sweden
- Norway

Of these 25 countries, 9 did not respond to the survey: Portugal, Ireland, Croatia, Hungary, Bulgaria, Slovakia, Greece, Cyprus, and Latvia. Malta was not contacted as there is no PRO in this country.

Following this broad benchmark, 5 methods were analysed in depth, after validation by ADEME:

- BATBASE (Belgium, Netherlands)
- ECOBATTERIEN's method (Luxembourg)
- RESCSER OY assistance to producers' declarations (Finland)
- CDCNPA Guidelines (Italy)
- ECOBAT assistance to producers' declarations (Czech Republic)

The reasons for selecting these methods are provided in section 3.2.2.

The PROs in charge of these methods have been interviewed. They did not wish to provide direct contacts of their members so that we could ask for their feedback on the feasibility and reliability of the methods used. Therefore, the surveys circulated via EPBA (European Portable Battery Association) and via certain PROs[10] to obtain feedback from producers. The feedback received was limited (3 from RECSER OY members and 3 from EPBA members).

Batteries and accumulators were not weighed in the context of this mission (outside the scope of the mission).

[10] All PROs were asked to distribute a survey.

Organisation	Country	Name	Function
EPBA	EU	Hans CRAEN	Secretary General
BEBAT	Belgium	Martine VANHEERS	Director of Finance, Customer Service, Legal & Public Affairs
STIBAT	Netherlands	Harm NOORMAN Wendy WIELINK	Director and Producer Services Coordinator
ECOBATTERIEN	Luxembourg	Andy MAXANT	Director
CDCNPA	Italy	Luca TEPISCH	Secretary General
COBAT	Italy	Andrea CARLUCCIO	Social responsibility and service
ERION	Italy	Emilia CROCELLE	Support for producers
RECSER OY	Finland	Liisa Marie STEINBACK	Operational Director
ECOBAT	Czech Republic	Petr KRATOCHVIL	Director

Table 1 : List of stakeholders interviewed for the in-depth analysis

2.2. Management of electric mobility batteries

A literature review was conducted to identify the most relevant EU Member States for an analysis of the management of electric mobility batteries. European experts were also consulted. The Monitoring Committee's members were also consulted prior to the selection. The final selection was approved by ADEME.

The following selection criteria were used:

- Country coverage relevant for light and heavy mobility, both market segments are included in the study;
- Maturity of the electric mobility market (number of vehicles, market share);
- Existence of PROs in charge of batteries, and links with the ELV or WEEE EPR;
- Diversity of governance and funding models;
- Existence of second life schemes;
- Typology of different countries (Northern and Southern Europe).

The 5 countries finally selected were:

- Germany: it is the largest European market for electric and hybrid vehicles,
- Belgium: it is the largest European market for electrically assisted bikes. It has an EPR scheme for light mobility and a competition between two PROs from the BA and ELV schemes for heavy mobility (electric and hybrid vehicles),
- The Netherlands: it is the largest European market per capita for electrically assisted bikes. It has an EPR scheme for heavy mobility batteries, associated with the ELV EPR, and a scheme for light mobility batteries, associated with the BA EPR,
- Spain has an active ELV scheme in the management of mobility batteries and is one of the leading European countries in car manufacturing. It is a southern country with a similar population density to France.
- Norway: it is the European market with the highest penetration rate of electric and hybrid vehicles,

Data on volumes placed on the market are included in the chapters on countries in section 0.

For each country, telephone interviews were conducted to explore the regulatory, operational, and financing aspects of the light and heavy mobility scheme.

The actors interviewed are the following:

Organisation	Role	Country	Name	Function
UBA	Public authorities	Germany	Regina KOHLMEYER	ELV, batteries and WEEE EPR Section
UBA	Public authorities	Germany	Axel STROBELT Falk PETRIKOWSKI	EPR Section Batteries and used batteries
LRP	ELV centres	Germany	Marius POHL	Plant Manager
BEBAT	BA PRO	Belgium	Martine VANHEERS	Director of Finance, Customer Service, Legal & Public Affairs
FEBELAUTO	ELV and heavy mobility BA PRO	Belgium	Catherine LENAERTS	Director
OVAM	Public authority - waste resources agency	Belgium	Marleen DIRCKX Lies VERLINDEN	In charge of the BEBAT EPR In charge of the FEBELAUTO EPR
BRUSSELS ENVIRONMENT	Public authority - agency and Ministry of the Environment	Belgium	Frederik LESSELIERS	Waste Department
SIGRAUTO	Association ELV EPR	Spain	Manuel KINDELAN	Director
ECOPILAS / RECYCLIA	PRO	Spain	Virginia BLASCI Jorge DE GRADO	Management support Environmental technician
MITECO	Public authority - Ministry of the Environment	Spain	Gabriel Santervás GOMEZ	Circular Economy Department
ARN	ELV and heavy mobility BA PRO	Netherlands	Janet KES	CEO and Director of Public Affairs
STIBAT	BA PRO	Netherlands	Harm NOORMAN Wendy WIELINK	Director and Producer Services Coordinator
RAI	Federation of car manufacturers	Netherlands	Gerard KONING	Green mobility manager
RWS	Public authority - environment agency	Netherlands	Arjen BROUWER	EPR Advisor
NEW	Public authority - environment agency	Norway	Ole Thomas THOMMESEN	Senior Advisor, Circular Economy
AUTORETUR	ELV PRO	Norway	Guro Kristine MILLI	Senior Advisor

NORSIRK	BA and WEEE PRO	Norway	Morten ONSRUD	Director of Battery Compliance

Table 2 : List of stakeholders interviewed for the in-depth analysis

In Germany, GRS BATTERIEN (in charge of a voluntary mobility EPR scheme), VDA (federation of car manufacturers) and BMW did not respond to the interview requests. The interviews with UBA and LRP were supplemented by extensive literature reviews and data obtained from a telephone interview with GRS BATTERIEN conducted by RDC Environment in 2019.

In Norway, BATTERIRETUR, in charge of the heavy mobility batteries EPR scheme, did not respond to the interview requests. Literature reviews and consultations with other stakeholders in the scheme did not allow us to clarify the whole functioning of the scheme in this report.

3. Methods for calculating average unit weights

3.1. Methods for calculating average unit weights used in France

3.1.1. Presentation of the actors

In France, two PROs are responsible for the extended producer responsibility of portable batteries and accumulators: COREPILE and SCRELEC.

COREPILE's members place on the market around 22,000 tonnes of PBAs per year. 75% of these tonnages are primary batteries (single use batteries) and 25% are secondary batteries (rechargeable batteries), also known as accumulators. In comparison, SCRELEC's members place on the market around 13,000 tonnes of PBAs, with primary batteries accounting for 40% of tonnages and secondary batteries for 60%.

In the past, the differentiation between COREPILE and SCRELEC based on their members' primary/secondary battery typology was stronger. Today, members do not choose one or the other of the two PROs according to this criterion.

COREPILE's members include some of the largest battery manufacturers (DURACELL, ENERGIZER, etc.) and many retailers (both for primary batteries from retailer's brands and for batteries incorporated into electrical or electronic devices). SCRELEC has fewer representatives of the retail sector among its members but represents more specialised retailers who sell batteries incorporated into electrical and electronic devices (many of its members are producers of tools, toys, etc.).

Therefore, the two PROs represent producers of standardised and non-standardised PBAs. Standardised PBAs have a defined format and therefore a predictable unit weight. They mainly correspond to primary alkaline and saline batteries, lithium, and buttons. Non-standardised PBAs correspond mainly to PBAs integrated into electrical and electronic devices (accumulators).

As a result, most PBAs placed on the market by SCRELEC's members are non-standardised. In comparison, 90% of the tonnages placed on the market by COREPILE's members correspond to 20 standard formats.

In terms of membership, COREPILE and SCRELEC had 1169 and 2093 members respectively in 2021 and since the addition of online marketplaces in 2022, they would have around 4000 and 5000 members respectively.

3.1.2. COREPILE

3.1.2.1. Method of reporting

For standardised PBAs, COREPILE has a reference system of average weights based on the BATBASE database established by the Belgian PRO BEBAT. The standard includes 466 references. Before 2016, COREPILE sometimes corrected the weight indicated in BATBASE to consider more precise information from the producer. Since 2016, COREPILE relies exclusively on the BATBASE (and this for all references included in the BATBASE, and not exclusively for some of the most common references).

For non-standardised PBAs, COREPILE's members directly report the total weight of the quantities they place on the market.

Most COREPILE's members use this reference system indirectly when they declare standardised PBAs. Indeed, for these PBAs, COREPILE's members only declare the reference and the quantities put on the market in number of units. Then, the total weight of these PBAs is automatically calculated by the COREPILE declaration tool using the average weights of BATBASE.

The version of the standard used by COREPILE is the same since 2016. However, according to COREPILE, the average weight of the main formats varies very slightly over time, so regular updating of the standard does not seem necessary to ensure good reliability of the average weights used and therefore of the total weights reported.

It is possible for a registrant to modify the average weights of the standard PBAs proposed by the COREPILE declaration software by filling in a line with their own weight. The method of reporting is the same, regardless of the type of member (manufacturer, importer, retailer).

3.1.2.2. Relationship with EPR fees

The weights declared by COREPILE's members via the average weights of BATBASE (or directly for non-standardised formats) are those used to calculate members' EPR fees and are also those communicated to ADEME on SYDEREP.

The EPR fee scale is expressed in EUR/kg per PBA category (alkaline batteries, saline batteries, lithium batteries, button cells, Ni-MH batteries, lithium-ion batteries, lithium-polymer batteries, lead batteries, Ni-Cd batteries). The EPR fee is therefore calculated based on the declared weight. The price paid corresponds to the actual cost of treatment. The fee scale is also expressed in EUR/unit for standardised formats, the conversion being made via the average unit weights of BATBASE.

3.1.2.3. Verification of declarations

The average weight of standardised formats is therefore imposed on members. Standard sizes can correspond to both primary and secondary batteries (although the latter is less common). For example, the AA size may correspond to a LR6 (primary, alkaline) or HR6 (secondary, NiMH) battery.

For non-standardised formats, COREPILE does not know how its members determine the weight of the declared PBAs. However, these represent a relatively small proportion of the declarations made to COREPILE (83.2% of the total tonnage corresponds to standardised formats with an IEC reference, formats included in the BATBASE).

COREPILE is legally obliged to audit the declarations of some of its members every year. The members audited must represent at least 20% (15% before 2020) of the tonnages declared in the year in question. Errors in declarations are not very frequent, particularly because COREPILE carries out consistency checks when receiving declarations from its members and before transmission to SYDEREP. The unit weight of non-standardised formats is one of the parameters audited. These audits are based on documents, with the supplier's data sheet used to justify the weight of the battery declared by the member. The unit weights in the BATBASE are not updated, as is the case in the BATBASE itself.

3.1.3. SCRELEC

3.1.3.1. Method of reporting

For both standardised and non-standardised PBAs, SCRELEC's members declare the total weight of their quantities placed on the market themselves, in addition to declaring the number of units. For registrants of PBAs integrated into electrical or electronic devices (which represent the majority at SCRELEC), they declare the unit weight of the battery or accumulator, the number of batteries or accumulators per device and the number of devices. SCRELEC does not know the methods used by its members to determine the weight of their quantities placed on the market. Only an audit of a member would provide this information. SCRELEC does, however, provide its members with an average weight standard for certain key standardised references. This reference system is used solely to help members who do not know the weight of their quantities placed on the market. This standard is only indicative, the registrant does not necessarily have to use it. This standard is based on an internal calculation: for a given type of battery, it is the average of the weights declared by the members for this reference. The reference year from which the average weights were calculated is unknown. The standard database has not been updated since its creation, and SCRELEC does not intend to update it in the short term (like the BATBASE used by COREPILE).

There is little information about the weight of PBAs (on PBAs as well as on electrical devices). Therefore, some members consult SCRELEC to obtain information on the weight of certain PBAs. SCRELEC can provide the information if it is a common format for which it has an average weight calculated internally, but generally SCRELEC advises its members to request this information from the manufacturer when purchasing the battery or accumulator.

SCRELEC has integrated confidence intervals for each type of PBA into its declaration software. If the declared weight is outside this interval, the software rejects the entry. This avoids declaration of outliers.

3.1.3.2. Relationship with EPR fees

The weights thus declared are directly used to calculate the EPR fees to be paid by the member. These same weights are communicated to ADEME on SYDEREP. Members must declare their type (manufacturer, importer, retailer) at the time of reporting, but this has no impact on the method of reporting used.

The EPR fee scale is expressed in EUR/kg per PBA category, so the EPR fee is calculated based on the declared weight. The price paid corresponds to the actual cost of treatment. SCRELEC also indicates the price of certain key references in EUR/unit as an indication, the conversion is made using the average unit weights calculated by SCRELEC. Therefore, the member is responsible for the reporting.

3.1.3.3. Verification of declarations

As regards the control of members' reporting, just like COREPILE, SCRELEC is legally obliged to audit a proportion of its members every year. The members audited must represent cumulatively at least 20% (15% before 2020) of the tonnages declared in the year in question. The audit is conducted exclusively based on documents; no device is dismantled to check the weight of the battery.

It should be noted that errors in declarations (on the weight of the battery, the number of batteries or the weight of the device) are very uncommon (three to four per year). For the member concerned, errors can have a significant impact on the declaration (repeated error on many units sold).

3.1.4. Opinions of producers

A survey has been distributed to around 30 producers who are members of COREPILE and SCRELEC to identify their opinion regarding the reliability and ease of use of the methods used in France. Only 4 answers were received (1 from a COREPILE's member and 3 from SCRELEC's members, 1 EEE manufacturer and 3 EEE importers), so the results cannot be extrapolated. No one has reported any difficulties concerning the standards currently used, the ease of use being rated at 4 or 5/5. Only 2 out of 4 respondents commented on reliability.

- Companies indicate that average unit weights are part of their information systems or come from battery manufacturers' data sheets and that this information is readily available.
- A SME member of SCRELEC find it difficult to associate its batteries with an IEC reference if the declarations are associated with this type of nomenclature because this information is not systematically available.
- Respondents were not aware of or did not wish to comment on the methods used abroad.

3.1.5. Cross-sectional analysis

The **Erreur ! Source du renvoi introuvable.** below summarises the characteristics of the standards used by C OREPILE and SCRELEC to determine the average unit weights.

PRO	COREPILE	SCRELEC
Name of the standard	BATBASE 2016	Average of members
Author of the standard	BEBAT	SCRELEC
Users of the standard	COREPILE	Members
Context of use		
Type of declaration by producers	Number of units for standard formats Number of units and weights for non-standard formats (no use of the BATBASE standard)	Units and weights for all formats For batteries and accumulators included in EEE, declaration in addition to the unit weight and number of units
Prescriptive / indicative standard	Indicative By default for standard formats but can be changed	Indicative, allows members who wish to do so to calculate the weight to be declared for some references. All members can also declare their own weight.
Characteristics of the method		
Source of data	BEBAT - BATBASE[11]	SCRELEC's members

[11] However, for 15 references, the unit weight of BATBASE and COREPILE are different, but these references represent less than one percent of the tonnage marketed.

Year of data	2016	Unknown
Updating of data	No	No
Number of references	466 (standard formats)	29
Nomenclature used	IEC	IEC
Transparency of the method	Available on request	Public standard, available with the fee scale No public information on the method used to develop it
Overall assessment		
Advantages	Convenience: members do not need to know the average weight for standard formats Comparability: BATBASE is also used in Belgium, the Netherlands and Germany Allows to display the unit fee scale for key formats BATBASE developed by a PRO with more experience and more resources (BEBAT)	Letting the producers find the average weight themselves is more accurate (SCRELEC is concerned that the BATBASE weights are underestimated) Allows to display the unit fee scale for key formats
Disadvantages	Loss of accuracy compared to the actual weight placed on the market	Low number of references in the fee scale for which an average unit weight is proposed.

Table 3 : Cross-sectional analysis of the reference systems used

The average unit weights used by the two French PROs have been compared in the Figure 1 below.

Electrochemical couple	Nomenclature IEC	Difference in weight between SCRELEC and COREPILE in % (baseline value: COREPILE)
Alkaline batteries	LR6	5.5%
Alkaline batteries	LR03	9.8%
Lithium button cell batteries	CR2032	-6.1%
Alkaline batteries	LR14	1.7%
Alkaline batteries	LR20	5.9%
Alkaline button cell batteries	LR44	0.0%
Saline batteries	R6	15.0%
Alkaline batteries	6LR61	2.7%
Saline batteries	R03	-4.2%
Alkaline batteries	3LR12	1.3%
Lithium button cell batteries	CR2025	4.0%
Lithium button cell batteries	CR2016	5.9%
Saline batteries	3R12	13.5%
Saline batteries	R14	22.1%
Saline batteries	R20	8.3%
Saline batteries	6F22	11.5%
Lithium batteries	2CR11108 2CR1/3N	-1.1%
Lithium batteries	CR2	0.9%
Lithium batteries	2CR5	-2.3%
Lithium batteries	CR123A	-1.2%
Alkaline button cell batteries	LR55	28.6%
Alkaline button cell batteries	LR54	0.0%
Alkaline button cell batteries	LR43	0.0%
Alkaline button cell batteries	4LR44	18.9%
Alkaline button cell batteries	LR9	20.0%

Figure 1 : Comparison of average unit weights used by SCRELEC and COREPILE (primary batteries) Source: SCRELEC, COREPILE

A negative percentage (yellow) means that SCRELEC's value is lower than that of COREPILE.

A positive percentage (purple) means that SCRELEC's value is higher than that of COREPILE.

The unit weights in absolute terms used by COREPILE and SCRELEC are available in the Annex.

The weight variations between COREPILE and SCRELEC (taking COREPILE's weight as the baseline) range from -6% to 29%.

Out of 25 primary PBA references common to both standards (Figure 1), the average weight of SCRELEC is higher than that of COREPILE for 20 references and the average weight of COREPILE is higher than that of SCRELEC for 5 references. 3 references have strictly the same weight.

The variation in weight is greater than or around 10% for 8 battery references: LR55, R14, LR9, 4LR44, R6, 3R12, 6F22, LR03. The weight ranges of these different references are rather heterogeneous (no trend towards heavy or light). Similarly, there is no electrochemical family or battery format (button, stick, etc.) that is over-represented among these 8 references. Therefore, there is no systematic error on a specific type of battery.

3.2. State of play of the methods applied in Europe

3.2.1. Overview

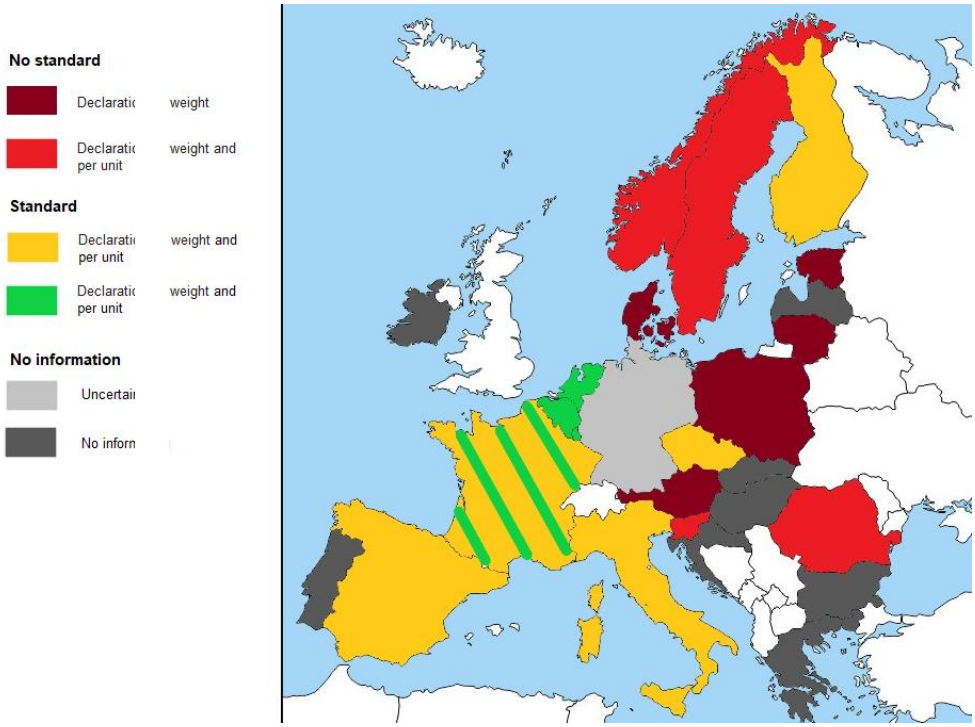


Figure 2 : Overview of the methods used in Europe for determining average unit weights

The benchmark of portable batteries and accumulators EPR systems of different countries enabled to distinguish 5 distinct methods of declaring the quantities placed on the market, which have a direct impact on the existence and type (if any) of standard for calculating the average unit weights:

1) For 6 countries (Lithuania, Estonia, Denmark, Austria, Germany (EPR), Poland), producers only provide **the total weight of the quantities they put on the market.** For these countries, the units are not relevant. The EPR fee scales are expressed in EUR/kg, so there is no standard for average unit weights and the weights are based on the declarations of the producers.

2) In 5 countries (Norway, Sweden, Spain (ECOLEC), Romania (ECOTIC), Slovenia) producers report **the total weight and the number of units** or **the number of units and the average unit weight** (Slovenia). The average unit weight is mostly calculated for statistical purposes from the total weight and number of units, for example to check whether a declared value is an outlier (e.g., industrial batteries or wrong units). However, there is no indicative or prescriptive standard. In Slovenia, average unit weights are reported by producers.

3) In three countries (Italy, Finland (RECSER OY), Spain (UNIBAT)), the producers declare **the total weights and the number of units placed on the market and have a simplified reference system of average unit weights.** In fact, for these countries, the average unit weight is calculated for about ten of the most common battery and accumulator references on the market. These average unit weights are offered as an indication to producers who do not know the weights of the batteries and accumulators they market.

   Both Italy and Finland (PRO RECSER OY) have their own methods for calculating unit weight. The different categories of batteries and accumulators are determined according to the electrochemical system (about 10 categories of portable batteries and accumulators). Each country has its own nomenclature. It is recommended by the CNCPA[12] in Italy but the PROs can adapt the nomenclature. It is specific to each PRO in Finland.

4) In the Czech Republic, producers declare **the total weights placed on the market and the number of units**. The average unit weight is calculated by the PRO ECOBAT CZ which uses the declaration

[12] Centro di Coordinamento Nazionale Pile e Accumulatori, National Coordination Centre for Batteries and Accumulators.

and in case of outliers, can recommend to the producer an average unit weight from an internal database.

5) For three countries (Luxembourg, Belgium, the Netherlands), the producer only provides the **number of units** of batteries and accumulators placed on the market. These three countries use a reference system to calculate the weights placed on the market, by using average unit weights. Belgium and the Netherlands use BATBASE while Luxembourg has its own standard. All three countries use the same IEC nomenclature. The BATBASE and Luxembourg nomenclatures are different.

Methods	Country	Fee scales
1) Declaration by total weight placed on the market (kg, tonnes)	Lithuania Estonia Denmark Austria Germany (ERP) Poland	EUR/kg or EUR/t (all)
2) Declaration by total weight placed on the market and number of units - no use of average unit weight	Norway Sweden Spain[13] (ECOLEC) Romania (ECOTIC) Slovenia France (SCRELEC, COREPILE non-standard formats)	Kr/kg EUR/kg EUR/kg EUR/unit (some references per kg)
3) Declaration by total weight and number of units - and average unit weight is indicated for some references	Italy Finland (RECSER OY) Spain (UNIBAT)	EUR/kg EUR/kg EUR/kg
4) **Declaration by total weight placed on the market and number of units - and average unit weight can be researched to help with declaration**	Czech Republic	EUR/kg
5) Declaration by number of units	Luxembourg Netherlands Belgium France (COREPILE, standard formats)	EUR/unit EUR/unit EUR/unit

Table 4 : Position of countries (and PROs) about reporting methods

[13] The PROs in Spain can choose how they operate.

Undetermined	Control by PROs	Control by public authorities
Estonia	Spain	Poland
Denmark	Italy	Sweden
	Sweden	Romania
	Finland	
	Luxembourg	
	Slovenia	
	France	

Table 5 : Control of declared weights

Some PROs have indicated that they do not check declarations, e.g., Denmark, Estonia. Public authorities in these countries may carry out checks. For the other countries questioned, information on the control of declarations could not be obtained.

3.2.2. Selection of methods for calculating average unit weight

As a result of the inventory, the average unit weight calculation methods selected for further investigation are as follows:

- Belgium and the Netherlands (BATBASE);
- Luxembourg (own standard);
- Finland (own standard);
- Italy (own standard);
- Czech Republic (own standard).

Spain was not selected because the PRO concerned did not wish to participate in the in-depth study due to the lack of remuneration.

Detailed information on each of these standards is provided in the Annex 5.2.

3.2.3. Survey of producers

A survey was distributed to EPBA members to identify their views on the reliability and ease of use of the methods used in Europe. Three responses were received, but two producers based in Switzerland and China indicated that they do not use any of the unit weight standards considered in this study. This could be due to declarations being made by importers or due to respondents' lack of knowledge of the precise declaration systems.

DURACELL indicated that it knows and reports the unit weight of its batteries directly from its mass balance according to a methodology common to all European countries. Reporting the weight of batteries is much simpler than for packaging (of the same batteries). DURACELL is open to simplifications if they do not change the financial contributions to be paid systematically. In practice, some countries require reporting in units, so it is likely that the respondent is not aware of all existing reporting systems.

The subject of unit weight standards does not mobilise producers and knowledge of the declaration system is not widespread among companies.

3.3. Cross-sectional analysis

The sources of data used to establish the average unit weights are declarations from producers (or device retailers if it is a standard by type of device as it is the case in Czech Republic). The information was obtained by different means depending on the country (product data sheets, direct survey of the PRO, average values from the federation, measurements from a retailer).

Three approaches to elaborating the standard were identified:

- A reference system for standard formats only, with non-standard formats being subject to specific weight research by the producer anyway (possibly within a given range). This approach has been adopted by MyBATBASE (Belgium, the Netherlands, COREPILE), Finland and Italy, as well as by SCRELEC. The scope of the reference system is very variable (743, 10 and 16 references, respectively): MyBATBASE aims to be exhaustive as the standard is prescriptive, while Finland, Italy and SCRELEC only provide an indication whose use is voluntary.

- A standard based on a market average (Luxembourg), using the more detailed MyBATBASE standard and data from the neighbouring Belgian market to establish average weights for 4 main categories of batteries (lead and non-lead batteries, sold alone or separately). This standard is not self-supporting and depends directly on the information on average weights, which is supposed to be representative of the market and given by a partner PRO that has a more complete reference system.
- An indicative standard by type of device (Czech Republic), facilitating the search for weights when the battery reference is not known, which seems to be the case for some EEE importers (see the results of the survey of French producers).

Surprisingly, the reference systems offering unit weights for standard formats did not use the same battery references as standard references. Thus, only 4 references are common to the BATBASE (out of 743 standard formats), CDCNPA (out of 16), RECSER OY (out of 10) and SCRELEC (out of 2) reference systems. In addition, significant variations (over 10%) in average unit weights are observed for some of the most widespread references (LR03). No specific trend emerges regarding the variations observed (no reference systematically above the others, no typology of batteries and accumulators with a higher unit weight for certain references).

Batbase IEC nomenclature	Difference in weight between CDCNPA and Batbase in %
LR03	18%
LR6/ZR6	5%
LR14	0%
6LR61	0%
LR20	2%
U9VL	36%
CR14505	-14%
HR6	4%

Table 6 : Variation in unit weights between BATBASE and Recser Oy (baseline value: BATBASE)

Batbase IEC nomenclature	Difference in weight between CDCNPA and Batbase in %
LR03	18%
R03	5%
HR3	33%
FR03	7%
LR6/ZR6	5%
R6	-17%
HR6	17%
KR6	0%
CR14505	-14%
LR14	2%
R14	18%
HR14	3%
LR20	12%
R20	-1%
HR20	4%

Table 7 : Variation in unit weights between BATBASE and CDCNPA (baseline value: BATBASE)

IEC	Change from BATBASE - CDCNPA	Change from BATBASE - RECSER OY	Change from BATBASE - SCRELEC
LR03	17.6%	18%	10%
LR6/ZR6	5%	5%	5%
LR14	2%	0%	2%
LR20	12%	2%	6%

Table 8 : Variation in unit weights between BATBASE and CDCNPA, RECSER OY and SCRELEC (baseline value: BATBASE)

In none of the countries studied are the benchmarks subject to detailed checks by public authorities or comments by producers. The approach to the development of the standard is shared with public authorities, but they are not involved in the choice of methodology or in the supervision of updates. No problems associated with this control approach were identified.

The declarations of the producers are controlled by the PRO, but the extent of these checks varies from country to country:

- Countries based on MyBATBASE control declarations on a sample basis:
  - For standard formats, only the adequacy of the references put on the market with those declared and the number of units put on the market.
  - For non-standard sizes, unit weights, based on the product sheets.
- Countries with indicative standards (Finland, Italy, Czech Republic) control unit weights, and units in case of inconsistencies only, by using product sheets.

None of the actors interviewed carry out checks based on actual measurements (weighing); the check is always based on documents.

3.4. Conclusions

3.4.1. At European level

Conclusion 1. The issue of unit weights is not a debate at European level.

The issue of elaborating quantities placed on the market is not identified by the European Commission or the JRC as a potential source of inhomogeneity for the calculation of collection rates for portable batteries and accumulators. The national competent public authorities are barely involved in the issue of average unit weights.

The stakeholders interviewed, including representatives of PROs and producers, perceive this point as very operational and not as a subject to be discussed. They are not aware of the methods used by other Member States and do not perceive the possible source of inhomogeneity that these methods may create.

Conclusion 2. The methods of reporting used by producers in Europe vary greatly and directly influence the existence and type (if any) of unit weight standards.

Some countries require direct declaration by weight without details on the number of units placed on the market. In this case, there is no standard of average unit weights in place.

Other countries require a declaration of units only (Belgium, the Netherlands, Luxembourg). In this case, the standard must offer references for all batteries and accumulators covering the market, if necessary, with weight ranges for non-standard formats, rather than average unit weights. The standard is therefore prescriptive.

Finally, some countries such as the Czech Republic and Italy, like in France, require a declaration of both weights and units, in which case the standard for average unit weights may be indicative and not necessarily prescriptive.

Conclusion 3. Harmonisation of the French method with other European countries does not seem possible in the short term because there is no consensus or majority system.

There is great inhomogeneity in the declaration systems, standards and unit weights used at European level, including for the same references. Apart from the MyBATBASE system which is used by several countries (Belgium, the Netherlands, Luxembourg, and France with COREPILE), there is no harmonisation.

Therefore, harmonisation with a possible European "system" does not seem possible in the short term since no system is used nor approved by the majority. It is possible to move towards the MyBATBASE system.

Conclusion 4. The design of the system must consider small registrants and the desire to limit free riders.

There is an initial cost to identify the battery reference per device or the average unit weight per reference. Reporting is easier in subsequent years by the development of internal information systems, particularly for larger companies.

A more restricted standard for small registrants (e.g., average weight based on averages of declarations by the largest registrants) allows to limit the cost for small producers. This is seen as a way to limit free riders, especially for small markets (Luxembourg).

Conclusion 5. The development of a standard will no longer be necessary in the long term if the actual unit weights are written on the batteries.

The European Parliament's amendment 452 of 10 March 2022 to the Battery Regulation (Annex VI) under discussion foresees the mandatory inscription of the battery weight directly on the battery[14]. This obligation, if it were to come into effect, could provide information to producers for declarations, making the need for a benchmark obsolete. The project of EU Regulation has not been definitively adopted at the time of writing.

3.4.2. At French level

Conclusion 6. Between the two French PROs, the approach is intrinsically different, and the average unit weights used by producers are different for the common references. There is no evidence to affirm that one standard is more reliable than another.

There is no evidence to favour the average weights used by one PRO over another. The approach adopted by COREPILE allows to harmonise the average unit weights used with the Netherlands and Belgium, and to simplify the declarations for standard formats. The approach adopted by SCRELEC considers that it is the producers' responsibility to declare unit weights but provides an indication for some references.

Conclusion 7. To obtain a harmonised system for declaring the quantities of portable batteries placed on the market at French level, it is necessary to choose:

- **between an indicative (with control) or prescriptive approach;**
- **the size of the standard;**
- **key references for which an average unit weight makes sense (no consensus).**

3.5. Recommendations

Recommandation 1. Work with a harmonised and prescriptive reference system of average unit weights at French level, for both PROs

It is desirable to harmonise the average unit weights used by the two PROs to make the French collection rate more reliable. A prescriptive reference system is therefore proposed for references representing a large part of the volumes placed on the market.

This seems to be acceptable to all French stakeholders if there is:

- A transparent method of calculating average weights;
- A quality database (preferably European via e.g., JRC, EUCOBAT or EPBA for economies of scale, but to be built);

[14] The Parliament's amendment concerns all batteries, not only portable ones (addition to Annex VI part A). It is possible to write the weight on the packaging if it is not feasible on the battery. Article 13 "The markings and QR code specified in paragraphs 1 to 5 shall be printed or engraved visibly, legibly and indelibly on the battery. If this is not feasible or not justified due to the nature and dimensions of the battery, the markings shall be placed on the packaging and on the documents accompanying the battery."

- A method managed (or at least approved) by European or French public authorities;
- Free and open access data for PROs;
- Data that can be modified at France's request if updating is necessary (e.g., changes in chemistries and references). It should be noted that in the case of a standard based on battery reference rather than on device, there is little need to update the unit weights because the weights do not change a lot over time. However, there is a need to consolidate the standard as new references are introduced;
- A pragmatic method to limit costs.

Recommandation 2. In the medium term, it is desirable to harmonise methods at European level to simplify pan-European declarations and achieve economies of scale in the keeping and maintenance of the reference system. The French public authorities could take this debate to the European level.

It would be desirable to harmonise the methods for calculating the quantities placed on the market at European level, since the methods analysed in this study lead to variations in weight of more than 10% for certain common references, with a possible significant effect on collection rates, as well as on the EPR fee paid by the various members.

To harmonise the reference systems, the European PROs will have to harmonise:

- Reference nomenclature: Both ANSI and IEC nomenclatures are used, as well as manufacturer-specific nomenclatures. One importer stated that they did not know the IEC numbers for batteries.
- Key standard references for which an average unit weight is relevant. Only 4 common references were identified.
- The average unit weights for the significant references in terms of products placed on the market, with variations of more than 10% for some key references. The differences in average weights for the same reference can be explained by the fact that the IEC reference is above all a commercial category. The same reference produced by the same manufacturer may cover a dozen different unit weights depending on the range (standard, premium) and the production plants. In any case, reference is a simplification of this reality.

However, it should be noted that the subject is not a priority at EU level or at the level of the various national PROs.

Recommandation 3. Use a Pareto approach to draw up a harmonised French standard per battery reference for a selection of priority standard references (e.g., references > 90% of sales by weight). No standard identified at French or European level has emerged as being the most reliable. It will be necessary to regularly add references with average unit weights to monitor market developments.

It is not necessary and not proportionate to harmonise the average unit weights used for all references because:

- For references placed on the market in small volumes, it is acceptable to rely on producer declarations even if there will be differences between producers, as there is little influence on the collection rate;
- There are several thousand battery references, which makes the construction of a complete standard tedious;
- The extension of the standard to numerous references sold in small volumes makes it more difficult for producers to identify the references when making declarations (in the first year) and requires the nomenclatures to be harmonised.

It is recommended that the prescriptive standard be based on the battery references rather than on the device references. Indeed, an approach by broad device categories requires calculating averages between several items of different brands, which therefore depend on varying market shares. To base all declarations on such a mandatory device reference would require frequent and therefore costly updating of average weights. An approach based on a very granular number of device references is not feasible because the number of device references is even greater than the number of battery references.

There is no data to support one existing standard over another in terms of data reliability. The deviations observed are not systematic and the producers who responded to the surveys believe that each standard is reliable.

Products placed on the market are highly concentrated on a few references, but it tends to change with the increase in sales of rechargeable batteries - more and more references are to be included in the standard. It will therefore be necessary to regularly review the need for additional average unit weight references to ensure that the standard still covers most products placed on the market (Pareto approach). The updating of the reference system could be synchronised with the approval period of PROs (typically 6 years). It is not considered necessary to update the unit weights per battery reference, or only infrequently (e.g., every 10 years), due to the relative stability in weights per reference.

Recommandation 4. Commission a third party to develop a national standard, with stakeholder consultation.

The validation of the standard by the public authorities is perceived as a factor of consensus and reliability by the French stakeholders.

A multi-stage approach is proposed:

- Mission of a third party to carry out or supervise the work of developing the standard and to meet a need for objectivity;
- Survey PROs to identify the battery and accumulator references that make up, for example, 80-90% of the market (threshold to be defined with stakeholders). The declarations on SYDEREP give information by chemistry but not by IEC reference;
- Validation of key references by stakeholders (committee);
- Comparison with European data (EUCOBAT, MyBATBASE) and harmonisation if relevant (or justification of differences or measurement by an independent national agency such as the Laboratoire National de Métrologie et d'Essais for key references for which a compromise is not easy) and then validation of data;
- Publication of the prescriptive reference framework.

Recommandation 5. It is recommended to let the PROs free to impose or suggest their own reference weights for additional references or to suggest reference weights per device to facilitate declarations. The elaboration of an indicative standard at European level by type of device can be encouraged.

For references that are not present in the harmonised reference systems because they represent smaller shares of the market, producers must be able to declare their own weight, but it can be difficult to identify for some producers. Moreover, for some actors, it is the identification of the battery reference that can be difficult.

The PROs must be able to facilitate declarations in these cases by offering:

- an indicative or prescriptive standard for its members, for additional battery and accumulator references not included in the harmonised standard;
- and/or a standard per device that makes it possible to link the reference of the device to that of the battery or accumulator and its weight. Device-specific standards can be particularly useful for importers of devices, who are those who struggle the most in identifying average unit weights. However, the updating of a reference system for each device should be carried out regularly by the PRO, considering market evolution, which is costly. It is recommended that the development of such a reference system be proposed at the European level to limit updating costs.

There is no need to harmonise this additional work at national level as it has little impact on collection rates. Each PRO could decide the level of service provided to their members and the most appropriate type of reference system (per device as in the Czech Republic or a reference system extended to more battery references such as MyBATBASE).

Recommandation 6. The average unit weight standard can also be used for declarations of EEE containing portable batteries or accumulators.

Declarations of EEE should identify the weights of EEE without batteries and accumulators. Information on batteries' average unit weights via a standard could facilitate the calculation of the weight without batteries. This requires coordination between PROs in charge of WEEE and BA, so that the battery unit weight standard is available for the declaration of quantities of EEE placed on the market.

4. Management of used mobility batteries

4.1. Description of the French scheme

There are two streams of electric mobility batteries on the market:

- Light electric mobility batteries[15] (LMT - Light Means of Transport);
- Batteries from electrified vehicles (electric, hybrid or plug-in hybrid) called heavy mobility in this report.

For these two streams, the management of batteries at the end of their life is different in terms of collection, transport, and sorting (at the sorting centre).

After these steps, the distinction between batteries from light electric mobility and electric vehicles is less relevant when batteries are destined for recycling. This is because the processes of discharge and treatment by recycling are not specific. Recycling is specific to the chemistry of the batteries but not to their application. Thus, the same actors will recycle batteries, usually lithium-ion, from both streams, as well as portable or industrial non-mobility Li-ion batteries.

As regards batteries which will have a second life, there remains a distinction between light and heavy electric mobility batteries. The actors, technical models and target applications are different depending on the origin of the battery.

The diagram below summarises the operation of the French electric mobility battery management scheme.

Second life is not a legal term but is a common term used in the flowchart that covers reuse and two terms envisaged under the forthcoming EU Battery Regulation: remanufacturing and repurposing (cf. 4.1.6 for more information)

[15] Includes: bikes, scooters, etc.

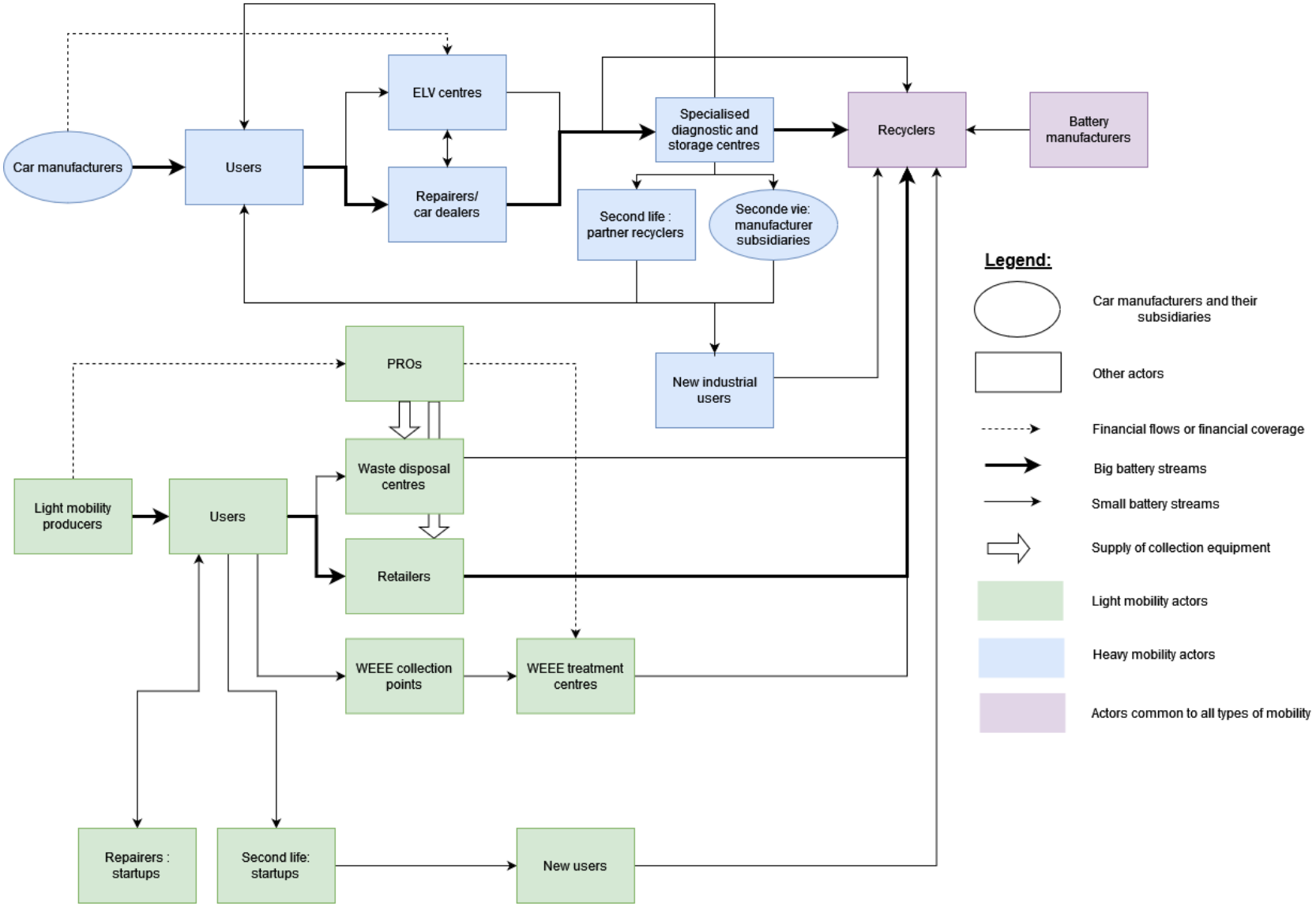


Figure 3 : Flow chart of the management of end-of-life electric mobility batteries in France

4.1.1. The PROs

In France, there is no approved PRO for the management of electric mobility batteries (light or heavy).

The PROs COREPILE and SCRELEC, which are approved for portable batteries and accumulators, have created voluntary collection schemes for light mobility batteries (without approval).

- Since 2018, COREPILE has partnered with UNION SPORT & CYCLE (USC) to collect light mobility batteries.
- Since 2020, SCRELEC has created a partnership with the FEDERATION DES PROFESSIONELS DE LA MICRO-MOBILITE (FP2M) and has developed a collaboration with the PRO ECOLOGIC for the collection of light mobility batteries.

COREPILE and SCRELEC organise the collection and processing of the same waste battery streams, i.e., scooters, electrically assisted bikes, and personal motorised vehicles such as skateboards, gyropods, skates and electric scooters.

They manage waste streams with a relatively short lifespan (about 5 years for batteries from electric bikes, about 2-3 years for batteries from scooters[16]) and operate within an insurance logic, with a certain anticipation of future costs ("pay-as-you-sell"). However, the EPR fee scale can be adjusted according to the costs actually incurred, as the PROs are careful not to build up excessive reserves.

There is no PRO active in the management of batteries for electrified vehicles. Car manufacturers or importers who market electric vehicle batteries currently manage batteries as individual systems without approval, as is the case for the entire ELV scheme and for industrial and automotive batteries. Although there are currently no specifications for these batteries, electric mobility batteries are so-called industrial batteries, and their producers are required to collect and treat their waste. The operation of the electric vehicle battery management scheme is likely to evolve, given the forthcoming European Batteries Regulation and the positioning of the scheme's actors, which is still under construction.

"Pay-as-you-sell", "Pay-as-you-collect".

In Europe, the Battery & Accumulator and/or End of Life Vehicle EPR PROs are involved in the management of electric mobility batteries. Depending on the European countries and the flows, two models for financing the management of mobility batteries by these PROs exist:

- The "Pay-as-you-sell" model where for each battery placed on the market, the producer pays a contribution for the future management of its end-of-life;
- The "Pay-as-you-collect" model where the producer pays a contribution according to the quantities of battery waste collected and processed by the PRO (with a forecast for the coming year).

4.1.2. Collection

4.1.2.1. Light electric mobility batteries

Batteries for light mobility (bikes, scooters) are managed by COREPILE and SCRELEC as part of their voluntary schemes, in addition to their obligations on PBAs. The proportion of the market covered by the voluntary schemes is not known[17]. Producers who are not members of collective schemes must legally take back batteries free of charge, but no such system has been identified.

From an organisational point of view, there are many synergies between the collection scheme and the portable battery scheme:

- The PROs have partnerships with collection points, some of which already collect portable batteries (multi-sport retailers, supermarkets, civic amenity sites) and others which are dedicated to this purpose (bike shops, independent sellers, etc.);
- The PROs have partnerships with WEEE dismantling and sorting centres to recover the batteries disposed of with the device, in the same way as for portable batteries.

[16] Source: FP2M The average lifespan of electric scooters on sale is three years (lifespan of the device). About 10% of batteries come back after one year, and more than 50% in the second year, notes the Federation. On the rental and self-service side, the lifespan of an electric scooter is about six months, and three to six months for the batteries.

[17] 93 members for COREPILE, 18 members for SCRELEC (2021). Placing on the market: 447 tonnes for SCRELEC and 1977 for COREPILE (2021).

For light mobility, 95 tonnes were collected by the COREPILE scheme in 2021 and 21 tonnes in 2021 by the SCRELEC scheme.

The collection of mobility batteries in dedicated collection points presents more risks than the collection of PBAs because they are exclusively Li-ion batteries that can cause fires (no inerting phenomenon by mixing with alkaline and saline batteries). COREPILE has developed specific management techniques for this waste stream, which is different from the primary batteries, which are mainly alkaline and saline batteries. This involves the choice of containers (ADR metal or plastic) and specific management procedures (control at the time of acceptance by the collection point - no free deposit, isolation of connectors, packaging in a bag, provision of vermiculite to wedge the batteries). SCRELEC, which already manages many Li-ion batteries via the collection of most portable batteries from WEEE dismantling centres in France, is adopting the same type of management as for portable batteries: use of ADR containers and distribution of safety sheets to collection points.

In addition to the battery waste collection points listed above, two other actors receive used batteries:

- Repair start-ups that receive used batteries from users who use their service, with or without a partnership with PROs;
- Retailers, as part of the after-sales service for items under warranty. In the context of taking back used batteries for repair, used batteries are not considered as waste when they are deposited by the user with a structure specialising in repair. They become waste if the battery is defective and cannot be re-used, or if the deposit is not made directly with the repairer.

Some start-ups and retailers have dedicated partnerships with PROs for the collection of defective batteries directly on their site.

4.1.2.2. Batteries from electrified vehicles

Batteries collected by the network of authorised repairers and car dealers

Currently, when an electric or hybrid vehicle no longer meets the needs of the owner (in the case of a damaged or defective battery), the owner will mainly turn to the manufacturer (the brand of the car) or to their insurer. The vehicle will then be directed mainly to 2 networks:

- Either the network of approved repairers (by the manufacturers);
- Or the network of car dealership.

Once the electric vehicle is taken to a repairer or car dealer, an initial diagnosis is made to determine the problem with the vehicle and/or the condition of the battery. They will either repair the vehicle and/or its battery or remove the battery from the vehicle.

Vehicle manufacturers provide repairers and car dealers with the information and tools to perform this initial diagnosis and to remove the battery from the vehicle. Communication and knowledge sharing (often confidential) between the manufacturer and the repairer/car dealer on battery diagnosis and management is made possible by the agreement and contracting between these actors.

Once the battery is removed from the vehicle and the vehicle is defined as an ELV, these two elements follow two different schemes:

- The ELVs, without their batteries, are sent to ELV centres;
- There are two possibilities for deposited batteries, depending on the results of the diagnosis:
    - Sending to a specialised diagnostic and storage centre for possible second life (final destination, either recycling or second life will depend on the results of the diagnosis);
    - Sent directly to recycling.

Batteries collected by the ELV centres

Electrified vehicles and the batteries they contain are referred to ELV centres in the following situations:

- Accident vehicles deemed technically irreparable;
- Vehicles that owners want to dispose of to obtain a certificate of destruction;
- Vehicles from impoundments;
- ELVs without batteries brought in by authorised repairers or car dealers, after the battery has been removed.

Currently, few end-of-life electric or hybrid vehicles (and therefore batteries) are collected and treated by ELV centres. In 2020, approximately 1,000 end-of-life electric and hybrid vehicles were received by about 290 ELV centres according to the centres' annual declarations to ADEME via SYDEREP, which represents 17% of ELV centres. Only 20 ELV centres received more than 10 end-of-life electric and hybrid vehicles in 2020. Some ELV

centres are authorised by manufacturers, which implies a formal agreement to share information and procedures for the treatment of end-of-life electric and hybrid vehicles and their batteries.[18]

- The electrified vehicles arriving at ELV centres today are:
- In most cases, vehicles that have been involved in an accident or disaster (known in the insurance industry as "insurance vehicles") are technically irreparable or for which the cost of repair exceeds the residual value of the vehicle (economically irreparable vehicles),
- End-of-life vehicles, vehicles with no residual economic value that the owner wishes to dispose of.

Competencies of ELV centres in battery management capacity vary greatly and are generally in an early state of development. Depending on the ELV centres, the batteries will be:

- Deposited and sent for recycling, in most cases, or more rarely for reuse/repurposing (and only hybrid vehicle batteries),
- Stored and awaiting treatment solution.

The recycler SNAM provides training to ELV centres in dismantling and battery management.

4.1.3. Transport

4.1.3.1. Light electric mobility batteries

This transport is provided by the collection and transport operators who are partners of the responsible PROs via contracts.

4.1.3.2. Batteries from electrified vehicles

Through subcontractors, the recycler transports the batteries from electric vehicles. To do this, they sign B-to-B contracts with car manufacturers for the processing of the batteries of the electric vehicles they put on the market, possibly in the form of exclusivity contracts, whereby the recycler receives all the batteries from a manufacturer. Transport takes place at the request of the manufacturer, either from a garage or from a temporary storage centre that allows the grouping of waste streams from different locations. On rare occasions, recyclers can transport batteries from ELV centres, mainly for batteries from damaged cars.

The transport of the batteries is carried out by semi-trailer; these usually have a capacity of 40 tons.

The transport of lithium-ion batteries is subject to the ADR regulation under a 3480 UN code. In France, Li-ion batteries are not classified as hazardous waste (unlike lead-acid batteries); this is not the case in all EU countries; in Spain, the Netherlands and some German Länder, used batteries are considered as hazardous waste.

The recycler SNAM provides training to transporters in battery management.

4.1.3.2.1. Cross-cutting aspects

From an operational point of view, batteries should be transported in P901 (good batteries) and P911 (defective batteries) containers. P911 containers have a fire extinguishing system, e.g., with a degassing valve, PyroBubbles®, or carbon dioxide snow. P901 containers can be made of wood or plastic to ensure that they are watertight in the event of an impact.

From a regulatory point of view, the ADR transport regulations, and the lack of harmonisation between EU Member States regarding the classification of batteries for hazardousness creates constraints for recyclers. These constraints (e.g., the obligation not to mix batteries with other types of waste) can lead to situations where an electric vehicle battery is transported alone in a truck.

Depending on the national legislation classifying waste as hazardous, the used battery (damaged or not) can be classified as follows according to the European Waste Shipment Regulation n°1013/2006:

- Classified as hazardous "amber waste": a waste shipment notification must be established. This document must be validated by all the competent authorities involved (expedition, destination, transit). The decision considers the type and origin of the waste, the destination and route, and the type of treatment. It takes a minimum of 3 months, and the document can only be issued for the single triptych, i.e., type of waste / departure address / delivery address.

[18] For more information on the figures for ELV treatment, including end-of-life electric and hybrid vehicles, it is possible to consult the annual reports published by ADEME on the ELV treatment scheme. Link: https://librairie.ademe.fr/recherche?controller=search&orderby=position&orderway=desc&search_query=VHU+&submit_search

- Classified as non-hazardous: a "green list contract" is required, which is the contract between the person arranging the transfer and the recipient. The consent of the competent authorities is not required, and the validation is immediately applicable. The shipment of waste must be accompanied by the contract, and the information document, also known as "Annex VII “of the European Regulation.

4.1.4. Sorting

Mobility batteries collected separately via the above-mentioned collection schemes do not undergo any special sorting process as they are already separated by chemistry.

Sorting is only done for PBAs, although some light mobility batteries may be found in them. The streams of these batteries arriving at the recycling facility may be sorted or unsorted. Unsorted waste streams go through a manual sorting stage to separate the waste stream by chemistry. This sorting is done visually and based on the experience of the sorters. In practice, it is a recognition of the shape/weight and size of the battery and then there may be an automatic sorting (screening, magnetic or electromagnetic).

4.1.5. Recycling

Recycling involves several stages: total discharge, dismantling, shredding and finally refining. It should also be noted that the recycling processes are specific to battery chemistry. Recycling facilities are designed for a specific chemistry, so actors will either have several facilities or several lines in the same facility to handle different battery chemistries. Furthermore, for the same battery chemistry, actors may apply different recycling technologies (or a combination of them).

4.1.5.1. Discharge of batteries

Small mobility batteries are not discharged.

For heavy mobility batteries, before dismantling and crushing, the batteries must be fully discharged. Batteries from crashed vehicles are diagnosed to determine the risk of unresponsiveness to the control system and the level of urgency for treatment. If there is no chemical instability and the electronics are switched off, it is possible to wait before treatment.

There are two methods of discharge:

- Resistive discharge - batteries are connected to a resistor in such a way as to exhaust their charge. This method is mainly used for industrial batteries arriving in packs (including electric mobility batteries).
- Electrolytic discharge - batteries are submerged in an electrolyte bath to cause a short circuit. This method is used mainly for large volumes of small batteries when connecting each battery individually to a resistor is not feasible, or where the packs are damaged.

4.1.5.2. Dismantling

When a shredding step is required for processing, the battery must first be dismantled. For now, batteries are dismantled manually: screws and bolts, various electronic components, wiring, BMS, battery shell (aluminium or scrap metal) are removed. Dismantling is necessary because battery crushers are not (at this stage) suitable for crushing the whole battery, as the size of the crusher "mouth" and the crushing force are not sufficient.

It should be noted that dismantling is not a systematic step in the sector; some actors process non-dismantled batteries in their furnaces directly via pyrolysis (for example, UMICORE practised this for years but has since stopped the practice due to difficulties in extracting recoverable fractions).

Dismantling is currently largely done manually because:

- The batteries come in different sizes and formats;
- Incoming volumes are too small to justify investment in an automation solution.

There is little or no standardisation in the format of mobility batteries. It is not uncommon for a car manufacturer to have between 5 and 10 different battery models, depending on the car model, power, etc. Light mobility batteries also vary in size and weight.

Perspectives

With the development of electric mobility, recyclers such as EURO DIEUZE INDUSTRIE (EDI) foresee an increase in the standardisation of batteries. This, together with the increase in the pool of end-of-life batteries and the automation of battery dismantling (possible thanks to standardisation), would allow recyclers to achieve economies

of scale in 5 to 10 years. Tests of automatic dismantling are also being carried out by SNAM. Eventually, there should be dismantling lines by car brand series. In addition, EDI is developing a shredder with a larger cutting table (the "mouth" of the shredder) to be able to shred larger battery cells without first having to carry out manual dismantling.

4.1.5.3. Shredding and separation of fractions

The shredding is done in batches according to the chemistry of the batteries processed (cells or modules) to keep control and visibility on the composition of the shredded material.

The batteries go through two shredding stages. The first shredding is done in enclosed and sealed shredders; during this shredding, gases and VOCs are captured and filtered. The second shredding stage further reduces the granulometry; the outgoing shredded material is then separated into 3 fractions via mechanical separation by sieving, application of magnets, etc.:

- Black mass[19] ,
- Paper/plastic and,
- Scrap metal.

Paper/plastic is incinerated with energy recovery as there is too much variation in composition to recycle. Scrap metal is recycled.

The black mass is placed in "big bags". Each big bag is systematically analysed in a laboratory to direct it towards the best recycling scheme. Depending on the recycler, the black mass is recycled in Europe or Asia (when the cobalt content is high, as recycling capacities by hydrometallurgy are lower in Europe).

4.1.5.4. Refining

The black mass will then be processed via two main refining methods: pyrometallurgy and/or hydrometallurgy.

4.1.5.4.1. Pyrometallurgy

Pyrometallurgy is a thermal metallurgical process used to separate and recover metals. The process consists of 3 steps:

- Heat treatment to homogenise the metal source (roasting);
- A chemical reaction (oxidation) allowing the separation;
- Refining.

In the context of Li-ion battery recycling, Li-ion batteries are processed in a high-temperature smelter (at temperatures above 1,000°C) which converts the metal oxides of cobalt, nickel and/or manganese into their reduced form (a molten metal alloy). This alloy is refined for use in new battery cathodes. The slag[20] contains lithium and is often used in concrete applications.

Currently in Europe, pyrometallurgy seems to be the focus of large-scale battery recycling activities and hydrometallurgy is only used on a small scale. Indeed, pyrometallurgy is the most successful and, historically, the most widely used process for recycling used batteries. Products from pyrometallurgy are frequently refined by hydrometallurgy (SNAM, Umicore), with the refining stage being carried out by different actors/sites.

4.1.5.4.2. Hydrometallurgy

Hydrometallurgy is a metal extraction technique that includes a step where the metal is solubilised to allow its purification. It is a liquid metal treatment process, hence the name hydrometallurgy. It consists of putting the various metals contained in an ore or concentrate into solution to separate them for recovery.

First, the powdered "black mass" must be dissolved in an acid bath (leaching). Once the mixture has been filtered, two technologies are used industrially to separate the active ingredients from the concentrate. The first, liquid-liquid extraction, consists of mixing the leaching solution with an immiscible organic solvent. The second method, precipitation, involves varying two parameters to separate the materials: temperature and pH.

Hydrometallurgy, while producing higher purity end products than pyrometallurgy, is more expensive in terms of management (200-400 EUR/tonne for pyrometallurgy, double for hydrometallurgy).

[19] Black mass is the fraction from the crushing of batteries that contains the metals that make up the electrodes and electrolytes. Thus, the composition of the black mass depends on the chemistry of the battery entering the recycling process.

[20] By-product of metallurgy containing the mineral fraction and metal oxides

4.1.5.4.3. Finished products

- Cobalt (cobalt sulphate) is recycled into new batteries or as a pigment for ceramics.
- Nickel (nickel sulphate) is used in the manufacture of new batteries.
- Lithium (lithium carbonate) is used either in the manufacture of new batteries or as an additive in concrete.
- Copper is used in the manufacture of cables.
- Other metals and plastics are used in various products.

4.1.6. Second life

4.1.6.1. Regulatory framework

Current EU legislation does not provide a regulatory framework for second life in the case of a different use. The general definition of reuse in the Waste Framework Directive 2008/98/EC only envisages reuse for a use identical to that for which the waste was designed, which is not applicable to second life for stationary use. The French definition (L. 541-1-1 of the Environmental Code), on the other hand, does not specify the notion of different or identical use in the case of reuse ("réutilisation"), but only specifies that the use must be identical in the case of direct reuse (so-called "réemploi", without going through the waste status). The Batteries Directive 2006/66/EC does not provide for a reuse target and does not define second life.

The proposed EU Battery Regulation published by the Commission in 2020 and amended in March 2022 by the Parliament aims to create a regulatory framework for second life.

Second life, although not defined as such, is given a legal framework with the creation of definitions:

- repurposing: "any operation which results in parts of the battery or the whole battery being used for purposes or applications other than that for which the battery was originally designed" (EC Proposal);
- preparation for repurposing: "any operation whereby parts of a waste battery or the whole of a waste battery are prepared for use for purposes or applications other than those for which the battery was originally designed" (Parliament's proposal);
- remanufacturing: "any operation consisting of the disassembly, restoration, replacement of components of used battery packs, battery modules and/or battery cells to restore a battery to a level of performance and quality equivalent to that of the original battery, for the same or a different purpose" (Parliament's proposal).

In addition, a minimum framework for obtaining the end-of-waste of batteries that have been subject to a preparation for reuse or remanufacturing operation is proposed. It requires that:

- the state-of-health has been assessed;
- the battery continues to be used;
- and that it is protected against damage during transport and unloading.

Discussions are still ongoing to clarify these criteria.

Finally, the European Parliament adopted an amendment proposing that "operators who place remanufactured or repurposed batteries on the market shall be considered as new producers of the battery and shall therefore be registered in accordance with Article 46 and be subject to extended producer responsibility in accordance with Article 47". If adopted, this amendment clarifies that the second/third life operator is responsible for covering the costs of managing the end of life of the battery after it has been remarketed.

The European Commission has further clarified, in an exchange organised for this study, that used batteries are considered waste (except for direct reuse "réemploi"). Preparation for reuse and preparation for remanufacturing should be considered as waste treatment operations. The remanufacturing of batteries that do not comply with the requirements of virgin production can be considered as reuse (not waste).

From the point of view of the safety of second life batteries, the proposed Regulation foresees the obligation for second life operators to comply with the appropriate quality control and safety instructions foreseen by the Regulation or other legislation and technical documents, depending on the intended applications. In other words, it is the second life operators who are responsible for ensuring the safety of batteries before they are put back on the market and not the original producers. Repurposed or remanufactured batteries must meet the regulatory requirements for the intended applications and comply with the same compliance tests as new batteries for those applications. In practice, existing standards are not suitable for second life in terms of the sampling process and the amount of destructive testing required. More suitable standards, based on the same tests but with an adapted test procedure, will have to be developed.

Work is underway through the International Committee on Electrochemistry to develop specific international standards for second life:

- IEC PT 63330 ED1 - Requirements for the reuse of secondary batteries (planned for end 2023) ;
- IEC PT 63338 - General guide for the reuse of secondary cells and batteries (planned for end 2023).

In the current versions of these draft standards, the tests foreseen still need to be simplified and clarified, in particular the tests on batteries coming out of the process of preparation for repurposing. The reuse of cells is not recommended in these texts, which may be relevant for heavy mobility where reuse can be done at the module level but could jeopardise business models related to light mobility with intervention at the cell level.

The European Commission has asked CEN/CELELEC to develop standards on second life batteries considering what has been done in American standards such as UL 1974. Work will start at the end of 2022. These standards will not be made mandatory, but compliance with them will lead to compliance with the relevant parts of the Regulation. In addition, the European Commission has mandated the European Committee for Standardisation (CEN) to develop new standards for applications that are currently poorly covered.

4.1.6.2.Second life of light mobility batteries

In France, only light mobility batteries (bikes and scooters) of users who take steps to repair or recondition them are taken care of by start-ups (e.g., DOCTIBIKE, VIRVOLT, NOWOS).

The battery is first diagnosed by the professional. Depending on the diagnosis, the user is offered to repair it (if possible) or recondition it. The economic actors speak of repair when the battery is modified technically or via software to be reused for the same purpose (change of the shell, of the system apart from the cells), and of reconditioning when the worn cells of a battery are replaced by new ones to extend the life of the battery[21] .

Currently, all light mobility batteries collected by COREPILE and SCRELEC are sent for recycling. However, SCRELEC is interested in reuse. Its interest is linked in particular to the saturation of the downstream recycling scheme. The PRO has started a reuse project in collaboration with DOCTIBIKE. The project is in the test phase. Tests are being carried out on:

- Sorting batteries to identify different batteries that can be repaired[22] , remanufactured or repurposed (some make dismantling or future use impossible). For example: battery with BMS with blocked proprietary systems;
- Identification of used battery parts and parts that can be given a second life.

4.1.6.3. Second life of heavy mobility batteries

Second life encompasses three main industrial models:

- Remanufacturing, which encompasses any process that involves disassembling a product, restoring, and replacing components, and testing individual parts and the entire product to its original design specifications. Performance after remanufacturing is expected to be the same as or better than the original performance specifications[23] , for the same or a different purpose[24] .
- Repair or "repair and return", where the battery retains its original identification number, its defective cells are replaced, and it is returned either to the owner (when the car owner also owns the battery) or to a battery pool when the car owner only rents the battery[25] .
- Repurposing, where the whole battery or only parts of it are used in an application other than that for which the battery was originally designed.

Technically, the diagnosis can be made at the level of the cell (e.g., SNAM with its subsidiary Phenix), the module, or the battery pack (e.g., ENTECH). It can be done electronically if there is an agreement with the manufacturer for access to information on the state-of-health of the battery parts, otherwise it is done physically. Similarly, replacement can be carried out at cell level (e.g., SNAM) or module level. Defective components are replaced by

[21] Reconditioning corresponds to the definition of remanufacturing proposed by the European Parliament. Repair does not necessarily involve a dismantling operation and is therefore not specifically covered by the draft Regulation but meets the definition of preparation for reuse in the Waste Framework Directive (same use). In France, repair is a reuse or preparation for reuse operation depending on the status of the battery (does not go through waste status for reuse).
[22] Regulatory term: Reuse or preparation for reuse depending on the status of the battery (does not go through waste status for reuse).
[23] Definition according to ACEA (European Automobile Manufacturers Association) - Source: PFA
[24] According to the European Parliament's amendment to the draft EU Battery Regulation
[25] This model is not the subject of a proposed definition in the European Regulation. It may correspond to the French notion of reuse or preparation for reuse, depending on the status of the battery (does not become a waste in case of reuse).

branded components in the case of remanufacturing for the same purpose, and by other types of components in the case of a different purpose, such as industrial stationary energy storage.

There are currently three main categories of repurposing second life projects:

- Night-time storage of electrical energy from "traditional" power plants (coal, gas, nuclear, etc.);
- Storage of electrical energy from intermittent electricity production facilities (photovoltaic, wind, etc.);
- Storage of electrical energy produced during the night in homes to take advantage of night-time rates.

These 3 types of battery second life projects are still pilot projects.

There are 3 trends in the market:

- Recyclers who reuse used batteries under their own brands,
- Recyclers who work with a car manufacturer to handle the repair and remanufacturing of their batteries,
- Car manufacturers who set up their own subsidiary to remanufacture their batteries.

The end of the responsibility of the original producer in case of repurposing (solution envisaged by the proposed EU Regulation) would remove significant concerns at the level of the original producers.

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4.1.7. SWOT analysis (Strengths, Weaknesses, Opportunities, Threats)

The table below shows the SWOT analysis of the electric mobility battery management scheme.

Assets	Weaknesses
Strong mobilisation of stakeholders (public authorities, car producers, collectors, and recyclers) to prevent and adapt to change, in the context of a paradigm shift in car traction technology from internal combustion engines to electric ones.	**The recycling of electric mobility batteries is intrinsically in deficit and therefore dependent on external financing**. Depending on the chemistry of the batteries, the deficit can be more or less important. For lithium iron phosphate batteries, for example, the imbalance is greater because the end products of recycling (iron, phosphorus) have a very low value compared to the cost of recycling.
A well-developed European and French network of electric mobility battery recyclers. Lithium-ion battery recycling capacities are already present in Europe for the main technologies relevant to electric mobility: NMC and lithium polymer (LCO, LMO). There are 2 main actors in France (SNAM and EURO DIEUZE INDUSTRIE).	**Uncertainty about the waste stream and the economic model slowing down investment decisions in treatment facilities.** The optimal life span of batteries for electric vehicles (without accidents, etc.) being high, the end of life of batteries will not arrive until 15-20 years after they are put on the market. This, together with the uncertainties about the future of the metals market and the technological evolution of batteries (and therefore of their composition), adds to the uncertainty about the opportunities for recycling raw materials.
Recycling contracts between car manufacturers and recyclers already in place. The sector is already organising itself to provide for the recycling of a growing stream of end-of-life batteries in the coming years.	
Existence of communication between car manufacturers and recyclers regarding the recyclability of electric mobility batteries, the objective of this communication being to integrate recyclability into the manufacture of batteries.	**Li-ion battery recycling scheme close to saturation of capacities at both French and European level.** Europe's lithium-ion battery processing capacity is about 80% used. Given the expected increase in the amount of batteries, European capacity will have to increase. Facilities are planned (Germany, Norway) to increase these capacities. According to EBRA[26] however, at this stage, there is relatively little investment compared to the estimated needs. There is a reluctance on the part of the actors who are waiting for a stabilisation of the market (linked to an increase in the amount of incoming waste) and a stabilisation of the regulations on batteries, which will have an impact on the conditions for recycling and the investments to be made. In France, 20 million euros have been marked for battery recycling under the fourth Investment Plan for the Future.
Synergies in recycling between light and heavy mobility batteries and PBAs, allowing for economies of scale. As both types of battery are lithium-based, the recycling actors are the same.	
Diversity of the typology of actors involved in the second life: either independent (light mobility), or in connection with recyclers or with battery producers (electric cars). This allows competition between different models and learning in a phase of construction of this scheme. Recyclers benefit from their end-of-life experience and are less subject	

[26] EBRA: European Battery Recycling Association.

to the brand image constraints of second life batteries than manufacturers because they can create their own brand. Producers who position themselves in the second life sector have the advantage of knowing the technical specifications of the batteries and having direct responsibility for the waste stream.	**Recyclability criteria not sufficiently considered in the design of the battery,** despite the existence of communication between manufacturers and recyclers on recyclability. This implies that recyclers, in the short term at least, must adapt to find suitable recycling solutions.
Favourable conditions for the sale of second-hand batteries to industry (B-to-B): the regulations allow contracts to set out responsibilities in the event of an accident. Thus, the actor active in the second life of batteries is better protected than for consumer use, for which the second life actor must always demonstrate that they are not responsible.	**Lack of harmonisation between European Member States regarding the classification of battery waste as hazardous**. This, together with restrictions on the transport of batteries, leads to situations where transporters are forced to achieve very low charging rates.
	Lack of harmonisation regarding the waste status of black mass. Some recyclers consider black mass to be a product, which facilitates its export outside Europe and implies a loss of control over the resources contained in black mass and no guarantee of recycling to European standards. It should be noted that the public authorities in the five countries studied in depth do not recognise black mass as a product, so the issue could be one of interpretation by recyclers.
	Not enough ecosystem functioning, strong competition between actors for the appropriation of the waste stream which is not favourable to the good relations necessary given the interdependence of the actors and the need to invest. The management of electric/hybrid car batteries is the subject of strong competition between manufacturers, ELV centres and collection operators.
	Development of the second life battery sector slowed down by costly R&D to carry out the necessary compliance tests to get back on the market and obtain CE conformity.
	Unclear responsibility for the second or third life of the battery: roles and financing of the end of life of the battery to be clarified.

Opportunities	Threats
Ongoing revision of the European battery regulation which will clarify the applicable framework and increase the ambition for battery management in Europe. The ambition is to collect, recycle and reuse more batteries and to ensure a strategic supply of critical metals to Europe. Some of the measures foreseen aim to clarify the framework for second life and to improve traceability and information sharing in the chain, with the aim of facilitating recycling and second life.	**Market pressure to lower battery production costs which may lead to increasing production of cheaper Lithium Iron Phosphate batteries with more expensive recycling**, linked to uncompetitive or even non-existent end-uses at present.
Development of battery recycling within European borders, which would allow control over recycled materials (rare metals) that can be re-integrated into the production of new batteries and reduce dependence on raw material producing countries.	**Producers may go bankrupt before the end of life of their batteries,** which could imply an imbalance in financing if the "pay-as-you-collect" model is chosen (so-called "orphan batteries") and battery recycling remains in deficit.
Development of partnerships to increase battery processing capacity in Europe, between different recyclers or between a recycler and an electric car manufacturer to create new recycling or second life lines.	**Possible technical difficulties to reach the recycling rates of the future EU regulation** according to EBRA, given the evolution of battery technologies (e.g., Lithium Iron Phosphate technology). **Decline in second life potential as battery technologies evolve.** Technologies with less cobalt lose capacity more quickly and are less reusable.
Robotisation or mechanisation of dismantling, reducing recycling and second life costs. The development of mechanised workshops by brand is anticipated.	
Improved sorting safety using thermal imaging cameras.	

4.2. Key questions for the benchmark

Based on the interviews with the French scheme, it was decided to look more closely at the following aspects in 5 European countries:

- How has the division of responsibilities between actors been organised for the management of electric mobility batteries? And why?
- Do producers pay fees to the PROs to manage waste for all categories? Or is it profitable?
- Which actors are funded (collectors, recyclers, or both)?
- Is it a "pay-as-you-sell" or "pay-as-you-collect" system (based on expected future costs or on current costs) and why?
- Are there national targets for the collection or recycling of electric mobility batteries? If so, how are they calculated (considering the lifetime of mobility batteries, the amount placed on the market, etc.)?
- Who are the actors in battery recycling and what are the links with other actors?
- Second life VS recycling
    - Who are the second life actors and what are the links with other actors?
    - How is the orientation between recycling and second life decided?
- How are the fire risks of lithium cells and batteries used in mobility managed (battery capacity and weight increase the risk of shock and fire)?
- Is the battery considered as hazardous waste?
- Is black mass considered a waste product or a product?
- What are the barriers and levers to improving battery waste management?

4.3. Cross-sectional analysis

4.3.1. Overview

	Germany	Belgium	Spain	Norway	Netherlands
Context					
Electric and hybrid vehicles sold / 1000 inhabitants / year	3	3	3	18	5
Registered electric and hybrid vehicles / 1000 inhabitants	8	11	8	90	23
Market share of electric and hybrid vehicles	26 %	7 %	9 %	68 %	23%
ELV EPR	Voluntary	Mandatory (collective or individual)	Voluntary	Mandatory	Mandatory, via ARN
EPR involving the financing of a collection system for mobility batteries	Voluntary	Mandatory	Mandatory	Mandatory	Voluntary Obligation to take back
Light mobility					
PRO	GRS BATTERIAN	BEBAT	EUROPEAN RECYCLING PLATFORM ESPAÑA, ECOLEC, ECOPILAS UNIBAT	NORSIRK, BATTERIRETUR	STIBAT
Type of payment	Pay-as-you-sell	Pay-as-you-sell	Pay-as-you-sell	Pay-as-you-sell	Pay-as-you-sell
Amount of financial contributions	Confidential information	≤ 150g = 0,057 EUR/piece > 150g and ≤ 500g = 0,200 EUR/piece > 500g and ≤ 2kg = 0.850 EUR/piece > 2kg and ≤10kg = 7,000 EUR/piece > 10kg and ≤ 20kg = 2,260 EUR/kg	Confidential information	Confidential information	For electric bikes: 1 EUR/kg placed on the market (2022).
Heavy mobility					
PRO	/	BEBAT, FEBELAUTO	EUROPEAN RECYCLING PLATFORM ESPAÑA, UNIBAT, ECOPILAS.	BATTERIRETUR HØYENERGI	ARN

	Germany	Belgium	Spain	Norway	Netherlands
Type of payment	Pay-as-you-collect	Pay-as-you-sell (administrative part) & pay-as-you-collect (operational management): BEBAT Pay-as-you-collect only: FEBELAUTO	Pay-as-you-sell (administrative part) & pay-as-you-collect (operational management)	Pay-as-you-sell	Pay-as-you-sell
Amount of financial contributions	No information	> 20kg = 0,053 EUR/piece (BEBAT, administrative fee only) No EPR fee scale because in pay-as-you-collect (FEBELAUTO)	Confidential information	No information	5kg = 3 EUR/battery > 5 kg and ≤ 15 kg (new 48V category) = 5 EUR/battery > 15 kg and ≤ 25 kg = 8 EUR/battery > 25 kg and ≤ 100 kg = 25 EUR/battery > 100 kg and ≤ 350 kg = 45 EUR/battery > 350 kg and ≤ 600 kg = 55 EUR/battery > 600 kg and ≤ 900 kg = 65 EUR/battery
Performance					
Tonnes collected	105 tonnes (light mobility) ND (heavy mobility)	174 tonnes (heavy mobility) NA (light mobility)	ECOPILAS (2020): 54 tonnes of electric mobility batteries: • 25 tonnes of batteries from electric or hybrid vehicles; • 19 tonnes of batteries from electric scooters and motorbikes; • 10 tonnes of electric bikes and scooters. No information for other PROs.	No information	No information on collection rate 127 tonnes (heavy mobility) 225 tonnes (bikes)
% recycling	No information	Heavy mobility: 11% recycling	No information	No consolidated information	Heavy mobility: 46%.
% second life	No information	Heavy mobility: 82% of which : • 61% Manufacturers' recalls - tests, some of which	No information	No consolidated information	Heavy mobility: 54%.

	Germany	Belgium	Spain	Norway	Netherlands
		are then sent for remanufacturing or second life; • 11% Remanufacturing - same use; • 10% Second life - different use.			
Regulations for mobility batteries					
Specific regulatory category mobility batteries	No	No	No	No	No
Specific collection targets	No	No	No 70% collection target for all industrial batteries excluding Pb and NiCd, including (but not limited to) mobility batteries.	No	No
Specific treatment objectives	No	A specific recycling efficiency target for traction batteries of 50% is set in the environmental agreement specific to electric and hybrid vehicle batteries and therefore applies to FEBELAUTO members.	No	No	No
Classification of Li-ion batteries as hazardous waste	All	Only if damaged	All	All	All
Clarification of the legal status of second-hand batteries	No	In progress	No information.	No information.	Yes
Specific safety rules / standards for Li-ion battery management	Compliance with ADR regulations, the regulations of the Federal Institute for Materials Research and Testing (BAM) and the German Road	BEBAT safety plan PLUS FEBELAUTO standards and BEBAT recommendations ADR transport	ADR transport Compulsory training for ELV centres dealing with the management of electric or hybrid ELVs and their batteries.	UN 38.3 approved containers, ADR regulations, training for ELV centres to handle undamaged electric vehicle batteries.	PGS (Publicatiereeks Gevaarlijke Stoffen) 15 and 37 (under construction) Circular on risk management for lithium-ion energy carriers ADR transport

	Germany	Belgium	Spain	Norway	Netherlands
	Transport Act (GüKG).				

4.3.2. The regulatory status of mobility batteries

As provided for in Directive 2006/66/EC, mobility batteries are included in a category of batteries known as industrial batteries, including light mobility batteries that can be carried by hand in all the countries surveyed, including Norway.

In Belgium, used Li-ion batteries are hazardous waste only if they are damaged, in which case they must be subject to specific transport and management measures. In the Netherlands, Germany, Norway, and Spain, all used Li-ion batteries are hazardous waste. The waste codes used vary from country to country. A European harmonisation with a specific hazardous waste code for Li-ion batteries is desired by the public authorities in these countries.

In all countries surveyed, used batteries are waste prior to diagnosis. In Belgium and the Netherlands, batteries that have been diagnosed and that are considered reusable are no longer waste according to certain criteria (in some parts of Belgium the criteria are still being developed). In case of second life for a different use, in both countries it has been clarified that:

- Original producers lose responsibility for the battery;
- The battery must be registered again and;
- The new person who places the batteries on the market must finance the take-back of those in the industrial battery category (in the case of stationary use), if necessary, via a PRO responsible for these batteries.

The clarifications on waste status adopted in Belgium and the Netherlands are, in principle, transposable to France. The report does not prejudge the decision of the French authorities on this point. If France wanted to adopt similar provisions, they would have to be adapted to the French context for End of Waste (the adoption of a Ministerial order is necessary in France, whereas the opinion of an agency is sufficient in the Netherlands or Flanders). As provided for in Directive 2006/66/EC, mobility batteries are included in a category of batteries known as industrial batteries, including light mobility batteries that can be carried by hand in all the countries surveyed, including Norway.

4.3.3. The organisational context of the mobility batteries EPR

For heavy mobility batteries:

In all the countries studied, the organisation of the EPR for ELV and automotive batteries has strongly influenced the initial organisation of EPR for electric mobility batteries.

- In Belgium, the management of heavy mobility batteries was initially entrusted to the PRO BEBAT (2014), which has been responsible for industrial, automotive, and portable batteries since 1995. Some manufacturers were not satisfied with the financing system set up by BEBAT and decided to join their PRO in charge of ELV management (FEBELAUTO) to design a more similar system. Then, subsequently, the management of heavy mobility batteries was shared with FEBELAUTO (2018).
- In the Netherlands, producers joined ARN from the beginning. The PRO in charge of ELVs already managed lead-acid car batteries. Initially, it was possible to join and finance ARN only for the administrative part, and to manage individually the operational part. Since 2021, accession to ARN requires to entrust the management as well, so for batteries, about 20% of the producers have decided to operate with an individual system. STIBAT, the PRO in charge of portable and industrial batteries, also offers a service for heavy mobility.
- In Germany, the system in place for ELVs is an individual market-based system, with also some collective systems organised. The management of electric mobility batteries therefore follows the same system, which prevents a centralised information system specific to mobility batteries.
- In Spain, there is no mandatory EPR for ELVs. Heavy mobility electric batteries are included in the EPR for batteries which is mandatory. The management of heavy mobility electric batteries has been entrusted to the various PROs responsible for used batteries. Car manufacturers are therefore members of the collective systems managed by these PRO.
- In Norway, the management of heavy mobility batteries is mixed. It is done by both BATTERIRETUR HØYENERGI (PRO in charge of batteries) and AUTORETUR (PRO in charge of ELV).In all the countries studied, the organisation of ELV EPR and automotive batteries EPR has strongly influenced the initial organisation of electric mobility batteries EPR.

For light mobility batteries:

In all the countries studied, the management of light mobility batteries has been entrusted to PROs in charge of portable batteries, due to the similarity of the waste streams and the collection schemes (retailers, civic amenity sites, WEEE treatment centres):

- In Belgium, the light mobility scheme concerns all types of vehicles (electric bikes, scooters, gyropods, etc.);
- In Germany, the scheme started with electric bikes before being extended to other personal motorised vehicles such as scooters, skateboards, gyropods, skates and electric scooters from 2019;
- In the Netherlands, the EPR system organised by STIBAT still only concerns electric bikes. Producers of other mobility devices can call on STIBAT for management but must then finance the EPR separately;
- In Spain, light mobility electric batteries fall within the scope of EPR batteries (considered as industrial or portable batteries if they weigh less than 1 kg). In most cases, the collection and sorting of these batteries is similar to the collection of portable batteries.
- In Norway, the industry covers all light mobility batteries.

The management of batteries for electric mopeds and motorbikes is still unclear and under construction:

- In Belgium, the scope of the environmental agreement applicable to electric vehicle batteries (heavy mobility) will probably be extended to very heavy mobility batteries (buses, trucks), motorbikes and scooters, to correspond to the field of activity of the members of FEBIAC (the sector federation). Discussions on its extension are underway with the stakeholders. The environmental agreement will not be extended to electric bicycles, as there is already a collective system in place (BEBAT).
- In the Netherlands there is competition for the management of motorbike and moped batteries. ARN's service also covers electric motorbikes. STIBAT, which is responsible for light mobility batteries, also offers a service for motorbikes on request. The management system for used electric moped called SRN (which only covers vehicles and not batteries for the moment) is also considering the management of electric batteries from mopeds.
- In Spain, electric batteries for these vehicles are in the scope of EPR for batteries. Legally, it is the producers who are responsible for managing these batteries, via the PRO to which they belong. However, little is known about the practices, given that this is a new waste stream which remains marginal. According to the Spanish association of ELV centres (SIGRAUTO), some producers of this type of vehicle are not in compliance with their responsibilities under EPR.

4.3.4. EPR for mobility batteries today

Regulatory organisation of the scheme

- In Belgium, a specific form of specification (called environmental agreement, established by each region) was developed for the traction battery management system developed by FEBELAUTO, with dedicated requirements. This text developed the concept of a "hybrid" financing system for battery management. Participation in an EPR system is mandatory also for light mobility batteries but there are no specific provisions (covered by the obligations applicable to industrial batteries).
- In the Netherlands, Spain, Germany, and Norway there are no dedicated requirements for mobility batteries. They are regulated by the national Battery and ELV/WEEE regulations[27] for battery removal obligations and there is no obligation to participate in a collective system.

Collection and treatment targets

Most of the countries surveyed have not set specific collection and treatment targets for mobility batteries:

- In the Netherlands, Germany, Spain, and Norway there are no specific collection targets for mobility batteries. The recycling efficiency targets are based on the EU Directive targets of 50% for all batteries excluding NiCd and Pb. In Spain, there is a collection target of 70% for industrial batteries excluding NiCd and Pb, which also concerns mobility batteries (but not only).
- In Belgium, the environmental agreement (type of specifications that frame the activity of PROs) applicable to the system set up by FEBELAUTO plans a specific recycling efficiency target of 50% for the electric traction batteries managed in the system, not only calculated as an average for all batteries including those outside the system. For the system managed by BEBAT, the objective is global since BEBAT manages all types of batteries (portable, industrial, and automotive).

The PROs in charge of mobility batteries

In all the countries studied, there are PROs in charge of the management of waste batteries, including electric mobility batteries. What varies between countries is the level of competition between the PROs and the existence of individual systems for the management of heavy mobility batteries.

[27] National regulations, transposing European directives, with specificities (see country chapters)

For heavy mobility batteries, countries still operate with a combination of collective and individual systems for the operational management part.

	Germany	Belgium	Spain	Norway	Netherlands
Market share of the collective management system	NA	100% (administrative part: 98.4% FEBAUTO, 1.6% BEBAT) 21% of batteries concerned by a collective system for the operational part	~100 %	~100 %	90% (in number of manufacturers)

Table 9 Cross-sectional analysis - collective management systems

This organisation is the result of car manufacturers' requests, as some of them wish to organise the take-back of their used batteries themselves, in particular for testing, R&D and second life; while others (typically non-European importers/manufacturers) prefer to adopt a collective system capable of ensuring local management.
To organise administrative management and reporting collectively, Belgium has developed the concept of a "hybrid" system. This has the advantage of centralising the registration of batteries and the reporting of the quantities collected and treated to verify the achievement of the European targets at national level, while giving the opportunity for manufacturers to organise themselves individually for the operational management. However, it is not certain that this organisation will be in line with the future EU Battery Regulation according to OVAM (Flemish Waste Treatment Agency).

- In Belgium, there is no individual system for batteries. All manufacturers are members of either FEBELAUTO (98.4% market share) or BEBAT (1.6%), at the request of FEBIAC, the industry federation. However, in both cases, these are "hybrid" financing systems, i.e., the administrative management is disconnected from the operational management, so that manufacturers who are part of the collective system for the administrative management can continue to organise and finance the operational management of the batteries through an individual system. In this case, 79% of the battery quantities of FEBELAUTO members do not make use of operational management by FEBELAUTO.
- In the Netherlands, 90% of manufacturers joined the collective system offered by ARN. TESLA, VOLVO, STELLANTIS and RENAULT have individual systems. Before 2021 ARN had a hybrid system similar to the one in place in Belgium and therefore represented all manufacturers, but this is no longer the case. Manufacturers who are not members of ARN can also turn to another collective system, such as the collective solution RENEOS, of which the PRO STIBAT is a member.
- In Germany, there is at least one collective system in place by LRP for about 80 producers. LRP organises the relationship between producers and treatment operators for the management of used batteries. The collective system does not meet the usual obligations of a PRO in France (no public reporting).
- In Spain, producers can join one of the collective systems or set up an individual system for battery management. In practice, most producers have joined a collective system.
- In Norway there is no individual system for batteries. The car manufacturers are members of either BATTERIRETUR or AUTORETUR.

For light mobility batteries, there is no individual system in practice. Depending on the country, one or more collective systems coexist:

- In Belgium, all producers are covered by BEBAT;
- In the Netherlands, 90% of the e-bike market is covered by STIBAT;
- In Germany, 90% of small mobility producers are covered by GRS BATTERIEN. The other producers are in theory covered by an individual system. In practice, however, the compliance of these systems is not assured: they may be free riders. The lack of obligation to organise a collection system in the framework of extended producer responsibility is a limit to joining a collective system.
- In Spain, four collective systems coexist: ECOPILAS, EUROPEAN RECYCLING PLATFORM ESPAÑA (ERP), FUNDACIÓN ECOLEC and UNIBAT.
- In Norway there are two collective systems, BATTERIRETUR and NORSIRK.

The funding system

For light mobility batteries, all identified systems are "pay-as-you-sell". The EPR fee scale is as follows:

<table>
<tr><th>Country</th><th>Fee scale</th></tr>
<tr><td>Germany</td><td>Confidential</td></tr>
<tr><td>Belgium</td><td>
<table>
<tr><th>Weight</th><th>Fee scale EUR/piece</th></tr>
<tr><td>≤ 150g</td><td>0,057</td></tr>
<tr><td>> 150g -≤ 500g</td><td>0,200</td></tr>
<tr><td>> 500g -≤ 2kg</td><td>0,850</td></tr>
<tr><td>> 2kg -≤ 10kg</td><td>7,000</td></tr>
</table>
> 10kg -≤ 20kg : 2,260 EUR/kg
</td></tr>
<tr><td>Spain</td><td>Confidential</td></tr>
<tr><td>Norway</td><td>Confidential</td></tr>
<tr><td>Netherlands</td><td>1 EUR/kg</td></tr>
</table>

Table 10 Cross-sectional analysis - Light Mobility – EPR fee scale

In comparison, the fee scales proposed by COREPILE[28] and SCRELEC[29] are unit scales. For Li-ion, they are almost systematically lower than the STIBAT's fee scale of 1 EUR/kg, especially for batteries and accumulators over 10 kg. The fee is higher than that proposed by BEBAT for batteries and accumulators of less than 2 kg but lower than that proposed by BEBAT between 2 and 20 kg.

For heavy mobility batteries, two types of funding schemes exist:

- "Pay-as-you-sell" financing, based on the quantities placed on the market in the year;
- "Pay-as-you-collect" financing, based on the quantities collected or placed on the market in the past.

In both systems, funding can apply to administrative management, operational management, or both (see below).

	Pay-as-you-sell	Pay-as-you-collect
Operational part	ARN (Netherlands) BATTERIRETUR HØYENERGI (Norway) AUTORETUR (Norway)	Germany BEBAT (Belgium) FEBELAUTO (Belgium) EUROPEAN RECYCLING PLATFORM ESPAÑA, UNIBAT, ECOPILAS (Spain)
Administrative part	ARN (Netherlands) BEBAT (Belgium)	FEBELAUTO (Belgium) EUROPEAN RECYCLING PLATFORM ESPAÑA, UNIBAT, ECOPILAS (Spain)

Table 11 Cross-sectional analysis - Heavy mobility - "pay-as-you-sell" or "pay-as-you-collect" financing

The fee scales are as follows. In the case of "pay-as-you-collect", there is no fee scale, since billing is based on actual costs incurred.

The Dutch fee scale is significantly higher as it considers treatment costs. The financial contributions in the Netherlands have been reduced by 50% in 2022 due to lower treatment costs.

Country	Fee scale
Germany	Not Relevant
Belgium	BEBAT (administrative part): 0,053 EUR/piece

[28] COREPILE - Scale 2022 https://www.corepile.fr/assets/uploads/sites/1/Bareme-Corepile-Mobilite-2022.pdf
[29] Not public but consulted in the context of this study

Spain	Confidential	
Norway	No information	
Netherlands	**Weight**	**Amount of EPR fees 2022 (EUR/piece)**
	≤ 5kg	3 EUR
	> 5 kg and ≤ 15 kg (new 48V category)	5 EUR
	> 15 kg and ≤ 25 kg	8 EUR
	> 25 kg and ≤ 100 kg	25 EUR
	> 100 kg and ≤ 350 kg	45 EUR
	> 350 kg and ≤ 600 kg	55 EUR
	> 600 kg and ≤ 900 kg	65 EUR

Table 12 Cross-sectional analysis - Heavy mobility – EPR fee scale

In Belgium, there is a compulsory financial guarantee system supervised by the public authorities (OVAM), with the aim of managing orphan traction batteries (heavy mobility) whose producer cannot be identified or is no longer financially solvent to pay the contribution relative to the battery management costs. There is no reimbursement to the holder if the battery is returned at the end of its life: this is not a deposit system but an insurance system (in the sense of risk pooling). The amount is paid by the producers, added to FEBELAUTO's revenue, and spent on management. The amount has been set at 0.01 EUR/kg and will normally be re-evaluated regularly.

In other countries operating on a “pay-as-you-collect” basis, no mechanism has been identified to manage orphan batteries.

4.3.5. The operational management system

General operation

The operational management is the same for all countries:

- For light mobility, a collection system for batteries is in place in WEEE treatment centres, specialised retailers and collection points managed by municipalities (civic amenity sites or other collection points). The collection aims to be separate from portable batteries. The PROs deal with the logistics via collection service providers who transport the batteries to sorting plants and then recycling/refining units. Sorting and recycling units are the same as those used for portable batteries (see section 274.1). There are also collaborations between PROs and second life projects in several countries, but these are mostly start-ups. Moreover, they are still at a development stage and therefore do not involve significant quantities to date.
- For heavy mobility, used batteries mainly come from garages and car dealerships, and a very small part, mainly from damaged vehicles, arrives in ELV centres (except for Norway which is a more developed market). The part coming from garages and car dealerships is in relatively good condition and does not generally go through the collective management systems set up via PROs. Instead, it is most often the subject of direct manufacturer recalls for testing, with a part also being sent for remanufacturing or second life. The part coming from ELV centres is still emerging. It is mainly vehicles that have been involved in accidents. When collective systems are set up, they take in the batteries of affiliated brands and send them for recycling. Some are also destined for second life, but the potential is lower than that of batteries taken back from garages and car dealerships.

It should be noted that the quantities collected to date in all countries are very limited because the waste stream is only emerging (for example, less than 500 vehicle equivalents per year in Belgium and the Netherlands). The operational management system is therefore still relatively immature. The operational functioning is the same for all countries:

Collective systems generally work with several different recyclers in different countries, a trend that has been exacerbated by the tension over recovery outlets in recent years. It should be noted that the Netherlands and Spain export all their electric mobility batteries for recycling as they do not have any battery recycling facilities in their country. Norway has just launched the largest Li-ion battery recycling unit in Europe.

Second life operators for light mobility batteries are rather start-ups and research projects.

Projects for the reuse of heavy mobility batteries are carried out by a variety of stakeholders:

- Car manufacturers reuse batteries for R&D tests, remanufacturing, use in their factories (forklift trucks) and second life, with partners. There are many projects in Germany in particular.

- In Belgium, the PRO FEBELAUTO has set up its own second life project, called WATT4EVER, with partners who are experts in energy systems, as there is no pre-existing second life project in Belgium.
- In the Netherlands, three projects exist with different types of project leaders: a start-up; a project run by a dealership of Mitsubishi, Nissan, and Hyundai vehicles; and a Chinese battery manufacturing company.
- In Spain, a second life initiative called BEEPLANET FACTORY has been identified.
- In Norway, several start-ups have been developing and reuse used electric vehicle batteries to create energy storage systems: ECO STOR (NISSAN Leaf battery), EYVON, HAGAL, CHAINPRO ENERGY, EATON (Nissan battery). Car manufacturers are involved in these projects, providing access to information to prepare batteries for reuse.

A European network of PROs in charge of batteries called RENEOS (including BEBAT, GRS BATTERIEN, COBAT (Italy), BATTERIRETUR and STIBAT as well as collection partners in other countries) was formed in 2019 to offer a common EPR service at European level, directed towards heavy mobility batteries. The service includes a digital reporting and traceability system. RENEOS did not wish to participate in the study. The list of members is not known.

	Germany	Belgium	Spain	Norway	Netherlands
Battery diagnosis before treatment	Not mandatory In practice yes	Yes, mandatory, realised by diagnostic centres designated by producers[30]	Not mandatory	Not mandatory In practice yes	Not mandatory In practice yes
Holder follows the producer's dismantling instructions	Not mandatory In practice yes	Yes, mandatory	Not mandatory Part of mandatory training at ELV centres	Not mandatory Part of mandatory training at ELV centres	Not mandatory Part of training at ELV centres financed by ARN
Producer/management organisation decides on end of life	Not mandatory In practice yes for batteries managed by LRP (negative price)	Yes, mandatory	Not mandatory In practice yes by ELV centres	Not mandatory In practice yes by ELV centres	Not mandatory In practice yes for batteries managed by ARN
Obligation of reporting to the PRO / producer	No	Yes, mandatory	Yes, mandatory	Yes, mandatory	No

Table 13 Management of heavy mobility batteries

The data available on collection performance related to mobility batteries is very fragmentary, due to the lack of obligation to keep and report dedicated statistics for these batteries in most countries. Collection and treatment statistics are often aggregated with other battery categories. In addition, the figures collected by existing collective systems are not representative of the whole sector due to the existence of individual EPR systems (heavy mobility), individual battery treatment/repair initiatives (light mobility) that do not report their statistics, and in the absence of reporting obligations for ELV centres (Netherlands, Spain, Germany) that wish to manage the batteries themselves. The available results are summarised in the full report, but they are not directly usable to compare the performance of the systems.

[30] ELV centres can also act as diagnostic centres.

	Germany	Belgium	Spain	Norway	Netherlands
Number of registered electric vehicles (/1000 inhabitants)	7,6	11	8	18	23
Quantity collected (kg/inhabitant)	ND	0,015	ND	ND	0,007[31]
Share collected in ELV centres	ND	<10%	ND	ND	5%
% recycling	ND	11%	ND	ND	46%
% second life	ND	82%[32]	ND	ND	54%

Table 14 Collection and treatment performance - Heavy Mobility

	Germany	Belgium	Spain	Norway	Netherlands
Quantities placed on the market (batteries/inhabitant/year)	0,06[33]	ND	ND	ND	0,09
Number of collection points (1 point per X inhabitants)[34]	30,740 inhabitants	ND	ND	ND	10,472 inhabitants
Quantity collected (kg/inhabitant/year)	0,001	ND	ND	ND	0,013[35]
% sent for recycling	100%	100%	~100 %	ND	100%
% sent for second life	0%	0%	~ 0 %	ND	0%

Table 15 Collection and treatment performance - Light Mobility

The following country specificities were noted for heavy mobility:

- Belgium has developed a particularly precise framework for the responsibilities of producers, take-back points, collectors, and treatment operators, depending on the various possible situations (e.g., take-back from a designated take-back point or from other types of take-back points). It gives a clear role of arbiter to the producers (car manufacturers or importers), who remain the decision-makers for the end-of-life of the battery.
- In Germany, Spain and the Netherlands, the regulatory framework appears to be less clear. Take-back points, and in particular ELV centres for batteries, are not obliged to consult producers to decide on the end of life of the battery or to provide them with the information needed for EPR reporting.
    - In Germany, as the management is not profitable and the system is "pay-as-you-collect", the take-back points consult the producers to finance the management and the producers have the choice of accepting the treatment costs or taking back the battery.
    - In Spain, according to SIGRAUTO, when a heavy mobility electric battery ends up in a ELV centre and if the centre can determine whether it still has a positive economic value, then they can sell it or recover it in another way. In this case, the ELV centre does not call on the PROs.
    - In the Netherlands, the ARN system is “pay-as-you-sell”, but ARN still leaves the choice to the producers to decide on the end of life of the battery and to opt for another treatment method: they pay the financial surplus if necessary but are not compensated if the cost is lower than the one of the collective systems.

The following country specificities were noted for light mobility:

[31] Brands affiliated to ARN only
[32] The difference with 100% corresponds to a temporary stock
[33] Estimate based on GRS annual report 2021 - 2 million e-bikes representing 40% of the market (NB: does not necessarily correspond to the market share in number of batteries)
[34] The figures presented include only the network of collection points at shops. It is supplemented by collection points at waste disposal centres.
[35] Electric bikes only

- The Netherlands does not have a collective collection system for mobility batteries other than e-bikes, although they can join the system for other industrial batteries ("pay-as-you-collect"). In addition, the identity of the producer is debated in the case of e-bike fleets, and there is a conflict between manufacturers and light mobility fleet companies concerning who should pay the contribution to the PRO.
- In Belgium, unlike the collection of portable batteries, there is no collection of light mobility batteries in companies or schools, for safety reasons.

Li-ion battery safety management

For light mobility, safety measures have been put in place by all identified collective systems.

The good practices identified are:

- Control of the collection points openings to prevent mobility batteries from being mixed with portable batteries. On the contrary, they are collected in collection points and containers that are more suitable in terms of fire safety (case of Belgium);
- Access control to ensure the safety of contact points and defective batteries;
- Use of special metal containers, e.g., with a fire valve;
- The development of guidelines with risk prevention measures and labelling recommendations for ADR-compliant transport;
- Having damaged batteries secured by the collector rather than by the collection point;
- Clarification of ADR transport rules by the PRO (Germany).

	Germany	Belgium	Spain	Norway	Netherlands
Control of access to the collection point	Not explicit	Yes	No	ND	No
Securing defective batteries before disposal	Yes, by GRS for damaged batteries	Yes	ND	ND	ND
Collection in specific drums	Yes, with a differentiation for damaged batteries	Yes, only ASP containers	Yes	Yes	Yes, on test
Document with risk management recommendations	Yes, GRS standard	Yes, BEBAT safety plan	No	Yes, developed by DSB	Yes, developed by public authorities
ADR transport	Yes	Yes	Yes, for lithium batteries	Yes	Yes

Table 16 Safety measures - Light Mobility

For heavy mobility, safety measures relate to the removal of the high voltage battery from the vehicle, its safekeeping, storage, and transport of batteries. All countries have risk management documents and recommendations. All countries comply with ADR regulations for the transport of electric batteries.

The good practices identified are the following:

- A strong incentive or obligation to train collection points: some countries have made it compulsory in the regulations, others use an obligation from the insurance companies, and others provide incentives for training via preferential tariff systems (with a more limited success to make sure operators follow updated trainings);
- The development of safety standards, the actor being responsible depends on the country: public authorities via specialised bodies (such as INERIS in France), in others this is done by insurance companies, in others it is the PRO or the sector association that has developed a standard;
- The existence of specific safety requirements for second life (only in the Netherlands).

	Germany	Belgium	Spain	Norway	Netherlands
Mandatory training of take-back points for the removal of high-voltage batteries	No But obligation of insurance	Yes	Yes	No	No
Incentives for risk prevention through collective systems	No	Yes, approval PLUS	Yes, webinars and training by SIGRAUTO	ND	Yes, ARN funding + start-up kit at preferential rate
Document with risk management recommendations	Yes, developed by the insurance federation	Yes, PLUS standard	Yes, developed by SIGRAUTO for good battery management	ND	Yes, developed by public authorities
ADR transport	Yes Specific coordination with the authorities for damaged batteries	Yes	Yes, for lithium batteries	Yes	Yes
Second life specifications	No	No	No	No	Yes

Table 17 Security measures - Heavy mobility

4.3.6. Relations with other EPR

Articulation with the WEEE EPR (light mobility)

In all countries surveyed except Norway, producers finance the management of WEEE without the battery and the management of the battery separately, via separate financial contributions to different PROs.

In some cases, users dispose of mobility devices with their batteries at collection points that are financed by the WEEE PROs (civic amenity sites, points at distributors).

In most countries, collection (from the collection point to the WEEE sorting / processing centre) is fully financed by the PRO responsible for WEEE. In Spain, a financial compensation for collection, dismantling (battery extraction) and sorting is foreseen between the PRO in charge of battery management and the PRO in charge of WEEE for the part that can be allocated to batteries.

In all countries, the dismantling of batteries is provided by the treatment centres and is part of the costs financed by the WEEE PRO.

In all countries, the supply of battery collection containers, collection from the WEEE centre, logistics to the final treatment and the cost of treatment are covered by the PRO in charge of mobility batteries. In Belgium and Germany, free collection from WEEE centres is provided for in the regulations governing the battery EPR.

In Germany, unlike for portable batteries, there is no obligation for WEEE treatment centres to return collected mobility batteries to producers or their representatives. They own them and can decide on their end-of-life. As these streams have a negative value at present, it is unlikely that they will choose to manage them individually.

Thus, if the battery is returned with the device, the WEEE PROs largely bear the associated logistical costs, except in Spain, where a cross-financing scheme is provided. In Germany, end-users (including private individuals) are obliged to separate the battery from the device when it is technically feasible, and this, before returning the WEEE to its collection point (except in the case of collection for reuse). The regulation provides that information on the mandatory separation of batteries before deposit of the device must be provided to users by producers, distributors, and public law bodies in charge of waste management, so that this obligation is known in practice.

NB: It should be noted that this organisation (the whole section on articulation with the WEEE EPR) is not specific to light mobility batteries but also concerns portable batteries.

Articulation with ELV EPR (heavy mobility)

The link between EPR for ELVs and EPR for batteries is less clear than the link between EPR for WEEE and batteries, as the entities in charge of collective systems (when there are any) are less separate. Moreover, they are not responsible for financing the entire sector (individual and hybrid systems), and the schemes operate more on a case-by-case basis.

- In Germany and Spain, the ELV management system is self-financed and market based. In contrast, the management of electric batteries from ELVs is not self-financed. When an ELV centre drops off a battery, they can but are not obliged to contact the producer or the PRO because they own the battery and can therefore have it treated as they wish:
    - In Germany, they can present a treatment price to the producer, who can choose to accept it or pay for the return logistics of the battery.
    - In Spain, they can call on the battery PRO to which the producer has subscribed.
- In the Netherlands, until 2021, the management of ELVs and ELV batteries in a collective system was handled by one entity: ARN. As a result of the obligation for car producers to participate in the ARN system (for ELV but not for the battery part), ARN has created two separate entities for reporting. Both management systems operate on a “pay-as-you-sell” basis. A flat-rate financing per vehicle placed on the market for the ELV part is used to finance both the administrative management and the management of the hazardous waste streams and tyres. A flat financing per weight range for starter and motion batteries is used to finance the administrative and operational management of the batteries. The declaration of batteries placed on the market is done through the myBATBASE declaration system via a collaboration with STIBAT, the PRO in charge of portable and other industrial batteries.
- In Belgium, 98.4% of HEVs (hybrid and electric vehicles) are covered by the same collective system for ELVs and batteries: the system set up by FEBELAUTO. A single entity manages both EPRs. FEBELAUTO's structural costs (human resources for reporting to the authorities, studies, etc.) and the financial guarantees required for orphan batteries are invoiced by FEBELAUTO's founding federation of car manufacturers, in proportion to the number of vehicles put on the market in year N-9 (estimate of the vehicle's lifespan), for all vehicles (electric or not). Battery management costs are invoiced on an actual basis (“pay-as-you-collect”) to members using FEBELAUTO's management service.

Articulation with EPR of industrial batteries outside of mobility (second life)

Both the Netherlands and Belgium have clarified that when mobility batteries are prepared for a second life in re-use (different use), the responsibility of the original producer of the battery ends and the re-user has to re-register the battery, e.g., as an industrial battery in the case of stationary or mobility use, and ensure the extended producer responsibility individually, or collectively by paying financial contributions to STIBAT and BEBAT, respectively.

4.3.7. Conclusions

There are several advantages to setting up collective (as opposed to individual) mobility battery management systems:

- Traceability and reporting on the EPR scheme, development of common IT tools
- Development of safety recommendations
- Sharing good practice

Greater transparency is observed in EPR schemes that have a collective system in place, supervised by the public authorities (Belgium, Netherlands) than in those without collective system (Germany). However, we also note that when there are several competing collective systems (Spain and Norway), information on the functioning of the collective systems is less transparent. France has voluntary (not officially approved by public authorities) competing collective schemes for light mobility but no collective scheme for the heavy mobility sector.

For light mobility, the sector operates in a very similar way to the portable battery sector in Europe in general, including France. Indeed, the operators and operating methods are very similar. The main issues to be considered in the design of the sector are:

- Regulatory obligation: the main problem with existing schemes is that they are voluntary (industrial batteries and not portable batteries). This is also the case in France. The schemes that have been developed are therefore still incomplete. A regulatory obligation would make it possible to limit free-riders (all countries) and to ensure complete coverage of mobility batteries (Netherlands). The identity of the producers that must pay a fee in the case of light mobility fleets should be clear to avoid disputes.
- Managing the safety of collection points: mobility batteries contain more energy than portable batteries and are more flammable than the portable battery mix because they contain only Li-ion and are not "inerted" by the presence of alkaline or salt batteries. Consideration must be given in France to defining appropriate collection points (bicycle professionals only or all retailers), the method of collection (open access or not) and the types of containers. The feedback from various countries compiled in the full report can serve as an inspiration.
- Regulating developing repair and second life activities. Provisions are planned in the Netherlands (safety standards, removal of waste status) and in Belgium[36].
- Regulating light mobility batteries via of a specific category in the regulation: the management of light mobility batteries in the same way as portable batteries implies a loss of visibility on the waste stream regarding the quantities collected and treated, and the treatment channels (Belgium). The creation of a specific category must be concomitant with the implementation of selective collection systems, thus separating light mobility from other batteries. The project of European Regulation gives the definition of a Light Means of Transport category and specific collection targets for this category are being considered.

There are two main challenges for the heavy mobility battery scheme in Europe:

- The expectation of some car manufacturers to individually control the operational management of heavy mobility batteries in view of the objectives expected in the European Battery Regulation regarding the incorporation of recycled materials (notably Li) and second life projects. On the contrary, other producers (rather importers) prefer a collective system. The countries surveyed have found different systems to combine the above-listed advantages of the collective system with flexibility in operational management:
    - The principle of the "hybrid" system implemented in Belgium allowing a single collective system for reporting but an individual or collective system for dismantling, collection and/or treatment (at the producer's choice);
    - Systematic consultation of the producer before choosing operational management, including for brands that have chosen the collective ARN system in the Netherlands;
    - The cohabitation of individual and collective systems (Germany, Spain, and the Netherlands).
- The choice of "pay-as-you-sell" or "pay-as-you-collect" :

[36] Varies by region

- The “pay-as-you-sell” system allows provisions to be made for future costs and avoids the risk of orphan batteries (e.g., the Netherlands). The scale can consider projected quantities collected and costs.
- The “pay-as-you-collect” system makes it possible to avoid making excessive provisions and adapts the payment directly to the real evolution of costs (collection, recycling), which are still not very stable because the waste management sector is under construction. Manufacturers provide their own financial guarantees and private provisions for future costs. In addition, the constitution of mutualised financial guarantees, compulsory and supervised by the public authorities (Belgium), in addition to the “pay-as-you-collect” system, enables to reduce the risks associated with orphan batteries.

The challenge of free riders is lower in the medium term for heavy mobility because there are fewer players in the market, which makes it easier to identify players who do not comply with the regulations. For example, one of the main EV manufacturers was pushed to join the Belgian system after a few years of free riding.

5. Annexes

5.1. Comparison of average unit weights used by SCRELEC and COREPILE

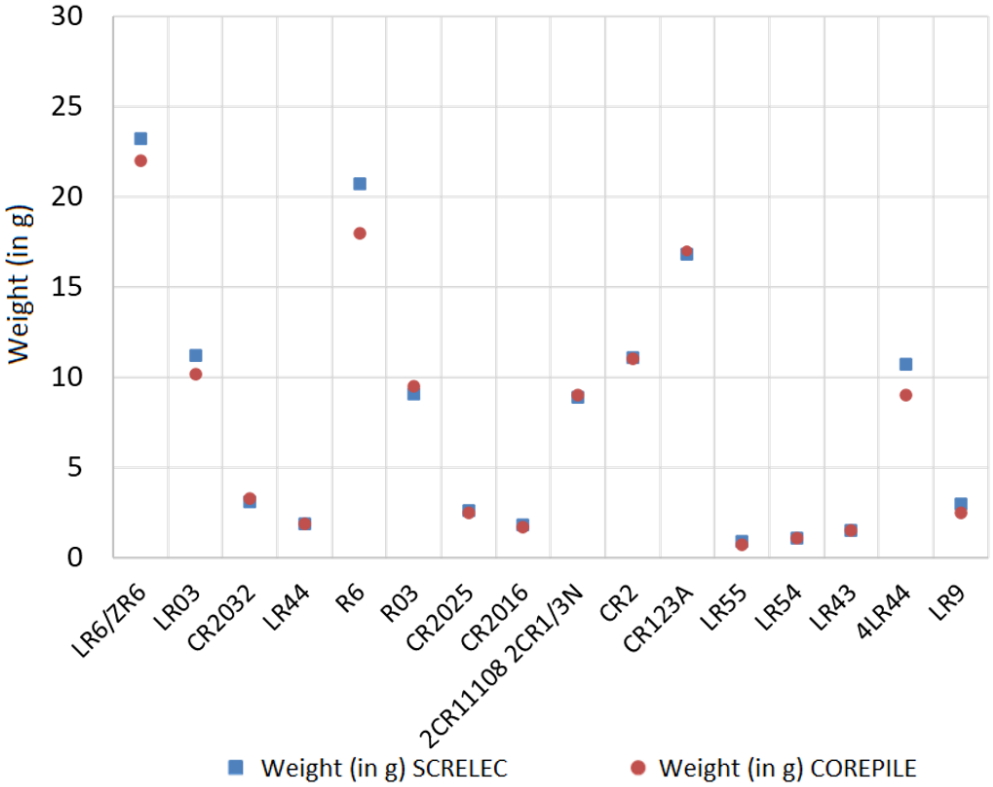


Figure 4 : Comparison of average unit weights used by SCRELEC and COREPILE

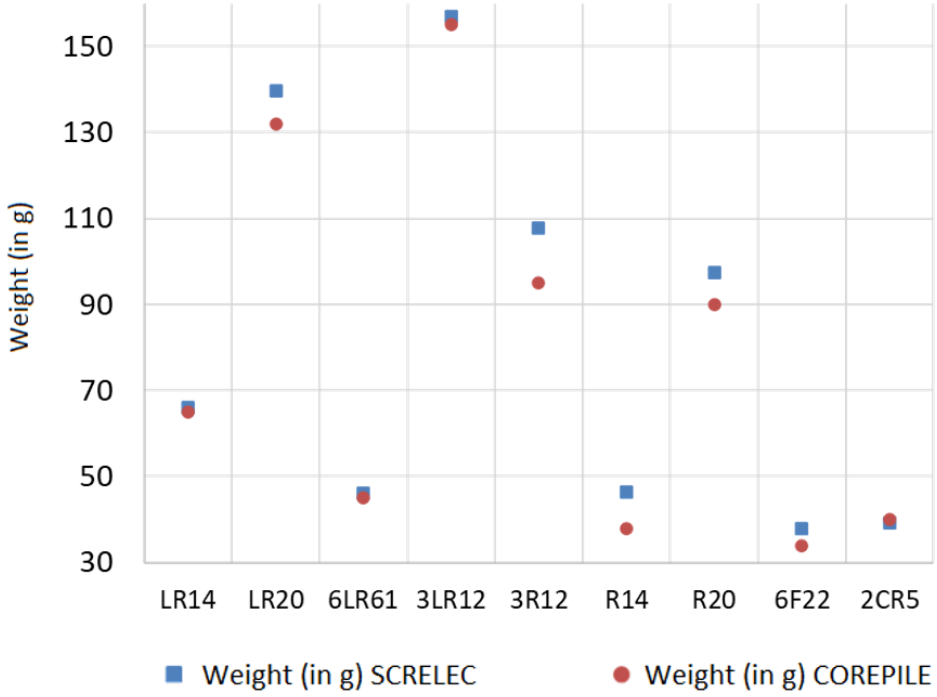


Figure 5 : Comparison of average unit weights used by SCRELEC and COREPILE

5.2. In-depth analysis of 5 average unit weight standards for portable batteries and accumulators used abroad

5.2.1. Belgium and the Netherlands

Overview	
Country	Belgium
PROs in charge of batteries and accumulators and waste streams taken in charge	BEBAT: portable, automotive, and industrial batteries (including mobility batteries)
Name of the method	BATBASE
Author of the method	BEBAT
Users of the method	PROs: BEBAT (Belgium), STIBAT[37] (Netherlands) and COREPILE (France) Producers who are members of these PROs must identify the references corresponding to their batteries in the database. The weight is then calculated automatically. A few years ago, other PROs used the BATBASE method (notably GRS BATTERIEN in Germany), but they stopped using it, notably because producers considered the reporting method complex.
Principle	BEBAT has developed an average unit weight reference for batteries with an IEC reference. BEBAT member producers must use this standard (complete or simplified, for small registrants) to declare.
Context of use	
Type of declaration by producers	For portable batteries and accumulators: in number of units only. BEBAT considers Li-ion batteries and accumulators of more than 2 kg and lead-acid batteries of more than 3 kg as industrial or automotive batteries. For other technologies, the threshold is set at 20 kg. For some industrial batteries (electric bikes, automotive) and for automotive lead-acid starter batteries: number of units and average unit weight. Producers of more than 10,000 units/year must use the monthly reporting framework rather than the annual reporting framework for smaller producers. In this monthly reporting framework, to declare quantities : - For standard formats, the producer searches the database for the BATBASE reference of the battery corresponding to their product via search functions (by chemistry, weight range, IEC reference, etc.). Each BATBASE reference is associated with a weight range and an average weight. Once the BATBASE reference has been chosen, the producer enters the number of units marketed, then the total tonnage marketed is calculated automatically. - For non-standard sizes, the producer must know the chemistry, the type of application, and the average unit weight range in which the battery to be declared falls, and then search for the BATBASE reference corresponding to this weight range. The average unit weight used is then the central value of the range. In this case, the average unit weight does not correspond to measured data or data from the

[37] The standard is used by Stichting EPAC (light mobility scheme), Stichting Batterijen (portable and industrial battery scheme) and ARN (heavy mobility scheme) via a platform provided by STIBAT. For information on the organisation of EPR in the Netherlands: chapter 5.

	literature, but to a reference value chosen by BEBAT to represent a weight range. It is as if the producer had to declare their own average weight, but the weight ranges define an accepted range of uncertainty (which is increasingly wide for heavier batteries). For button cells, there is a possibility to not look up the IEC code and then an average weight of button cells based on past years' declarations is applied. 90-91% of the units of batteries and accumulators placed on the market via BEBAT have a code in the IEC nomenclature. Producers of less than 10,000 units/year must use the simplified annual declaration framework. When closing the declarations based on the monthly declarations, the average unit weights are calculated for each category of the simplified reference system according to the proportion of each reference in the detailed declarations.
Consistency with WEEE reporting	No information, there is no coordination with the PRO RECUPEL (Belgium) in charge of WEEE.
Type of batteries involved	Automotive, industrial, mobile Primary and rechargeable
Prescriptive / indicative method	Prescriptive
Other relevant elements	A large proportion of the BEBAT producers (out of 4000 members) are small, which is why the simplified list was proposed. STIBAT (Netherlands) uses its own version of myBATBASE with some codes less and some more (95% of codes in common). The average unit weights are the same. The use of myBATBASE works on the same principle.
Characteristics of the method	
Source of data	Contacting the various producers when BEBAT was created
Type of data	Producer survey
Year of data	Late 90s - early 2000
Updating of data	The weights have not been updated since at least 2012. The average weights of the standard formats would not need to be updated according to BEBAT as they are stable. However, some non-standard references are added (e.g., electric bikes, stationary batteries for home storage) to avoid declarations in generic categories and to better know the types of batteries marketed. Since 2018, the weight ranges have been made consistent with the EPR fee scale (price/unit that varies according to the weight range).
Number of references	**Monthly, detailed repository** 4145 references of which 1397 for portable batteries: - 743 PBAs have a standard format of which 650 have a number in the IEC nomenclature and 93 have another type of reference (format, diameter). - 654 PBAs do not have a standard format. These are batteries for telephones, computers, tools, and wireless objects. **Annual benchmark, simplified** 76 references, including 10 for portable batteries (references split according to whether they are marketed alone or integrated into a device):

	- Li-ion PBAs :
	  o ≤150 g
	  o 150-500 g
	  o 500 g-2 kg
	- Leaded PBAs≤ 3 kg
	- Button, alkaline and saline, NiCd and primary lithium PBAs≤ 20 kg

Nomenclature used	BATBASE Nomenclature internal to BEBAT A BATBASE reference is a combination of chemistry, application, and size (if standard) or weight range (otherwise). Some formats are associated with the IEC nomenclature. Specific codes for certain manufacturers[38] are included in the database to assist in searching, but the corresponding references have the same average weight as all PBAs with the same IEC code.
Transparency of the method	The repository is publicly available[39] but the method is not publicly explained.
Other features	-
Verification of the relevance of the method / consistency checks	No
Control / validation of the method by public authorities	The regions (authorities responsible in Belgium for EPR control) are aware of the BATBASE system. They have not been involved in the construction of the database and do not ask questions about the methodology during the consultation committees. The main expectation is that the same method is used from year to year so that the figures are comparable.
Control / validation of the use of the method by producers	1000 audits have been carried out by BEBAT in 2021 (1/4 of the members), based on the declarations to identify outliers, especially in comparison with the declarations of previous years. There is an alert when variations exceed 20%. For 200 (5%), on-site checks are carried out by independent auditors. Weight control is carried out for non-standard formats, mainly based on product sheets. For standard references, once the reference has been checked, there is no weight control as it is assumed that the average weights are correct. All members must be audited once every 3 years. STIBAT carries out audits on a selection of members (no sample required). The following information is checked: the number of units marketed in the Netherlands only, the reference (standard sizes), and the weight range (non-standard sizes). The verification is based on documents (technical data sheets).
Feedback	
Ease of use	Managers who are new to reporting tell BEBAT and STIBAT that reporting is tedious because of the large number of references. For non-manufacturers, the difficulties lie in identifying the presence of a battery, the number of batteries, then the chemical family, the IEC code, and the weight range for non-standard formats. However, STIBAT reports that after the first few years, producers belonging to large companies integrate the correspondence between their references and the references in their own internal database, which facilitates their declarations. Smaller companies are generally eligible for simplified declarations.

[38] DURACELL, ENERGIZER, MAXELL, PHILIPS, VARTA, WONDER, UCAR
[39] Batbase : https://mybatbase.bebat.be/fr/faq/faq-listenumerosnomenclature/

	BEBAT helps producers who encounter difficulties in identifying their references via the search of product sheets, but sometimes this remains difficult. STIBAT members report an overall level of satisfaction with the service (8/10 via an annual survey) and complaints about the reporting system remain in the minority and fade over time.
Cost of use	No information
Reliability	No information, no comments received
Comparison with other past / foreign methods	BEBAT identifies that most countries use very wide reporting ranges in terms of weight, which raises the question of the reliability of the total weights reported.
Overall assessment	
Benefits	The database provides information to producers who may not know their average weight for standard sizes. For non-standard sizes, BEBAT specifies the range of uncertainty tolerated via the weight ranges. The large number of references allows for more accurate declarations and a better knowledge of the market by the PROs.
Disadvantages	Complexity for declarations. However, the simplified repository aims to reduce the administrative cost for small members.
Developments planned by the authors	No
Developments planned by users	No
Other remarks	BEBAT has proposed, together with EUCOBAT, that the weight and chemical family be indicated on batteries in the new European Battery Regulation (Annex VI). This could facilitate the identification of weights. The comparability of collection rates at European level requires better declaration of the placing on the market. This includes knowledge of the weights (e.g., via labelling on batteries), but also harmonised requirements for tracing declarants (free riders) and minimum requirements for auditing the declarations.
Transposability to France	-

5.2.2. Luxembourg

Overview	
Country	Luxembourg
PROs in charge of batteries and accumulators and waste streams taken in charge	ECOBATTERIEN: approved PRO for the EPR of portable, automotive, and industrial batteries and accumulators, including electric mobility batteries. There is no other PRO in charge of batteries and accumulators in Luxembourg. ECOTREL: approved PRO for the management of WEEE They are two different legal entities, but they share premises, staff, and reporting methods.
Name of the method	No name
Author of the method	ECOBATTERIEN / BEBAT
Users of the method	ECOBATTERIAN
Principle	ECOBATTERIEN has its own reference system to determine the weights placed on the market by its members and to declare them to the competent public authorities, based on the number of units declared per type of reference. Producers do not declare weights and therefore do not use the method directly.
Context of use	
Type of declaration by producers	Number of units only (for all batteries, standard or non-standard size)
Consistency with WEEE reporting	No WEEE producers only report units of WEEE and do not have to report weights of devices, with or without batteries.
Type of batteries involved	All batteries: portable, industrial, automotive Portable batteries are batteries <3kg in Luxembourg. Electric bike batteries over 3kg are declared with industrial batteries.
Prescriptive / indicative method	Prescriptive
Other relevant elements	-
Characteristics of the method	
Source of data	Members of BEBAT and ECOBATTERIEN
Type of data	Weighted average from detailed BEBAT declarations, possibly corrected by ECOBATTERIEN producer surveys. This is an indirect use of the BATBASE, the average unit weights of the BATBASE being weighted by the number of units declared in each category to provide more easily usable aggregated average unit weights. The average unit weights are elaborated from the data coming from the detailed declaration of BEBAT members (number of units, and average unit weight range for non-standard formats). There is a collaboration between BEBAT and ECOBATTERIEN, both members of EUCOBAT, to receive these data (without financial compensation).

Year of data	2021
Updating of data	Annually, by BEBAT. Although the average unit weights of the BATBASE do not evolve except in the case of the addition of new references, the proportion of the different categories of the BATBASE evolves every year, according to the evolution of quantities placed on the market. ECOBATTERIEN surveys are carried out about once a year (but less systematically).
Number of references	10 of which 4 for portable batteries[40]
Nomenclature used	- Non-lead portable batteries and accumulators sold alone - Portable non-lead batteries and accumulators sold in devices - Portable lead-acid batteries and accumulators sold alone - Portable non-lead batteries and accumulators sold in devices The variation in weight between references in the same category is not considered.
Transparency of the method	The repository is not publicly available and could not be obtained for the purpose of the study (confidentiality). The average weights are provided to the responsible public authorities (environmental administration under the Ministry of the Environment).
Other features	-
Verification of the relevance of the method / consistency checks	Surveys carried out almost annually by ECOBATTERIEN, which generally corroborate the average weights from BEBAT.
Control / validation of the method by public authorities	The public authorities are aware of the method used and approve of it.
Control / validation of the use of the method by producers	The method is not used by the producers but only by ECOBATTERIEN. ECOBATTERIEN checks the declarations of the producers only on the number of units declared and on the category of declaration, based on accounting documents such as invoices. Unit weights are not checked. ECOBATTERIEN is obliged to carry out checks on the declarations, but the method, frequency or representativeness of the sampling is not imposed.
Feedback	
Ease of use	No feedback from members The method is considered easy to use by ECOBATTERIEN, due to the small number of categories.
Cost of use	Low
Reliability	Good, corroborated by ECOBATTERIEN surveys

[40] ECOBATTERIEN declaration form https://www.ecobatterien.lu/volumes/files/Convention-dadh%C3%A9sion-Ecobatterien-v1.7-annexes_220406_060425.pdf

Comparison with other methods	ECOBATTERIEN used to use myBATBASE before but chose to use the simplified method since 2010, as BATBASE was considered too complicated to use for producers (extensive and time-consuming nomenclature).
Overall assessment	
Benefits	Simple method of declaration which avoids free riders in a small market like Luxembourg.
Disadvantages	No details on the categories of batteries and accumulators placed on the market.
Developments planned by the authors	No
Developments planned by users	Not applicable
Other remarks	The ECOBATTERIEN surveys show a real coherence with the BEBAT data and therefore validate the relevance of the method given the similarity of the markets.
Transposability to France	Limited, similarity of markets to be demonstrated.

5.2.3. Finland

Overview	
Country	Finland
PROs in charge of batteries and accumulators and waste streams taken in charge	RECSER OY has a 92% market share of the weight of portable batteries and accumulators placed on the market. ERP has a market share of 8%.
Name of the method	No name.
Author of the method	RECSER OY
Users of the method	RECSER OY member producers volunteers
Principle	RECSER OY has an indicative average unit weight benchmark for 10 common portable battery types to assist producers in their reporting. RECSER OY does not have a reference unit weight for other types of batteries and accumulators, and it is up to the producers to report the total weights.
Context of use	
Type of declaration by producers	Total weights Producers report directly the weights placed on the market. ERP declares to RECSER OY the weights marketed by its members and then RECSER OY takes care of declaring all the data to the public authorities. ERP Finland does not use an average weight method.
Consistency with WEEE reporting	Producers of EEE declare the weight of the EEE to the PRO responsible for WEEE, net of the weight of the battery. There are 5 PROs for WEEE in Finland. Three of them (ERP Finland, SER- Tuottajayhteisö, and Flip) use a common reporting system with RECSER OY which means that the producers also have access to the average weights of RECSER OY's repository to help them in their reporting.
Type of batteries involved	The standard covers portable batteries of standard size, mainly primary. There is no weight threshold for defining portable batteries in Finland.
Prescriptive / indicative method	Indicative
Other relevant elements	Method developed at the request of RECSER OY members.
Characteristics of the method	
Source of data	Several sources: EUCOBAT key figures from weights declared by EUCOBAT members, weights declared by producers directly to RECSER OY, product data sheets, ...
Type of data	Reference weight or weight range
Year of data	2020
Updating of data	Regular updates, depending on the updates made by EUCOBAT and/or the producers

Number of references	10
Nomenclature used	ANSI nomenclature <table><tr><td rowspan="5">**Alkaline batteries and similar**</td><td>AAA</td></tr><tr><td>AA</td></tr><tr><td>C</td></tr><tr><td>9V</td></tr><tr><td>D</td></tr><tr><td rowspan="3">**Lithium batteries (primary)**</td><td>9V</td></tr><tr><td>AA/FR6</td></tr><tr><td>Button batteries</td></tr><tr><td>**Batteries (NiMH etc.)**</td><td>AA/HR6</td></tr><tr><td>**Silver oxide batteries**</td><td>Button batteries</td></tr></table> No specific brands are listed. Users of specific brands are free to use specific average weights.
Transparency of the method	Available free of charge on their extranet for producers
Other features	-
Verification of the relevance of the method / consistency checks	RECSER OY has never found any problems of consistency between different stacks within the same reference.
Control / validation of the method by public authorities	No, but from 2023 onwards, producers and PROs will have to assess the reliability of the reported data every year as part of their self-monitoring plan. The public authority may, if necessary, appoint an external auditor to check the information.
Control / validation of the use of the method by producers	RECSER OY always advises its members to check the exact weight before declaration. The PRO can carry out checks on the declarations (on documents) in case of suspicion of non-compliance. For the time being, RECSER OY has only carried out checks where necessary (e.g., checking against previous years' declarations). In the future they may have to carry out more regular checks as part of their self-checking.
Feedback	
Ease of use	Three of the RECSER Oy members gave an average score of 5/5 to the ease of use of the repository.
Cost of use	No information
Reliability	Three of the RECSER Oy members gave an average score of 4.6/5 to the reliability of the repository.
Comparison with other past / foreign methods	No information: RECSER OY has never considered using another method like BATBASE.
Overall assessment	
Benefits	The method is based primarily on declarations of the masses placed on the market by producers and provides an aid for producers who do not know their weights well. The weight

	declarations are more in line with the actual costs of managing batteries at the end of their life. There was no negative feedback from producers on this method. This method of reporting is easy to use. The share of standard primary batteries on the market is constantly decreasing in favour of non-standard batteries, so RECSER OY does not feel the need to change its method. For rechargeable batteries, it is not possible to determine average weights in a comprehensive way due to the diversity of formats and the lack of a unified nomenclature. The advantages highlighted by the users of the register are reliability, speed, and ease of use. It was also considered appropriate for small and occasional producers.
Disadvantages	No reference weight for Li-ion and non-standard batteries. No disadvantages have been identified by users of the repository.
Developments planned by the authors	No
Developments planned by users	No information
Other remarks	-
Transposability to France	This method is similar to that used by SCRELEC.

5.2.4. Italy

Overview	
Country	Italy
PROs in charge of batteries and accumulators and waste streams taken in charge	The CDCNPA is a private company created to meet a regulatory obligation and is owned by the PROs. It centralises the data of the various PROs in charge of the EPR systems for portable, industrial, and automotive batteries and accumulators in Italy. It acts as a clearing house, optimises collection systems, keeps statistics on the scheme, maintains relations with the Ministry of the Environment and communicates with consumers. There are 13 collective schemes (PROs) for EPR of batteries and accumulators, 12 of which are for PBAs and 3 individual schemes for industrial and automotive accumulators. All of them are obliged to join the CDCNPA (some individual systems are not compliant). Among the collective EPR systems, the PROs with the largest market shares for portable batteries are COBAT, ERION, ERP. COBAT and ERP are also active in the management of WEEE.
Name of the method	Guidance for producers
Author of the method	CDCNPA
Users of the method	Producers ERION does not provide specific recommendations on unit weights and refers producers to the CDCNPA guidelines if requested.
Principle	The CDCNPA provides reference unit weights for 16 of the most common battery references. The PROs are free to recommend them to their members or not. For the other references, there are no reference weights, so producers must establish the unit weights themselves for their declarations.
Context of use	
Type of declaration by producers	Unit and weight (unit or total)
Consistency with WEEE reporting	The weight of the battery is not calculated when declaring WEEE. The weight declared for WEEE usually includes the weight of the device and the battery without distinction.
Type of batteries involved	The benchmark only covers the most common types of portable primary batteries. Batteries do not have a recorded average reference weight. There is no weight threshold to define portable batteries in Italy. Light mobility batteries are industrial batteries.
Prescriptive / indicative method	Code Each PRO can receive battery weight data from its members in any way it wishes (number of references, total or unit weight).
Other relevant elements	The PROs that are members of the CDCNPA have asked the latter to provide harmonised general information on the weights of the most common references to help producers to declare. Previously, the different PROs had each their own method, but many producers had difficulties in knowing the average unit weights.

Characteristics of the method	
Source of data	Statistical survey of the main producers carried out by the various PROs, which reported the average weight per reference confidentially. The CDCNPA then averaged the average weights to publish its benchmark.
Type of data	Reference weight (for all references excluding button cells) Weight range for button cells
Year of data	2018
Updating of data	No update planned
Number of references	16
Nomenclature used	ANSI nomenclature : - Button - AAA - AA - C - D For each model (except button), different reference weights are offered depending on the chemistry: alkaline, zinc-carbon (saline), NiMH, Lithium. A reference is a combination of ANSI format and electrochemistry. No specific brands are listed in the standard. The nomenclature used for the declarations as such includes 11 categories of portable batteries and accumulators: - Zinc carbon batteries - Zinc chloride batteries - Alkaline batteries - Lithium batteries - Zinc air batteries - Zinc-Silver Batteries - Lead-acid batteries - Nickel-cadmium batteries - Nickel Metal Hydride Batteries - Lithium batteries - Other
Transparency of the method	Public and accessible online However, the way in which the methodology was established is not publicly detailed and the raw data is confidential.
Other features	No significant variation was found between the data provided by the different PROs

Verification of the relevance of the method / consistency checks	No problem identified; no method planned
Control / validation of the method by public authorities	No, the public authorities have no control over the method used.
Control / validation of the use of the method by producers	The PROs are responsible for monitoring the declarations of their respective members. ERION carries out checks when there are deviations between the weights declared by a member in two consecutive years. The check includes a calculation of the average unit weights from the total weights and the number of units.
Feedback	
Ease of use	No problems reported with unit weights, the main concern of producers being the categorisation between portable and industrial.
Cost of use	No information
Reliability	No influence on reliability - no major impact noted
Comparison with other past / foreign methods	No information on methods used abroad
Overall assessment	
Benefits	According to ERION, imposing the declaration of weights on producers obliges them to seek their real weight, which would be more reliable than a declaration by unit and extrapolation from reference weights. NB: Reliability depends on the method of access to unit weights by producers, in particular those placing devices on the market, and for example on the reliability of technical data sheets.
Disadvantages	The standard does not include an average weight for batteries. Producers must declare their own weight, which is usually not a problem because their products are more specific, and they know their characteristics better than primary battery producers.
Developments planned by the authors	No
Developments planned by users	No
Other remarks	The definition of a harmonised nomenclature to identify batteries at European level would be relevant.
Transposability to France	The approach of developing an indicative reference framework drawn up by an independent body for all PROs is transposable to France, provided that this third-party body is designated.

5.2.5. Czech Republic

Overview	
Country	Czech Republic
PROs in charge of batteries and accumulators and waste streams taken in charge	There are two PROs in charge of portable batteries and accumulators in the Czech Republic: - ECOBAT: PRO also in charge of industrial and automotive batteries and accumulators - REMA Battery: subsidiary of an PRO in charge of WEEE
Name of the method	No name
Author of the method	ECOBAT
Users of the method	ECOBAT members, mainly small companies placing portable batteries on the market inside EEE (typically for applications such as toothbrushes, electric shavers, DIY tools...). Producers of primary batteries in standard formats do not need assistance in determining average weights as these are batteries for which information is readily available or measurable. About 3% of the 400 members who market batteries in EEE use the standard proposed by ECOBAT.
Principle	ECOBAT offers average unit weights from an internal database on request only when members have declared inconsistent weights and have difficulties in declaring the correct weights.
Context of use	
Type of declaration by producers	Number of units and total tonnage, since 2021 (new regulation) Before 2021, the format of the declarations was defined by each PRO, with ECOBAT requiring a declaration by number of units only for button cells, and by weight only for other cells.
Consistency with WEEE reporting	The EEE producers declare the weights of EEE and batteries to the PROs in charge of WEEE with which ECOBAT cooperates (ASEKOL and ELEKTROWIN) and pay the EPR fees for the whole. The declarations concerning the batteries are then sent to ECOBAT for verification and the EPR fees corresponding to the batteries are paid out by the partners considering the declarations. For the calculation of the EEE weights, the PROs deduct the battery weights in their EEE declarations to the WEEE PROs. Given the WEEE/PA cooperation, the battery weights are consistent for the joint members.
Type of batteries involved	Portable and industrial batteries and accumulators (light mobility such as electric bikes, scooters), the standard being used mainly for accumulators. For the primary piles, ECOBAT has value intervals to check the consistency of the declarations. When unit weights are inconsistent, producers are contacted to correct their declarations. They can easily perform a weighing and therefore do not need the ECOBAT reference system. This is more useful for accumulators (secondary batteries) incorporated in devices.

Prescriptive / indicative method	Indicative
Other relevant elements	The declaration in number of units and weight allows a better control of the declarations than the previous declaration in weight only and is used to identify inconsistencies / errors in the declarations.
Description of the method	
Source of data	Survey carried out by one of the 3 main retailers of electrical and electronic products, member of ECOBAT, based on product sheets and measurements of the weight of batteries contained in the devices brought back to the after-sales service. The survey covers a wide range of products.
Type of data	Average unit weight per type of chemistry and per type of electronic device (e.g., drone, toothbrush...)
Year of data	October - November 2021 The database has been in existence for many years, with the previous version dating from around 2015.
Updating of data	Every 3-4 years Addition of emerging products as they emerge (e.g., drones)
Number of references	469
Nomenclature used	Parts list of the retailer
Transparency of the method	The method is not provided online as it is considered the PRO's own knowledge.
Other features	The repository is not used by all members. Access to the database is provided free of charge to members who need it. Producers can associate each category with batteries' figures (units) directly in the database to automatically calculate the total weight for declarations. The database is not automatically connected to the reporting system.
Verification of the relevance of the method / consistency checks	No, but regularly updated
Control / validation of the method by public authorities	The public authorities do not monitor the database. It is not a priority issue for them, and they would not have the human capacity to do so.
Control / validation of the use of the method by producers	Yes, specific support ECOBAT has the declarations provided by the PROs in charge of WEEE partners verified by independent auditors (based on the reports). The auditor checks the consistency of the declarations with the typical battery chemistries of the declared applications, and the expected average unit weight ranges. Tolerance ranges between declared and observed unit weights are allowed (+/- 1g for batteries under 25g, +/- 3g up to 150g, +/-10g above 150g).

	When values are outside the expected values, ECOBAT contacts the producers to check the values and asks them if they can correct their values with accurate data, especially from their suppliers. If this data is not available, in particular for small registrants, ECOBAT proposes to use their reference system. ECOBAT does not have the financial capacity to support all registrants and therefore prioritises according to the inconsistencies observed. The work is entrusted to 2 external auditors.
Feedback	
Ease of use	Positive feedback from members on the existence of the framework
Cost of use	Free access
Reliability	According to ECOBAT, the uncertainty is of the order of 15%.
Comparison with other past / foreign methods	The BATBASE method is known to ECOBAT and there are exchanges of information between PROs. However, it was decided to develop an own system because : - The BATBASE system would have required a change in the membership reporting system, - and the PRO had no visibility on the financial impact in terms of total contributions paid. The non-alignment with the method used by other PROs is not currently perceived as an issue by ECOBAT.
Overall assessment	
Benefits	ECOBAT's main motivation is financial. 80% of the declaration errors are to their disadvantage (underestimated weight). Verification and correction therefore allow for the collection of the correct amount of EPR fees. The method is appreciated by the members, whose core business is not to identify battery weights.
Disadvantages	Uncertainty on recommended unit weights (about 15%), however this is more reliable than some voluntary declarations.
Developments planned by the authors	ECOBAT plans to integrate the database directly into the reporting system so that recommendations are available to all and not just in the case of obvious inconsistencies.
Developments planned by users	No
Other remarks	The priority for the PRO and the authorities is to develop safe collection and recycling of batteries. The reporting procedures are important for the PRO's financial balance sheet but are not considered a key issue for the scheme in general.
Transposability to France	-

Some results from the ECOBAT benchmark have been extracted in the **Erreur ! Source du renvoi introuvable.** below. The benchmark presents unit weights of batteries and batteries' figures per type of device by listing the type of battery and the associated chemistry. The greater variability in weights is due to the diversity of devices considered. The battery weight will be lower for office accessories (headphones, keyboards, telephones, MP3 actors, camcorders etc.) than for household devices (hoovers, lawnmowers etc.).

The weight of button cells has not been listed in the repository.

There is some similarity with the other repositories: the first category probably corresponds to a 22g LR06 battery in the BATBASE, the second category to a 10.2g LR03 battery in the BATBASE.

Category	Type of device in which batteries are included	Unit weight (kg)	Product group	Type of product	Chemistry
1	Small household devices/Ironing and spraying, lawnmower Outdoor toys/scooter PC, games and office equipment/Office and shop/Calculator Household/garbage can Electronic musical instruments Watch/Alarm clock, Clock	0.023	Prismatic and cylindrical	Primary	AlMn
2	Consumer electronics/TVs or presentation technology (projector) Consumer electronics/AV accessories Small household devices/Health care Small household devices/Fan PC, games, and office equipment/PC accessories	0.011			
3	Consumer Electronics/TVs or Presentation Technology (Video Projector) Home Devices/Mobile Air Conditioning	0.009			
4	Small devices/Shaving, cutting/Epilators and depilators/Women's shaving machine and epilator	0.002			
5	Consumer electronics/Satellite and terrestrial reception	0.11			
6	Home, Leisure & Garden/Measuring Instruments	0.04			
7	Musical instruments/Home, hobby and garden accessories/Extension cables, forks, and connectors	0.034			
8	Small devices/scales	0.012			
9	Portable DVD	0.0002	Prismatic and cylindrical	Secondary	Li-ion
10	Wireless in-ear headset	0.002			
11	GSM/Hand free accessory	0.003			
12	Wireless keyboard	0.005			
13	MP3/MP4 actor Headphones	0.01			
14	Razor	0.02			
15	Outdoor or car camcorders	0.025			

16	GPS navigation Phone/Smartphone Small devices/Dental hygiene (electric toothbrush)	0.03			
17	Wireless speakers Wireless hearing aids Camcorders Tablets	0.05			
18	Office automation/data terminals	0.1			
19	Drill, screwdriver Lawnmower	0.2			
20	Consumer electronics/Energy/Power supply	0.25			
21	Small devices/hand hoover	0.3			
22	Robotic hoovers	0.5			
23	Cordless hoovers	0.75			
24	Hair/beard trimmer	0.05	Prismatic and cylindrical	Secondary	NiMH
25	Phones and GPS/Talkies Small devices/Baby phones	0.013			
26	Solar lamp	0.027			

Table 18 Excerpt from the ECOBAT standard - presentation by type of unit weight

5.3. In-depth analysis of electric mobility battery management in 5 countries

The reasons for the selection of the 5 countries are given in section 2.2. For each country, an overview is provided in the form of a summary table and a diagram representing the differentiating elements of the management of heavy mobility batteries in the country (financial and information organisation). The management of light mobility batteries is similar between all countries (see section 4.3) and has therefore not been mapped out. Similarly, the different types of collection points for heavy mobility batteries (car dealers, ELV centres) are the same for all countries and have therefore not been mapped. The diagram showing the operation in France (see **Erreur ! Source du renvoi introuvable.**) also applies to the other European countries for the light mobility part and the details of the collection points.

5.3.1. Germany

5.3.1.1. Overview

Context	
Population	83 million (2019, Eurostat)
Population density (inhab./km²)	235 (2019, Eurostat)
Sales of electric and hybrid vehicles (/year per 1000 inhabitants)	8.2 (2021, Elektroauto)[41]
Market share of electric and hybrid vehicles (%)	26.0 (2021, La Tribune, Elektroauto)[42]
Number of electric and hybrid vehicles registered[43]	633,424 (2019, Eurostat)
Number of registered electric and hybrid vehicles (/1000 inhabitants)	7.6 (2019, Eurostat)
Extended producer responsibility	
End-of-life vehicles	Individual systems
Light mobility batteries	Take-back obligation by retailers and voluntary EPR scheme - PRO GRS BATTERIEN
Heavy mobility batteries	Individual systems (little information)
Other batteries (portable, industrial, automotive)	EPR scheme for portable batteries - PROs: GRS BATTERIEN, ERP, CCR REBAT, ÖCORECELL, DS ENTSORGUNGS- UND DIENSTLEISTUNGS-GMBH Obligation for retailers to take back car batteries
Regulations for mobility batteries	
Collection targets	No
Treatment objectives	Non-specific, 50% recycling efficiency targets for all batteries
Specific collection / safety regulations	No

[41] Source: Matthias Schmidt - European Electric Car Market Intelligence Study (2021) A total of 355,961 electric vehicles and 325,439 hybrid vehicles were sold in Germany in 2021. https://www.elektroauto-news.net/2022/2021-knapp-ein-drittel-aller-e-autos-in-deutschland-zugelassen

[42] Source: based on La Tribune article of 18/01/2022, 2.6 million vehicles registered in Germany in 2021

[43] For all countries, this figure refers to the number of electric and hybrid vehicles in circulation

Approval of ELV centres	No
Performance	
Collection rate (or quantities collected)	Heavy mobility: No information Light mobility: 105 tonnes
Recycling rate	No information
Second life rate	No information

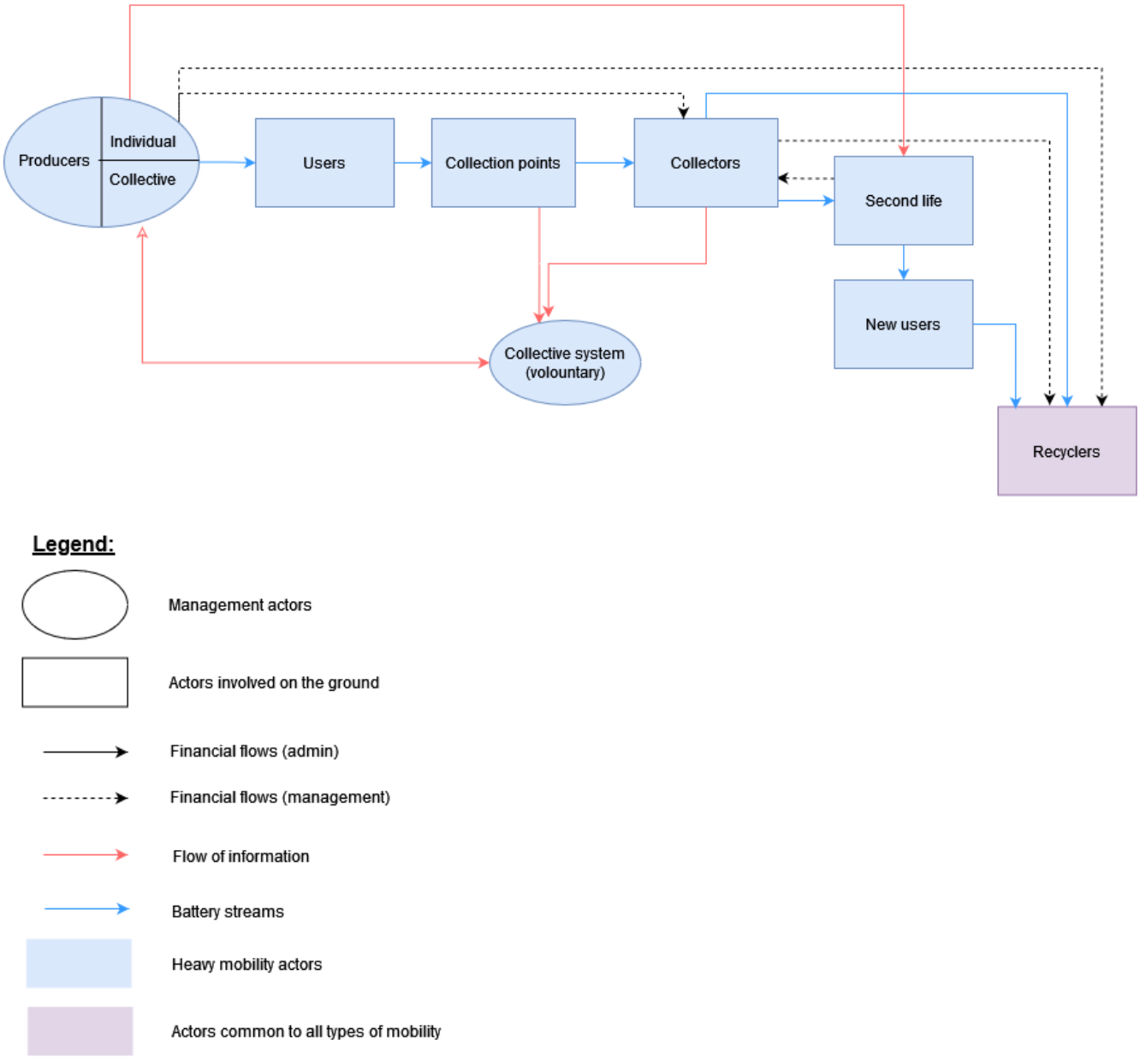


Figure 6 : Heavy mobility battery management in Germany

5.3.1.2. History

Context :

In compliance with the European framework, there is a functioning collection and treatment system for all batteries and accumulators (portable, automotive, and industrial) in Germany, with a take-back system by retailers, civic amenity sites and mobile collections, as well as voluntary collection points, and an obligation to dismantle batteries by WEEE and ELV treatment centres.

In Germany there are about 10 recyclers of LI-ion batteries (not specific to mobility).

Past developments : No relevant evidence for mobility batteries

Perspectives

- The UBA (Environment Agency) considers, in accordance with the European Commission's regulatory review, that its regulatory framework is inadequate for the evolution of the market, and in particular for the management of batteries for electric and hybrid vehicles. Germany has planned to amend its regulatory framework once the future EU Battery Regulation is adopted and has not made any specific provisions prior to this adoption.
- The UBA considers that the establishment of PROs for the management of automotive and industrial batteries, including electric mobility batteries, would facilitate take-back by reducing the number of interlocutors for the delivery of used batteries (difficult to identify the initial responsible producer in the current system). However, this would lead to increased compliance costs for producers and public authorities and would limit the emergence of individual solutions.

5.3.1.3. Regulatory framework

Status and classification of mobility batteries :

There is no dedicated category for "mobility batteries" in the German regulations. They are part of the definition of industrial batteries[44] .

Li-ion batteries are considered as hazardous waste. Since there is no specific hazardous waste code (code 16 06 05 "other batteries and accumulators" being a non-hazardous waste entry), according to the German administration, Li-ion batteries removed from vehicles should be classified under code 16 01 21* (hazardous components other than those mentioned in 16 01 07 to 16 01 11, 16 01 13 and 16 01 14) of the European Waste Nomenclature. Li-ion batteries removed from WEEE are classified under the European Waste Nomenclature code 16 02 15* (hazardous components removed from discarded equipment). The German authorities are in favour of a harmonised classification solution at European level with a specific hazardous waste code for Li-ion batteries.

This status is not necessarily applied in practice as the LRP group in charge of several ELV centres considers that Li-ion batteries in good condition are not hazardous waste but that damaged batteries are.

Regulation on extended producer responsibility for batteries:

The German Battery Act (BatterieG) of 25 June 2009 (BGBl. I p. 1582), in its version as last amended by Article 1 of the Act of 3 November 2020 (BGBl. I p. 2280)[45] provides a framework for battery EPR.

- Specific elements foreseen according to the types of batteries
    - **Voluntary organisation of an EPR scheme:** Producers of portable batteries are obliged to implement extended producer responsibility, either individually or collectively via an PRO. For automotive and industrial batteries, as in France, they can do so but are not obliged to and the BatterieG law does not explicitly mention the possible organisation.
    - **Individual system vs. PRO:** There is no PRO for industrial batteries, nor for automotive batteries. There are 10 PROs for portable batteries (in 2022).
    - **Obligation to take back :**
        - Producers of all types of batteries are obliged to take back batteries collected by retailers, ELV centres and WEEE treatment centres. For portable batteries,

[44] Industrial batteries are defined as batteries used for industrial, commercial, or agricultural purposes, or to power electric or hybrid vehicles. The notion of vehicle considered in this definition is in line with recital 9) of the EU Battery Directive 2006/66/EC, i.e., it includes "batteries and accumulators used in electric vehicles, such as cars, wheelchairs, bikes, airport vehicles and automatic transport vehicles".

[45] German Battery Act (BatterieG): https://www.gesetze-im-internet.de/battg/

producers are additionally obliged to take back batteries collected by public waste management authorities and voluntary collection points.
        - Retailers (of all types of batteries) are obliged to take back from the final consumer all types of used batteries they have or had in their product range. This also applies to industrial batteries and therefore to mobility batteries.
        - Public waste management authorities have an obligation to take back portable batteries (including portable batteries included in EEE which must be separated). They have no obligation regarding mobility batteries.
        - Producers of industrial or automotive batteries should offer retailers of these batteries and WEEE treatment centres and ELV centres a reasonable and free solution for the return of batteries.
    - **Obligations concerning the mode of organisation:**
        - Retailers and voluntary collection points are obliged to hand over the portable batteries they collect to the PRO responsible for them.
        - Retailers and WEEE and ELV treatment centres are under no obligation to return collected automotive and industrial (including mobility) batteries to producers or their representatives. They are the owners and can decide on their end-of-life.
    - **Deposit for automotive batteries sold alone:** Retailers of automotive batteries must charge a deposit of EUR 7.5 including VAT to the end-user (who may be a private individual), which is returned if the end-user returns the used battery. This deposit obligation does not apply to automotive batteries installed in a vehicle that is sold to the end user and does not apply to electric and hybrid vehicles (which are not automotive batteries).
    - **Pay-as-you-sell vs. pay-as-you-collect:** Financial contributions for portable batteries should be based on the quantities marketed and the collection rate (pay-as-you-sell). There is no legal guidance on how the fees should be collected by the PROs that would be formed to manage electric traction batteries. The UBA (Umweltbundesamt[46]) considers that the financial contributions currently collected for electric vehicle batteries are based on the quantities collected (pay-as-you-collect).
    - **Objectives**
        - Collection: The collection rate target for portable batteries is 50% (a national target that is higher than the EU target of 45% in 2016 but calculated according to the terms of EU Directive 2006/66/EC). There is no collection rate target for other types of batteries.
        - Treatment: The recycling efficiency targets are those of Directive 2006/66/EC, i.e., 50% for all batteries except NiCd and lead acid (including mobility batteries).
    - **Specific framework for second life**: There is no specific regulatory framework (or target) for second life in Germany.

- **Approval systems**

The UBA is the competent authority for the control of PROs and individual systems, and the authority to which the mandatory declarations related to batteries must be made.

For portable batteries, the conditions for a PRO to be authorised by the UBA (which is the competent authority) are the following:

- Prove that the collection target for portable batteries and accumulators will be met (the collection rate target is 50%).
- Offer free take-back of used batteries from devices at affiliated collection points: retailers, public waste operators, treatment facilities, and voluntary collection points.
- Provide the affiliated take-back points with suitable take-back containers and transport containers free of charge, in accordance with the legal requirements for dangerous goods.
- Collect free of charge within 15 working days used batteries supplied by affiliated collection points, regardless of their nature, type, brand, or origin as soon as their members report a collection mass above certain threshold.
- Organise the handover of used batteries collected from affiliated collection points to actors who will ensure their recycling. Disposal of portable batteries is only possible if they cannot be identified, and disposal of industrial and automotive batteries by incineration or landfill is prohibited (disposal is only possible for recycling residues).

[46] German Environmental Agency

The first two conditions must be verified by an independent expert. The EAR Foundation (Elektroaltgeraate-register ®) has been fulfilling the role of approving PROs on behalf of the UBA since 2021.

Active PROs

There are 10 active PROs for portable batteries[47] :

- GRS: 5 separate legal entities - one central entity and 4 separate entities: consumer, e-mobility, health, and DIY tools
- REBAT and REBAT +
- ERP (LANDBELL)
- ÖCORECELL
- DS ENTSORGUNGS GMBH

Only GRS is active for light mobility batteries.
Collective systems for heavy mobility batteries are not registered.

Regulation on extended producer responsibility for vehicles

The End-of-Life Vehicle Ordinance in the version published on 21 June 2002 (BGBl. I p. 2214),[48] as last amended by Article 1 of the Ordinance of 18 November 2020 (BGBl. I p. 2451) defines the framework for extended producer responsibility for vehicles. The ELV Treatment Act (AltfahrzeugG)[49] defines the conditions for the treatment of ELVs.

- **PRO:** There is no PRO for ELV.
- **Framework for batteries in the regulation**
    - Operators of ELV collection points, dismantlers (ELV centres), shredders and other treatment facilities must, immediately after delivery of each ELV, remove the batteries and store them separately in acid-proof containers or on a non-draining, acid-proof surface. This requirement also applies to batteries from electric and hybrid vehicles.
    - There are no specific regulatory requirements for electric and hybrid vehicle batteries.

Regulation on extended producer responsibility for EEE

The German Electrical and Electronic Equipment Act of 20 October 2015 (BGBl. I p. 1739), as last amended by Article 23 of the Act of 10 August 2021 (BGBl. I p. 3436) defines the applicable framework for the extended producer responsibility for EEE.[50]

The WEEE Management Ordinance of 21/06/2021 (EAG-BehandV) defines the conditions for the treatment of WEEE.[51]

These texts transpose the provisions of the European WEEE Directive.

- **PROs**

There is no PRO for WEEE, but there is a clearing house system.

- **Framework for batteries in the regulation**
    - The end-user of EEE is obliged to separate the battery from the EEE if technically feasible (and without damaging the battery) before returning the EEE and battery to the municipality or collection point (including private individuals). This does not apply in case of collection of WEEE for preparation for re-use. Collection must be organised in such a way as to allow for subsequent recycling or reuse and to minimise fire risks. Information must be provided to

[47] List of PROs: https://www.ear-system.de/ear-verzeichnis/battgruecknahmesysteme#no-back
[48] ELV Ordinance: https://www.gesetze-im-internet.de/altautov/BJNR166610997.html
[49] ELV Treatment Act AltfahrzeugG https://www.bgbl.de/xaver/bgbl/start.xav?start=%2F%2F*%5B%40attr_id%3D%27bgbl102s2199.pdf%27%5D#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl102s2199.pdf%27%5D__1655288407426
[50] German EEA law: https://www.gesetze-im-internet.de/elektrog_2015/BJNR173910015.html
[51] German WEEE Management Ordinance: https://www.gesetze-im-internet.de/eag-behandv/BJNR184100021.html#BJNR184100021BJNG000300000

users by both producers, retailers and public waste management bodies. This may concern light mobility batteries considered as EEE (scooters, electric bikes...).

- EEE devices in the categories of displays, large devices and small devices containing batteries must be collected separately at collection points run by the municipalities responsible for waste management. This may include batteries for light mobility (e.g., scooters).
- Batteries should be extracted from WEEE before shredding, and if not extracted before, then after shredding. Extraction must be carried out in such a way that the batteries are chemically identifiable and separable. The extracted batteries must be prepared for reuse or recycling unless such treatment is not technically possible or permitted.

Status of the black mass

Black mass without electrolyte is classified as waste in Germany. Several hazardous waste codes are used: 19 12 11* other wastes (including mixtures) from mechanical treatment of waste containing dangerous substances, 06 03 15* metal oxides containing heavy metals and 19 10 05* other fractions containing dangerous substances.

5.3.1.4. Light mobility battery management

EPR scheme

Description of the system

In cooperation with the Zweirad Industrie Verband, GRS BATTERIEN, one of the 10 PROs in the portable battery scheme, has developed a voluntary collection scheme for e-bike batteries. The company officially in charge is called GRS SERVICE GMBH and the PRO bears the brand name GRS eMobility.

In 2019, the PRO represented 80% of the mobility market. In 2021, 150 producers were part of the PRO. The UBA welcomes the formation of this voluntary PRO.

There are no other collective extended producer responsibility schemes in Germany. The other producers are therefore obliged to take back batteries individually. The REBAT PRO in charge of portable batteries, for example, offers a take-back system for industrial batteries (mobility and non-mobility), but this is not financed by producers[52] .

Producers of light industrial batteries entrust GRS with the extended producer responsibility as stipulated by the regulations (BattG art. 26), in return for a financial contribution. GRS offers free take-back from retailers and WEEE processing centres.

In concrete terms, GRS provides specialist retailers, who are obliged by regulation to take back batteries, with initial equipment including a 60L collection container, an information poster for users and an information letter on the correct and safe handling of Li-ion batteries.

There are no other applicable regulatory requirements (collection targets, etc.) than the generic requirements for the management of industrial batteries, unlike for portable batteries.

Since 2019, this solution has also been made available for the batteries of small electric vehicles such as scooters, motorbikes, Segways and other personal motorised vehicles such as scooters, skateboards, gyropods, skates and electric scooters.

Financing

The financing system is pay-as-you-sell.

The EPR fee scale is not public.

Collection points

The PRO has set up a network of voluntary collection points at:

- Local public authorities in charge of waste management,
- Bike sellers and other specialist sellers,
- Repair points,
- Voluntary collection points.

In 2021, the PRO had a collection point network of 2700 points and collected 105 tonnes of mobility batteries.

For safety reasons, mobility batteries are collected separately from portable batteries.

[52] Offer from REBAT https://rebat.de/hersteller-und-vertreiber/li-ion-industriebatterien/

Safety - special features of mobility batteries

The transport of lithium batteries must comply with the ADR (European Agreement on the Transport of Dangerous Goods), the regulations of the Federal Institute for Materials Research and Testing (BAM) and the German Road Transport Act (GüKG).

Since 2012, GRS BATTERIEN has developed safety standards for all its collection points and offers training to them.

<table>
<tr><th colspan="3">Category</th><th colspan="2">Collection</th><th colspan="2">Security</th><th colspan="2">Transport</th></tr>
<tr><td colspan="3">Batteries < 500g each
NB: excluding mobility, mix of portable batteries</td><td></td><td>Green drums
Max 30 kg</td><td rowspan="4">All damaged lithium batteries should be individually protected against short circuit with tape, and if possible, each lithium battery.
Batteries should be protected from excessive movement in transport packaging. Collection points should only require the removal of full drums and fill the unfilled parts of the drum with non-electrical cushioning material (vermiculite).</td><td rowspan="4">Collection points can pack the batteries and charge the drums.</td><td>-</td><td>Non-ADR transport.
The amount of lithium per transport unit must not exceed 333 kg.</td></tr>
<tr><td rowspan="3">Batteries > 500 g each</td><td>Undamaged, unmixed</td><td rowspan="2"></td><td>Yellow drums</td><td>Lithium batteries from 12 kg/piece which, due to their size, do not fit into the yellow drums, can be packed in strong outer packaging provided that the batteries themselves have a strong, impact-resistant outer casing.</td><td>ADR transport.
The cartridge below defines the ADR rules applicable to yellow drums: the diamond defines the corresponding ADR provisions and packing instruction. The circle defines the applicable packing group category according to ADR.
</td></tr>
<tr><td>Undamaged mixed</td><td>Inner packaging should be used in yellow drums to avoid contact.</td></tr>
<tr><td>Damaged</td><td>GRS eMobility solution (collection only by specialist car dealers)</td><td></td><td>Red barrels</td><td>The red drums are pre-filled with non-conductive insulating material (vermiculite) before the drum is delivered to the collection point. This allows for less stringent transport conditions. Since the classification of batteries as damaged and safe for transport requires extensive knowledge in handling lithium batteries or consultation with the battery manufacturer, this container system is not currently available for the take-back of portable waste batteries, but only for the take-back of mobility batteries by specialised car dealers.
Batteries are packed separately in PE bags separated by insulating material (vermiculite). Only one battery if weight >30 kg.</td><td>ADR transport. The box below defines the applicable ADR rules:
</td></tr>
<tr><td></td><td>≤5kg each</td><td>Red box
The box can hold up</td><td>The batteries are packed separately in PE bags separated by insulating material (vermiculite).</td><td></td></tr>
</table>

Category			Collection	Security		Transport	
				to 3 batteries.		The batteries are placed in separate compartments. Safety cushions are used for cushioning.	ADR transport. The box below defines the applicable ADR rules: 
		> 5kg each		Red container The container can hold 195 kg of batteries.		GRS itself acts as packer or commissions an authorised professional.	The batteries are packed separately. The packaging is liquid-tight, includes heat-resistant and heat-insulating plates, and contains absorbent cushioning material used in combination with overload and overpressure protection.

Table 19 GRS Batterien - Safety measures for the collection, removal, and transport of Li-ion batteries

A summary document lists the measures to be taken according to the type of container, which determines the rules applicable at ADR level.[53] Yellow and red containers are subject to ADR and must therefore comply with all requirements. A report provides more details on the ADR rules[54] .

Links with WEEE EPR

No information

Treatment

The batteries collected by GRS are all recycled. There is no second life for batteries. GRS investigated the relevance of the second life of light mobility batteries in 2017-2018 and found it not relevant at this time for the following reasons:

- The finished product is not standardised, and the producer cannot guarantee a lifetime or a number of cycles to the user.
- Manual testing of used cells to characterise them is necessary and makes the operation more expensive than using new cells;
- The model is based on a free take-back of batteries. However, if demand increases GRS anticipates that consumers will no longer give these batteries away for free as they still have the capacity to be used as replacement batteries.
- The automotive projects are more promising because the tests are profitable due to the high power of the tested modules (lower test cost / battery value ratio).

There are many Li-ion battery recyclers in Germany:

Company	Location	Annual treatment capacity (tonnes)[55]
ACCUREC RECYCLING GmbH	Krefeld, NRW	3 000 - 6 000
NICKELHÜTTE AUE GmbH	Aue, Sachsen	4 000
ECOBAT SOLUTIONS GmbH (Formerly PROMESA GmbH & Co. KG)	Hettstedt, Sachsen-Anhalt	3 200
DUESENFELD GmbH	Wendeburg, Niedersachsen	3 000 + mobile 1 500
REDUX RECYCLING GmbH	Bremerhaven, Niedersachsen	10 000
ERLOS GmbH	Zwickau, Sachsen Schönfels, Sachsen	1 000
EST ENERGETICS Gmbh	Rothenburg/Oberlausitz, Sachsen	Unknown

Table 20 Current recycling capacity for Li-ion batteries in Germany

The Table 21 below lists the numerous recycling units that are also planned for the coming years.

Company	Location	Annual treatment capacity (tonnes)[56]	Expected start date
VW	Salzgitter, Niedersachsen	1 500 (3,600 from electric vehicle batteries)	Pilot since January 2021.
PRIMOBIUS GmbH (Joint Venture between Australian "NeoMetals" and a German manufacturer "SMS")	Hilchenbach, North Rhine-Westphalia	Demonstrator: 3 650 t Planned commercial capacity: 20,000 t	Demonstrator since March 2022. Commercial scale planned for Q2/2022
LARS WALCH GmbH & Co KG	Baudenbach, Bavaria	ND	ND
AURUBIS	Hamburg	ND	Pilot then 2027
SPREEWERK LÜBBEN GmbH (General Atomics Europe)	Lübben, Brandenburg	ND	Q3/2022

[53] GRS Batterien - Checklist on labelling for battery collection
https://www.grs-batterien.de/fileadmin/Downloads/Sicherheit/GRS_Checkliste_Kennzeichnungspflicht_V01_Feb2021_01.pdf
[54] GRS Batterien - Standard for the safety of Li-ion batteries
https://www.grs-batterien.de/fileadmin/Downloads/Sicherheit/GRS-Merkblatt_Sicherheitsstandard_V01_Feb2021.pdf
[55] Source: UBA, based on recycling company reports from various years, information from recycling company websites, presentations at events. The UBA does not guarantee the validity of this information from companies or the press.
[56] Source: UBA, based on recycling companies' reports from various years, information from recycling companies' websites, presentations at events). The UBA does not guarantee the validity of this information from companies or the press.

ROTH INTERNATIONAL GmbH	Weiden, Bavaria	ND	Q3/2022
Licular GmbH (100 % daughter of Mercedes- Benz)	Kuppenheim, Baden Wurtenberg	2 500	Planned for 2023
CATL	Arnstadt, Thüringen	ND	2025

Table 21 Planned recycling capacity of Li-ion batteries in Germany

Second life

There are few second life projects for light mobility batteries in Germany.

In 2017, the RE²BA project was conducted by SAUBERMACHER (Austrian waste management company), in cooperation with AVL LIST GmbH (Austrian motor system development company), KTM AG (motorbike manufacturer), MONTANUNIVERSITÄT EOBEN AND SMART POWER GmbH & Co KG (German-based energy and charging system development and installation company). Together, they built a stationary storage medium (prototype) for the first time from used KTM electric motorbike batteries. Future areas of application are private domestic stationary storage, e.g., for photovoltaic installations, peak shaving in industry or for local grid stabilisation for energy suppliers. This Austrian-based project involves a German partner.

On the other hand, there are companies that have been active for several years in the repair and reconditioning of light mobility batteries (with cell replacement, BMS repair, electronic circuit replacement, capacity improvement, etc.): LIOFIT GmbH, MCAKKU, AKKUZENTRUM.DE - GTE INDUSTRIEELEKTRONIK GMBH, MTW AKKUTECHNIK GMBH, KS BIKES GMBH, BATTERIE24.DE, AKKUMAN.DE - WSB BATTERY TECHNOLOGY GMBH. In this model, the used cells are usually replaced.

5.3.1.5. Heavy mobility battery management

EPR scheme

Description of the system

Producers must finance the cost of transport and recycling, and potentially also the costs of collection and collection containers. They must indeed comply with Art. 8 of the Batteries Act, i.e., offer a reasonable system for the free return and recycling of batteries collected from retailers and ELV treatment centres.

However, there is no obligation to set up a PRO. The UBA believes that extended producer responsibility has already been implemented for heavy duty batteries but that given the small quantities of used batteries arriving annually, the level of visibility of the organisations in charge of their management is still low.

The LRP Group claims to organise the largest collective ELV take-back system in Germany. It organises free of charge take-back for 20 to 25 brands (some of them belonging to the same car manufacturer group (e.g., Volkswagen, Porsche, Audi...) throughout the country, with the help of 80 ELV centres and partner take-back companies (including companies that are not part of the LRP group). Its responsibility in this context is to ensure free of charge take-back anywhere in Germany, to organise the logistics of the vehicles if necessary to a partner network centre, and to put the producers in touch with the treatment operators. Its role is therefore different from that of a PRO as understood in France. Partner brands can deal with other take-back systems as well. According to LRP, the other existing take-back systems are more local and smaller.

In addition, the LRP Group directly operates 5 ELV centres in Eastern Germany and processes approximately 20,000 ELVs annually.

The operation of the ELV scheme is completely market-based to date in Germany. Generally, ELV owners are paid to dispose of their cars, but this is not the case for electric and hybrid vehicles.

The holders of ELVs and mobility batteries (e.g., ELV centres, garages, etc.) are the owners of the ELVs and used batteries in Germany. They are not obliged to hand over the ELVs/batteries to the producers or their agents and can decide on their end of life in accordance with the regulations, without consulting them.

Batteries are collected either from ELV centres or from retailers (especially garages).

The requirements are the same whether the batteries are used separately or within an ELV.

Financing

Type: pay-as-you-collect

Fee scale: none

It is up to the PROs to decide whether financing is based on the quantities placed on the market and/or the quantities collected. The German regulation does not require this. The UBA believes that contributions are most commonly based on volumes collected (pay-as-you-collect). This was confirmed by one operator (LRP).

As the management of HEV batteries[57] is not self-financed, when LRP receives used HEVs, they contact the producer responsible for the management of the batteries and present a price for the treatment of the batteries based on the prices of the partner recycler (e.g., BASF). The producer can decide to accept this cost and pay the recycler directly, or to pay for the logistics to take back the battery and deal with it at their own expense. LRP ensures the extraction of the batteries and the role of intermediary between producers and treatment operators.

Management of electric and hybrid ELVs

The modalities for the treatment of mandatory ELVs are specified in the dedicated regulations. LRP has external audits performed every year to demonstrate compliance. There are no specific requirements for HEVs such as a specific environmental permit. A different waste code is simply used to designate the removed Li-ion batteries.

According to LRP, most of the electric and hybrid ELVs received for processing so far in Germany are prototype vehicles tested during production, with high mileage. Another potential source of used HEVs are auctions organised by insurance companies that resell ELVs. To date, LRP does not buy ELVs through auctions (including electric and hybrid ELVs) because the value of the materials is not high enough to give the ELV a positive price and because there is strong competition with the repair market.

[57] Electric and hybrid vehicles

The hybrid and electric vehicles are accepted in all ELV centres managed by LRP as they all work with the same standards. They can also be accepted by competitors. For the time being, as volumes are limited, they are stored and then all sent to one of LRP's ELV centres, which is better equipped to handle them, and to reduce storage costs.

The treatment process for electric and hybrid ELVs follows the following steps:

- The ELV is checked, categorised into fast-disposal ELVs and ELVs that require careful dismantling (depending on the car model and the economic potential of the spare parts);
- The ELV is then stored in an appropriate storage area. As long as the batteries do not present any particular risk (no accidental ELVs), the ELV can be stored for up to 2 weeks because it is more economically viable to manage several electric and hybrid ELVs of the same type in a row.
- Batteries are disposed of in accordance with the regulations and diagnosed for a second life.
- The ELV then follows the normal circuit: removal of spare parts, depollution, shredding and recovery of materials.

LRP does not deal with crashed electric and hybrid ELVs and damaged batteries because there is no viable business model at present, and they do not have enough suitable storage containers for these batteries. This may change as the industry develops. These batteries are probably processed by other ELV centres (no specific information).

There is no statistical monitoring of collected mobility batteries. Data is collected on the quantities of batteries recycled by chemistry, but it does not allow an estimate of the quantities and proportions of Li-ion mobility batteries collected or recycled.

Safety - special features of mobility batteries

According to the European ELV Directive, vehicle producers must provide the information necessary for the extraction of relevant vehicle components from ELVs.

The manufacturers have fulfilled this requirement by setting up the IDIS database[58] (International Dismantling Information System), which contains individual and detailed information on the dismantling of high-voltage batteries for each electric and hybrid vehicle model. The database is managed in Germany but is international in scope. It contains information from 26 producers and over 3000 vehicle models, reflecting practices and regulations in 41 countries worldwide. Access to the database is possible for all commercial companies active in ELV management, including ELV centres and ELV recyclers, through a simple registration.

There are several regulations that generally regulate occupational safety (ArbSchG and BetrSichV) and clarify that the responsibility for accident prevention lies with the company. The DGUV (Deutsche Gesetzliche Unfallversicherung - central federation of the social insurance bodies for occupational accidents and diseases in the private and public sectors in Germany) requires specific training and qualifications for working with high-voltage systems. This is therefore not a regulatory requirement but a liability insurance requirement.

DGUV Information 209-093 (August 2021)[59] describes in more detail the qualifications needed to work on vehicles with high voltage systems:

- The person working on high voltage batteries must have been trained in the theoretical basis of electrical engineering and the practical skills of using high voltage components, tools, and resources.
- Work instructions must be defined by the employer for the use of high-voltage systems.
- The employer must carry out a risk assessment.
- Work should only begin after the power has been switched off: switch off the contact, protect against reactivation and check that the power is off. Possibly earth and short-circuit (generally not recommended, manufacturer's instructions must be followed), and cover or delimit electrically live neighbouring parts if work is required on these parts.
- Protective measures against the formation of electric arcs must be implemented (list provided);
- A different level of qualification is required depending on the nature of the work to be carried out;
- In the event of an accident, personal protective equipment is required and if the battery is severely damaged, the fire brigade must intervene;
- Vehicles containing high voltage batteries and high voltage components must be marked;
- Information on the actions already taken by the first responders on the battery should be shared for the next steps (e.g., from a garage to an ELV centre);
- The work area must be delimited.

[58] IDIS database http://www.idis2.com/

[59] DGUV occupational safety regulations for electrically powered ELVs https://publikationen.dguv.de/widgets/pdf/download/article/3982 A previous version dates from 2012, so this topic has already been developed for 10 years in Germany.

Further safety recommendations[60] are provided by the DGUV for other stages of the life cycle of electric and hybrid vehicles: rescue and extinguishing of vehicles by fire brigades, vehicle maintenance, work on buses, use of industrial trucks, logistics trade (light mobility).

ELV centres must comply with fire safety regulations. These regulations do not contain any specific provisions for HEV batteries, but the application of these regulations requires high-voltage batteries to be stored in dedicated storage areas.

The transport of Li-ion batteries complies with the regulations concerning the transport of dangerous goods and in particular the ADR regulations, which define the precautions, packaging, responsibilities, and training necessary for safe transport.

The transport of damaged Li-ion batteries must be coordinated with the Federal Institute for Materials Research and Testing (BAM).

Treatment

There is no organised industry and therefore no statistics available specifically for mobility batteries.

The German public authorities have funded several research projects on second life:

- StarTrak[61] , a project led by the public research institute Fraunhofer, aims to determine the residual lifetime of batteries from mobility for other uses such as work machines and stationary buffer storage for photovoltaic installations, and to define ageing models based on the cyclic ageing of Li-ion cells.
- In the SeLiBa project, different applications for the reuse of used lithium-ion traction batteries are evaluated from an ecological and economic point of view to determine the potential savings and to compare the results with recycling. The project partners are the University of Esslingen with the Institute for Sustainable Energy Technology and Mobility (INEM) and the Faculty of Basic Sciences as well as the medium-sized company CTC CARTECH COMPANY GmbH based in Böblingen.
- The Oekobat 2020 project led by VARTA STORAGE (battery manufacturer) is to test the use of heavy mobility batteries in stationary use.

All battery research projects are listed by the German Li-ion Battery Competence Centre (KLIB) at the Battery Forum website[62] .

In addition, there are several active second life models to date. These are still demonstrator-type projects, which have a commercial function but also serve to test the systems.

- The waste management company REMONDIS operates one of the largest stationary electricity storage facilities from second-hand batteries at the Lippe plant (1000 batteries, 12 million W)[63] . The project includes the car manufacturer DAIMLER AG (MERCREDES-BENZ Group), which manages a light mobility fleet, recovers and reconditions the batteries for stationary use via the DAIMLER subsidiary ACCUMOTIVE. The stored energy is sold by a joint venture between GETEC (provider of energy services such as planning, design, maintenance, purchasing, etc.), THE MOBILITY HOUSE (German SME active in electricity storage and charging systems) and DAIMLER AG. REMONDIS operates the recycling site in Lippe where the electricity storage unit is installed and will be responsible for the management of the batteries after their stationary use.

[60] DGUV recommendation: https://www.dguv.de/de/praevention/themen-a-z/elektromobilitaet/index.jsp
[61] Project Startrak: https://www.erneuerbar-mobil.de/node/133
[62] Batteries Forum website: https://www.batterieforum-deutschland.de/projektdatenbank/
[63] REMONDIS / DAIMLER project: https://www.remondis-lippewerk.de/second-use-batteriespeicher/

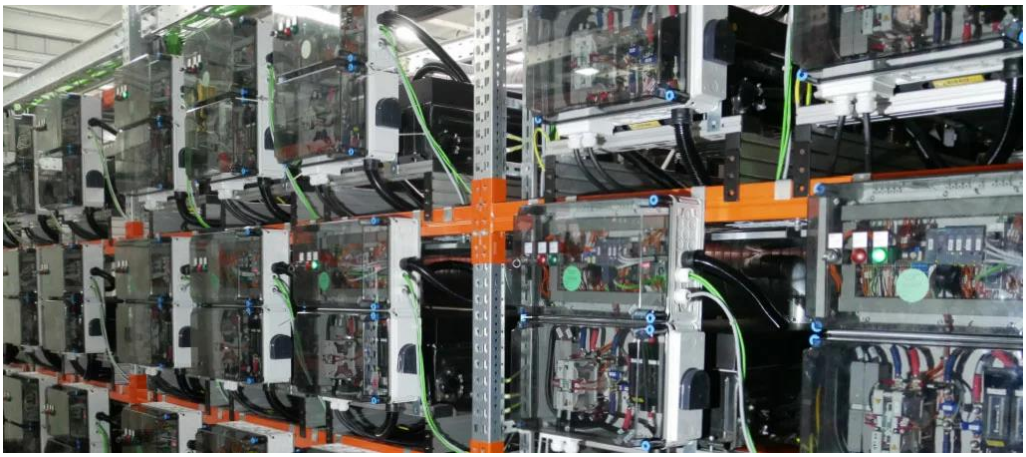


Figure 7 : REMONDIS stationary storage unit, Lippe

- In 2019, THE MOBILITY HOUSE together with AUDI commissioned a stationary energy storage system on the EUREF campus in Berlin using 20 AUDI e-tron batteries from test fleets with an output of 1.25 MW and a storage capacity of 1.9 MWh. The installation is being used to test various stationary uses: fast charging of electric cars, grid services, charge management...
- Since 2018, THE MOBILITY HOUSE company has carried out the AVANCED BATTERY STORAGE project with RENAULT, FENECON (energy solutions), DEMETER (financier) and MITSUI (raw materials trading) designing stationary electricity storage containers from 72 RENAULT Zoe batteries each, for a total capacity of 20 MWh in Germany (3MWh to start in Everlingen). A deployment in France (Flins, Douai) has also been implemented.
- The Berlin-based start-up BETTERIES AMPS GmbH processes old electric vehicle batteries into affordable energy systems. The new energy storage systems have a modular design and are oriented towards different applications: for example, energy storage, solar storage, cargo bikes, electric rickshaws.
- BMW, VATTENFALL (energy supplier) and BOSCH (power tools and automotive supplier) have interconnected 2600 battery modules to create an electricity storage unit in Hamburg (2018)[64] .
- BMW has had an electricity storage unit at the BMW Group's plant in Leipzig since 2017, interconnecting 500 BMW i3 batteries[65] .
- DAIMLER (MERCEDES Group) has a stationary storage project with the city of Hannover since 2017 involving 1800 replacement batteries for e-smarts with a capacity of 17.4 MWh[66] .
- AUDI is using the batteries from its tested electric car prototypes to convert the drive system of industrial trucks running on lead-acid batteries to second-life Li-ion batteries at its production site in Ingolstadt.[67] The batteries are dismantled, with 24 of the 36 modules of an electric car of the e-tron model being usable for the industrial trucks.

[64] BMW / Vattenfall project: https://group.vattenfall.com/de/newsroom/blog/2018/september/second-life-batterien-energiespeicher
[65] BMW project: https://www.automobil-produktion.de/hersteller/wirtschaft/bmw-alte-i3-batterien-versorgen-leipziger-werk-mit-strom-119.html
[66] DAIMLER project: https://www.welt.de/wirtschaft/article170092400/Wie-BMW-und-Daimler-alte-Akkus-weiterleben-lassen.html
[67] AUDI project: https://www.auto-motor-und-sport.de/tech-zukunft/audi-ingolstadt-lithium-ionen-akkus/

5.3.1.6. Overall assessment

Strengths	Weaknesses
Numerous recycling units installed and to be installed A dynamic ecosystem of car manufacturers for the take-back of batteries, particularly in the context of second life projects (heavy mobility) High demand for grid balancing projects due to the intermittent energy share in the German electricity mix	Lack of traceability on the end of life of heavy mobility batteries (as with the ELV scheme in general): there is a high proportion of illegal exports of ELVs, as the certificates provided for traceability are not well verified No specific monitoring by public authorities of the mobility battery waste stream and its management Unfavourable prices for battery recycling and high cost of managing damaged batteries Regulations not adapted to the development of electric mobility batteries (voluntary EPR schemes)
Opportunities	**Threats**
Evolution of the European Battery Regulation Evolution of the ELV Directive Commercial roll-out of second life projects Positive economic outlook according to the LRP ELV centre due to growth in volumes and outlets for recycling Improved traceability - Catena X digital disassembly certificate project which should include European battery passport information	No threats identified

5.3.2. Belgium

5.3.2.1. Overview

Context	
Population	11.52 million (Statbel, 2021)
Population density (inhab./km²)	375 (Statbel, 2021)
Sales of electric and hybrid vehicles per capita (/year per 1000 inhabitants)	3.2 (Eurostat, 2019)
Market share of electric and hybrid vehicles (%)	7% (Eurostat, 2019)
Number of electric and hybrid vehicles registered	126,322 (Eurostat, 2019)
Number of registered electric and hybrid vehicles (per 1000 inhabitants)	11 (Eurostat, 2019)
Extended producer responsibility	
End-of-life vehicles	EPR scheme - management body FEBELAUTO
Light mobility batteries	EPR scheme - management body BEBAT Financial contribution to the administrative and operational management.
Heavy mobility batteries	EPR scheme - 2 management bodies FEBELAUTO (98.4%) and BEBAT (1.6%) Hybrid system - financial contribution to administrative management and pay-as-you-collect financing for collection and processing.
Other batteries (portable, industrial, automotive)	EPR scheme - management body BEBAT
Regulations for mobility batteries	
Collection targets	No
Treatment objectives	The European objective of 50% recycling efficiency for all batteries, excluding NiCd and Pb, has been specifically defined for electric traction batteries in the environmental agreement applicable to FEBELAUTO, and is not only applicable on average to all industrial and portable batteries concerned. Common European recycling target for BEBAT
Specific collection / safety regulations	Yes
Approval of ELV centres	Yes, verification by independent third parties (not by public authorities). Specific approval for electric vehicle batteries.
Performance	
Collection rate (or quantities collected)	174 tonnes of heavy mobility batteries collected (FEBELAUTO, 2021)

Recycling rate	Heavy mobility: 11% recycling (FEBELAUTO, 2021)*
Second life rate	Heavy mobility: 82% reuse (FEBELAUTO, 2021)* - Manufacturer recalls - testing, some of which is then sent for remanufacturing or second life (61%) - Remanufacturing - same use (11%) - Second life - repurposing- different use (10%)

* There is 7% stock

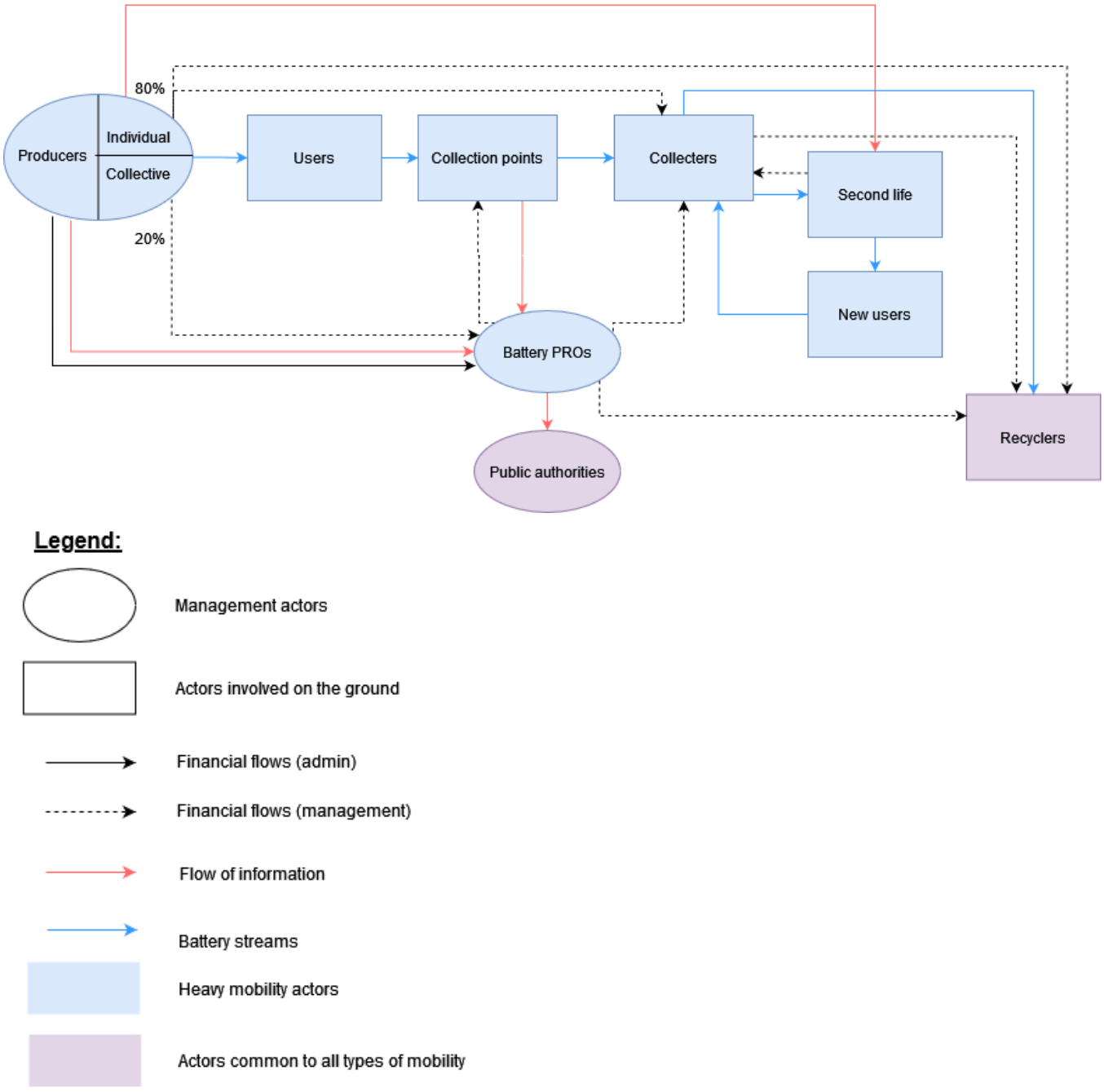


Figure 8 : Heavy mobility battery management in Belgium

5.3.2.2.History

Context:

Since 1998, electric mobility batteries have been part of the scope of the existing EPR for batteries and accumulators managed by the PRO BEBAT, like other industrial batteries, without any specific regulatory or organisational provisions. Moreover, car manufacturers were already affiliated with BEBAT for the lead-acid car batteries they placed on the market.

During the 2010s, FEBELAUTO (management body in charge of EPR for ELVs) and BEBAT (management body in charge of EPR for batteries and accumulators) tried to work together to develop a joint collection and management network for traction batteries for electric and hybrid vehicles. This initiative did not succeed given the different economic models initially chosen for the payment of administrative contributions for these batteries (administrative contribution in pay-as-you-sell for BEBAT, administrative contribution according to real costs distributed via past market shares for FEBELAUTO).

In addition, FEBELAUTO members wanted to propose a scheme via FEBELAUTO for batteries to avoid setting up separate schemes for the different parts of an ELV (tyres, batteries, etc.) and to keep control of their respective end-of-life.

The representatives of the car manufacturers therefore expressed to the public authorities their wish to be able to organise the management of heavy mobility batteries via a PRO separate from BEBAT, in conjunction with FEBELAUTO, the organisation already in charge of ELV management. This request was accepted by the public authorities, who had no objections to this competition. According to OVAM[68] , the competition between the two PROs encourages them to offer a good level of service.

Dedicated environmental agreements[69] have therefore been adopted by the Belgian regional public authorities from 2018 onwards to allow manufacturers' representatives to bid for the take-back of electric and hybrid mobility batteries only (and not portable, automotive, or industrial batteries outside mobility). At the time of the negotiation of the Flemish environmental agreement, OVAM states that two points were key for car manufacturers:

- The hybrid system, i.e., the possibility for car manufacturers to be part of a collective body for the administrative management but to keep the choice of having the collection and processing done by the collective body or individually.
- Payment of financial contributions according to the actual service offered by the PRO (if the manufacturer calls on it for management) and not in anticipation of future costs (pay-as-you-collect).

FEBIAC, the Belgian federation of car manufacturers, has asked all its members to join one of two PROs (rather than using an individual system) to ensure harmonisation of the scheme.

Past developments

- The waste battery management scheme for electric and hybrid mobility has existed via BEBAT since 2014;
- The waste battery management scheme for electric and hybrid mobility has existed via FEBELAUTO since 2018;
- Initially, the FEBELAUTO system was reserved for categories M1 and N1 (cars and LCVs) and has since been extended to category L (mopeds, tricycles, quadricycles, etc.).

Perspectives

- The Flemish environmental agreement on mobility batteries will expire in 2023 and has not yet been evaluated. It will be extended until the entry into force of the new European Battery Regulation to ensure consistency.
- The scope of the Flemish environmental agreement will probably be extended to very heavy mobility batteries (buses, trucks) and motorbikes and scooters, to match the scope of FEBIAC members. The environmental agreement will not be extended to electric bikes. Discussions are ongoing with stakeholders in view of this extension.
- OVAM anticipates and fears that the hybrid system will not be allowed under the future EU Regulation.

[68] Flemish Waste Agency

[69] The environmental agreement is the equivalent of the "cahier des charges" of EPR schemes in France. The main difference with the French specifications is that an environmental agreement must be formally approved by the sector representatives, consultation with stakeholders is not sufficient.

5.3.2.3. Regulatory framework

In Belgium, the environment is a regional competence. The regulations relating to waste management and the organisation of EPR schemes (known as "take-back obligations") are therefore established at the level of the 3 regions (Walloon Region, Brussels-Capital Region, and Flemish Region), with the objective of harmonisation between the regions achieved through interregional cooperation. All the texts were analysed. However, the references of certain provisions are only identified for one region, and it is specified when particularities have been identified.

Status and classification of mobility batteries:

From a regulatory point of view, according to the European framework, electric mobility batteries are industrial batteries[70] . BEBAT has introduced the category "propulsion batteries" in its declaration system and defines a list of criteria to specify in which category batteries are classified.[71]

The waste classification follows the European waste classification. Used Li-ion batteries are not hazardous waste at European level, but some countries/regions may consider them hazardous. In Flanders, batteries are considered non-hazardous. A discussion is underway at European level to change the status of battery waste. OVAM has planned to harmonise the Flemish regulation with the European framework but has not planned any specific initiative. Although non-hazardous waste, different safety rules apply.

According to FEBELAUTO, defective or damaged batteries are considered as hazardous waste, whereas intact batteries are considered as non-hazardous waste. A battery is considered defective or damaged if it meets any of the following properties:

- Rapid increase in temperature;
- Production of flame, emission of gas vapour, or toxic, flammable, or corrosive liquids;
- Heat, moisture or chemical loss or leakage;
- Deformation of the battery, cells, or modules (especially swelling).

OVAM states that it is not the classification of the battery that changes in the case of a defective battery but the applicable ADR safety measures (use of inert materials for transport, separate storage area, limitation of storage time).

Regarding the waste status of batteries, interpretations vary from region to region:

- In Brussels, the environmental agreement refers to the definition of waste. In practice, if the battery has not been diagnosed, it is waste. After diagnosis, there are exceptions if specific conditions are met. A study commissioned by Brussels Environment is underway to define these conditions.
- In Flanders, prior to diagnosis, batteries are waste because their potential for reuse is not certain. After the diagnosis, the choice is made to send the battery :
    - Either in preparation for reuse[72] or recycling, in which case the waste status is retained;
    - Either directly reuse the battery for the same purpose, without further preparation before use, i.e. transfer the battery to a new user. This applies to maintenance and repair operations. In the case of professional activities involving the collection of several batteries for direct re-use, the following conditions apply:
        - Each battery has been tested for functionality and the test report is firmly attached to the battery itself or to the packaging.
        - The battery holder should have a copy of the invoice and a copy of the contract for the sale and/or transfer of ownership of the battery to demonstrate that the battery is intended for direct re-use and is fully functional.
- In Wallonia, the status of batteries for second life, as waste or as product, has not been clarified.

Regulation on extended producer responsibility for batteries

- Name of regulatory texts:
    - Order of the Walloon Government of 23 September 2010 introducing an obligation to take back certain waste[73] .

[70] Order of the Walloon Government of 23 September 2010 establishing a take-back obligation for certain waste
[71] BEBAT decision tree: https://www.bebat.be/fr/arbre-decisionnel
[72] Recovery operation including checking, cleaning and/or repair of batteries. Repair means the replacement of defective or ageing components or modules, or software changes. The repaired battery complies with the original specifications of the battery.
[73] AGW 23/09/2020: http://environnement.wallonie.be/legis/dechets/decat027.htm

- Decree of the Government of the Brussels-Capital Region of 1er December 2016 on waste management[74]
- Environmental agreement of 5 December 2013 on the implementation of the take-back obligation for waste portable and industrial batteries and accumulators[75] (Wallonia)
- Environmental agreement of 5 December 2013 on the implementation of the take-back obligation for waste automotive batteries and accumulators[76] (Wallonia)
- Environmental agreement of 4 February 2021 on the implementation of the obligation to take back traction batteries for electric and hybrid vehicles[77]
- Environmental agreement of 14/06/2019 on waste batteries and accumulators in the Brussels Capital Region[78]
- Environmental agreement of 14/06/2019 on traction batteries for hybrid and electric vehicles in the Brussels-Capital Region[79]
- Materialendecreet 23 DECEMBER 2011. - Decreet betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen[80]
- VLAREMA-17 FEBRUARI 2012. - Besluit van de Vlaamse Regering tot vaststelling van het Vlaams reglement betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen[81]
- 15 JUNI 2018. - Milieubeleidsovereenkomst betreffende de aanvaardingsplicht voor afgedankte batterijen en accu's[82]
- 15 JUNI 2018. - Milieubeleidsovereenkomst (mbo) over batterijen voor de aandrijving van hybride en elektrische voertuigen (HEV) voor het Vlaamse Gewest[83]

These texts transpose the applicable European directives, with specificities described below.

- EPR scheme

In the three regions, all waste batteries, and accumulators (portable, industrial, automotive) are subject to the EPR obligation[84] .

In the three regions, the battery producers who generate this waste can comply with the EPR obligation either within the framework of an individual prevention and management plan (an individual system supervised by the administration, with a validity that cannot exceed 5 years); or by executing an environmental agreement and entrusting their obligations to a management organisation to which they have subscribed (equivalent to an PRO)[85] and which respects the environmental agreements of the 3 regions.

An environmental agreement is a tool that requires an agreement between the regional administration and the professional organisations. Different professional federations were involved depending on the region and the type of batteries and accumulators: representatives of garages and car dealers in the automotive sector, the management body (BEBAT), the federation of agricultural machinery and equipment suppliers, the federation of the automotive and cycle industry (FEBIAC), the federation of motorbike retailers.

There are environmental agreements that cover all categories of batteries and accumulators, which govern the activity of the BEBAT management organisation, and environmental agreements that only cover batteries and accumulators for electric and hybrid vehicles, which govern the FEBELAUTO management organisation.

Electric and hybrid vehicle traction batteries are from the L, M1 and N1 categories, i.e., mopeds, motorbikes, cars, and LCVs, but not trucks, buses, trolleys, and electric bikes. Batteries must be over 20kg and have a voltage greater than 60VDC, NiMH, lithium, or other technology, including fuel cells (technology for hydrogen vehicles). The extension of the scope to heavy vehicles is under discussion with stakeholders.

[74] AGRBC 01/12/2016: http://www.ejustice.just.fgov.be/cgi/article_body.pl?language=fr&pub_date=2017-01-13&numac=2016031801&caller=summary

[75] Wallonia Environmental Agreement 05/12/2013 industrial laptops: http://environnement.wallonie.be/legis/conventionenv/conv021.html

[76] Environmental Agreement Wallonia 05/12/2013 automobiles: http://environnement.wallonie.be/legis/conventionenv/conv018.html

[77] Walloon Environmental Agreement 04/02/2021 VEH batteries https://www.febelauto.be/public/Convention-batteries-HEV_Moniteur2022.pdf

[78] Environmental agreement 14/06/2019 RBC batteries and accumulators : https://environnement.brussels/sites/default/files/user_files/20190313_conventionpiles.pdf

[79] Environmental agreement 14/06/2019 RBC EV batteries: https://www.febelauto.be/public/MBO-batteries-2019.pdf

[80] Flemish material decree: https://navigator.emis.vito.be/mijn-navigator?woId=41743

[81] VLAREMA: https://navigator.emis.vito.be/mijn-navigator?woId=43991

[82] Flemish Environmental Agreement Batteries and Accumulators: https://cms.bebat.be/sites/default/files/2019-03/MBO%20Vlaanderen%2015-06-2018.pdf

[83] Flemish Environmental Agreement VEH batteries: https://www.febelauto.be/public/MBO-Febelauto-BS-4-okt-2018.pdf

[84] art.2 and art.25, AGW of 13/09/2010, art. 2.1.1 of AGRBC of 01/12/16, art 3.1.1 VLAREMA

[85] There is a third tool, the approved management organisation, but this is not applied to batteries and accumulators; this instrument concerns packaging.

- Organisation

The organisation distinguishes between two types of batteries and accumulators:

1) Batteries and accumulators subject to an environmental fee (financing of collection and recycling, and administrative fee); this category includes portable batteries and accumulators and, at the discretion of the management body, categories of industrial batteries and accumulators other than lead batteries (art. 9 of the Walloon Region's environmental agreement);

2) Batteries and accumulators subject to an administrative fee (financing of a monitoring and reporting system and of prevention actions, but not of collection and recycling). This category includes automotive batteries, industrial leaded batteries (art. 20. §8 of the Walloon Region's environmental agreement), and electric and hybrid vehicle batteries (this is either mandatory or a de facto choice, depending on the region and environmental agreement).

For all batteries and accumulators:

Retailers must take back from households and business users the waste concerned by the relevant streams they present free of charge[86] .

The take-back contractor (producer or management organisation) is obliged to take back waste portable and industrial batteries and accumulators from WEEE or ELV dismantling facilities[87] .

For batteries and accumulators subject to administrative fee:

The waste holders can choose the collection and treatment operators. The compensation for the collection and treatment costs is then borne by the waste holders and fixed between the holders and the collection and transport operators, by contract. The contract considers any revenue that may be generated by the take-back. Professional holders or producers can call on the management organisation for management in return for coverage of the real and full costs set via an agreement[88] .

Producers (individually or collectively) must provide a "sufficiently dense network of authorised collection points" for the free deposit of batteries and accumulators, with trained staff (environmental agreements in Flanders and Brussels).

Producers shall inform their customers of the end-of-life arrangements "at least for batteries and accumulators intended for use in hybrid and electric vehicles"[89] .

If categories of batteries subject to an administrative fee are found at the collection points run by the management organisation or another collection network, the producer is notified and must bear the costs of collection and management. They shall pay the collection, management and storage costs incurred by the organisation in charge of the collection network prior to collection[90] .

Waste over 20kg for electric and hybrid vehicle traction is not household waste and is not accepted at waste collection centres / should not be the subject of cooperation with municipalities[91] .

The amount of the contributions may or may not appear on invoices between professionals[92] .

For batteries and accumulators subject to environmental fee:

The management organisation must conclude contracts with the intermunicipal companies for the categories of batteries covered by the environmental fee (in practice, portable batteries and accumulators and light mobility batteries).

The management organisation must comply with the conditions for awarding collection and processing contracts[93]. The amount must be shown on invoices between professionals[94] .

[86] art. 29 (batteries and accumulators), art. 32 (industrial batteries and accumulators) AGW of 23/09/2010, art 2.4.3 and 2.4.4 of the AGRBC of 01/12/2016
[87] art.29 and art.32. AGW of 23/09/2010 art. 2.4.4 of the AGRBC of 01/12/2016
[88] art. 11§4 of the CBR Environmental Agreement
[89] art. 11 of the CBR Environmental Agreement
[90] art 11§6 of the CBR Environmental Agreement
[91] Art. 10 CBR Environmental Agreement, Art. 3.4.5.1 VLAREMA
[92] art. 22 of the Flemish Environmental Agreement
[93] art. 12 of the environmental agreement of the Walloon region
[94] art. 22 of the Flemish Environmental Agreement

For automotive batteries and accumulators:

Garages are obliged to take back automotive batteries and accumulators and the organisations in charge of EPR (individual producers and management organisations) are obliged to offer them a free and regular collection service[95] . However, this obligation does not cover (industrial) electric traction batteries.

In Flanders, car batteries are not subject to a mandatory agreement with municipalities if the value at the collection point is positive[96] , which is the case in practice.

For batteries and accumulators for electric and hybrid vehicles:

The producer is obliged to carry out a diagnosis, within its own network of take-back points or any authorised establishment designated by it or by the management organisation. Retailers, ELV centres, garages and body shops that collect batteries must comply with the instructions and recommendations of the producer-manufacturer and the management organisation.

The take-back point must report to the producers and the management organisation (PRO) the information concerning the treatment methods (energy recovery, recycling, etc.) and the details of the new holder.

Financial guarantees must be provided for all batteries placed on the market to manage orphan batteries, according to the Flemish Environmental Agreement. Submitted annually to OVAM for approval, the amount of the guarantee is established considering the number of HEV batteries placed on the market and a realistic assessment of the future financing needs due to orphan batteries, considering the estimated lifetime of the batteries and their existing guarantees. There is no reimbursement of financial guarantees for the batteries finally managed, the calculation of the amount considers projections of orphan batteries. Brussels decided to take the work of OVAM as a starting point but to carry out an evaluation in 2022 to check whether the amounts provided for by OVAM are sufficient or need to be adapted.

The take-back contractor must report to the competent regional authorities, among other things, the quantities of industrial waste batteries placed on the market, collected, and treated each year according to the treatment methods and an assessment of the average composition of the products placed on the market[97].

- Objectives

The collection targets only concern portable batteries and accumulators (50% in Wallonia, 45% in Flanders, 50% in Brussels[98]) and are calculated for each region according to the European calculation methods. The targets in Wallonia and Brussels exceed the European target of 45%.

Recycling efficiency targets are expressed by battery technology. In line with the European Directive, an average recycling efficiency target of 50% of all collected batteries and accumulators is set[99] . In Flanders, the target is to be achieved for both portable and automotive/industrial batteries and accumulators, while in Wallonia and Brussels, the target is calculated for all batteries. The other targets relate to Pb and NiCd technologies specifically.

A specific recycling target of 50% for traction batteries is set in the environmental agreement specific to electric and hybrid vehicle batteries and therefore applies to FEBELAUTO members.

There are no second life targets. However, the management organisation is obliged through the environmental agreements to examine the opportunities and constraints for re-use. This is organised through studies and partnerships (see management sections below). There are no specific obligations of means or results. The administration in Flanders and Brussels also undertakes to play an active role in this research. The environmental agreements also state that "after technical diagnosis of the remaining capacity of a battery or its components, certain industrial batteries or components may be reused (either for the same or another application)"[100] . To date, therefore, re-use is not mandatory.

[95] art.33. AGW of 13/09/2010, art. 2.4.4 of the AGRBC of 01/12/2016
[96] art 3.4.5.1 of VLAREMA
[97] art. 37 AGW of 13/09/2010
[98] art.30 AGW of 13/09/2010; art 3.4.5.2 VLAREMA, art 2.4.7 AGRBC of 01/12/2016
[99] art. 34§2 AGW of 13/09/2010
[100] art. 14 of the CBR Environmental Agreement and art. 14 of the Flemish Environmental Agreement

- Specific framework for second life

Extended producer responsibility is transferred to the operator preparing for re-use (but not in the case of re-use)[101] .

In Wallonia, batteries used for the same purpose (mobility) are considered as reused and the responsibility for their management remains with the original producer. Batteries used for another purpose (secondary use) fall outside the scope of the environmental agreement and the responsible producer becomes the operator who prepared this new use, which must comply with the environmental agreement on industrial batteries via the BEBAT management body or an individual plan[102] . Reporting is foreseen to the administration for these batteries to a secondary use considered as a "transfer of ownership".

The environmental agreements relating to traction batteries provide that the prevention plan to be implemented by producers or management organisations should aim to extend the life of batteries through quality control and/or diagnostic operations, and actions to facilitate disassembly, reuse and identify opportunities and barriers to the development of reuse and secondary use of batteries and their components.

- Approval systems:

The management bodies must submit management plans to the 3 regions according to the requirements of the respective environmental agreements. The regions are part of the management body's board of directors.

Annual reporting to the competent regional authorities (Service Public Wallonie, OVAM in Flanders and Brussels-Environment) is foreseen, as well as financial information and information on prevention actions. Environmental agreements generally have a duration of 5 years before they are revised, but they can be extended.

- Active PROs

BEBAT is an active management organisation for all batteries and accumulators (portable, automotive, industrial, light, and heavy-duty mobility).

FEBELAUTO is an active management body for ELVs and for heavy industrial electric and hybrid traction batteries (>20kg). FEBELAUTO is not active for automotive batteries and accumulators.

Regulation on extended producer responsibility for vehicles

- Name of regulatory texts:
    - Order of the Walloon Government of 23 September 2010 introducing an obligation to take back certain waste.
    - Order of the Walloon Government of 27 February 2003 determining the sectoral conditions for facilities for the grouping or sorting of recyclable metal waste, facilities for the grouping, sorting or recovery of end-of-life vehicle parts, centres for the dismantling and depollution of end-of-life vehicles and centres for the destruction of end-of-life vehicles and the treatment of ferrous and non-ferrous metals[103]
    - Decree of the Government of the Brussels-Capital Region of 1er December 2016 on waste management
    - Materialendecreet 23 DECEMBER 2011. - Decreet betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen
    - VLAREMA-17 FEBRUARI 2012. - Besluit van de Vlaamse Regering tot vaststelling van het Vlaams reglement betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen[104]
    - Flemish Environmental Agreement of 22/06/2018: Milieubeleidsovereenkomst betreffende de aanvaardingsplicht voor afgedankte voertuigen[105]
    - Environmental agreement on the execution of the take-back obligation for end-of-life vehicles of 04/02/2021[106]

[101] art. 3.4.5.1 VLAREMA, Walloon environmental agreement on traction batteries
[102] art. 18 and 19. of the Walloon environmental agreement on traction batteries
[103] AGW 27/02/2003: https://www.febelauto.be/public/Arrete-royal-du-27-fe%CC%81vrier-2003.pdf
[104] VLAREMA: https://www.febelauto.be/public/VLAREMA-hfdst-5-2-4_juni2019.pdf
[105] Flemish Environmental Agreement of 22/06/2018 ELV: https://www.febelauto.be/public/MBO-Febelauto-AGV-BS-4-okt-2018.pdf
[106] Walloon Environmental Agreement of 04/02/2021 ELV: https://www.febelauto.be/public/Convention_VHU_Moniteur2022.pdf

- Environmental agreement on end-of-life vehicles for the Brussels Capital Region of 14/06/2019[107]

- Provisions

ELVs are subject to EPR in all three regions. As with other waste streams, EPR can be organised via a collective system (management body or approved body) or via an individual plan (individual system). FEBELAUTO is the only approved management body for ELVs.

For ELVs, the regulatory conditions applicable to EPR do not provide for the development of an EPR fee scale, so that the correspondence between the notion of management body and PRO covering management costs in the sense in which it is understood in France is not total. FEBELAUTO's 2021 budget amounts to EUR 1.4 million, of which EUR 400,000 are rebilled costs. The difference is paid for by membership fees and contributions from members (80%) and partner federations. This budget is used to finance the administrative management of the scheme and is not used to finance collection and treatment. The management costs of tyres and batteries for electric and hybrid vehicles[108] are re-invoiced to the producers.

ELVs must be depolluted to remove, isolate, and selectively treat hazardous components, including batteries. Batteries must be managed in accordance with the take-back obligation for batteries and accumulators, and the recycling targets for batteries must be met.

FEBELAUTO has designed a standard for "+-approved" centres which includes provisions relating to electric and hybrid vehicle batteries. Approval requires an audit to be carried out in relation to the FEBELAUTO standard[109] (see section 5.3.2.5).

Regulation on extended producer responsibility for EEE

- Order of the Walloon Government of 23 September 2010 introducing an obligation to take back certain waste.
- Decree of the Government of the Brussels-Capital Region of 1er December 2016 on waste management
- VLAREMA-17 FEBRUARI 2012. - Besluit van de Vlaamse Regering tot vaststelling van het Vlaams reglement betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen[110]
- Flemish Environmental Agreement of 18/05/2016: Milieubeleidsovereenkomst betreffende de aanvaardingsplicht voor afgedankte AEEA[111]
- Walloon Environmental Agreement on the implementation of the WEEE take-back obligation of 10/06/2010[112]
- Environmental agreement on WEEE for the Brussels Capital Region of 08/07/2019[113]

- Provisions

RECUPEL is the only management organisation for the WEEE scheme in Belgium.

There are no specific provisions in the WEEE regulation for batteries. WEEE must be cleaned up before recycling, which includes the removal of the battery according to EU law (WEEE Directive).

Status of the black mass

In Flanders, black mass is considered as waste and not as a product of recycling.

[107] RBC Environmental Agreement 04/06/2016 ELV: https://www.febelauto.be/public/MBO-ELV-2019.pdf
[108] FEBELAUTO annual report: https://www.febelauto.be/rapportannuel2021/rapports-et-rapport-financier.html
[109] PLUS FEBELAUTO standard: https://www.febelauto.be/public/Febelauto-norm-REVISION-AVRIL-2020-VERSION-FR.pdf
[110] VLAREMA: https://www.febelauto.be/public/VLAREMA-hfdst-5-2-4_juni2019.pdf
[111] Flemish Environmental Agreement of 18/05/2016 WEEE: https://www.recupel.be/media/1467/pages-from-mbo-vlaanderen.pdf
[112] Walloon Environmental Agreement 10/06/2010 WEEE : https://www.recupel.be/media/1442/milieubeleidsovereenkomst-wl-20100511-fr.pdf
[113] RBC Environmental Agreement 08/07/2019 WEEE: https://www.recupel.be/media/2412/mbo-brussel-2019.pdf

5.3.2.4. Light mobility battery management

EPR scheme

EPR for light mobility batteries (<20kg) is mandatory.

Financing

BEBAT is the only management organisation active in the management of light mobility batteries. The financing of the scheme works on a "pay-as-you-sell" basis with two types of fee scales:

- Under 10 kg (electric bikes, scooters), the fee scale is provided per piece

Weight	Fee scale 2022 (EUR/piece)
≤ 150g	0,057
> 150g -≤ 500g	0,200
> 500g -≤ 2kg	0,850
> 2kg -≤ 10kg	7,000

- Between 10 and 20 kg, the fee scale is provided by weight:

Weight	Fee scale 2022 (EUR/kg)
> 10kg -≤ 20kg	2,260

The fee is an environmental fee, i.e., it finances both reporting, prevention actions and management itself (collection, sorting, treatment).

Description of the system

Light mobility batteries follow the management scheme for portable batteries:

- Mobility batteries and accumulators are collected:
  - At civic amenity sites: it is compulsory for BEBAT to collect at all civic amenity sites,
  - Through retail partners,
  - In WEEE dismantling centres: there is cooperation with the management organisation RECUPEL for the collection of batteries and accumulators from WEEE.

- The collection contract is awarded to a company by tender. SUEZ / VEOLIA was selected for all BEBAT's collection contracts during the last call for tenders.

Compared to portable batteries, the special features are

- The type of collection containers used (see Collection points) ;
- Collection schemes. Portable batteries and accumulators (excluding mobility) are also collected from companies, general retailers without access control and from schools. The BEBAT prevention plan currently being implemented stipulates that the small opening sizes of the collection containers de facto prevent collection via these schemes without access control. Among the partner retailers, specific retailers in the cycle and scooter markets were selected for soft mobility, with access control.

Collection points

Batteries and accumulators for soft mobility are collected in 520 l metal drums called "ASP[114] " with a 33 cm diameter opening. These containers comply with ADR legislation for the transport of lithium batteries, including damaged ones.

Collection points at bike retailers are perceived as high-risk by OVAM and are therefore monitored more closely, via the BEBAT security plan.

[114] Tanks for hazardous waste



Figure 9 : ASP" containers

Safety - special features of mobility batteries

BEBAT has developed a battery safety plan with specific provisions for mobility batteries. The ASP collection points are not freely accessible by the waste holder but managed by the point operator (or their staff), which allows the state of batteries to be checked before they are deposited in the collection point, and to secure them before they are deposited if they are damaged or defective (insulating tape, plastic film in the case of damaged, swollen batteries or batteries with loose contacts).

The containers are also equipped with a flap in the lid for fire control (evacuates smoke but contains flames), a temperature sensor and a filling sensor.

Portable batteries are sent in more conventional metal containers (openings <100mm). The separate collection of mobility batteries is intended to make the collection point safe. All batteries are then collected via the same collection rounds and sent to the same SORTBAT sorting centre owned by BEBAT.

The transport complies with ADR regulations.

Shops hosting mobility batteries do not need an environmental permit (as for portable batteries).

Links with WEEE EPR

RECUPEL is responsible for the dismantling of the batteries at the WEEE processing centres, and BEBAT is responsible for the supply of collection containers, collection, and processing.

Treatment

Sorting is carried out by SORTBAT. For the recycling of Li-ion, BEBAT works with several operators: EURO DIEUZE INDUSTRIE (France) and ACCUREC (Germany).

BEBAT does not specifically track collection and recycling statistics for mobility batteries.

There are several projects around the second life of light mobility batteries in Belgium:

- In Flanders, BATTERYPACKSERVICE (a spare parts shop) and HOOGMARTENS (a public works company) are planning to reuse used electric bike battery cells to make roadworks signs and replace the primary batteries currently used. A prototype has been produced.
- In Brussels, BILMO's Mobile Battery project (start-up) aims to make charging bins with a mobile battery unit suitable for cargo bikes from used electric bike batteries. They can be used for events, markets, festivals, and large bars.
- In Brussels, the Sustainer project of SLIBAT (start-up) aims to manufacture a prototype of a mobile construction battery with batteries mainly from electric bikes.
- In Brussels, DAUREMA (start-up) aims to manufacture an easily repairable battery from used electric bike batteries that can be used for various purposes, such as cargo bikes.

These projects are still in the pilot stage.
No statistics are available on the quantities treated in this way, as the waste stream is still marginal.

5.3.2.5. Heavy mobility battery management

EPR scheme

EPR is mandatory.

FEBELAUTO and BEBAT are the two management organisations active in the management of heavy mobility batteries:

- FEBELAUTO for batteries >20kg and >60V DC of vehicle categories L, M1 and N1
  Since 2015, FEBELAUTO has been representing most car brands for the charging of their batteries (98.4% of HEVs put on the market in 2021).
    - VOLKSWAGEN, AUDI, SEAT, SKODA, PORSCHE, CUPRA, BENTLEY, BUGATTI, LAMBORGHINI
    - NISSAN
    - HONDA
    - VOLVO
    - MERCEDES, SMART
    - RENAULT, DACIA, ALPINE
    - KIA
    - OPEL, VAUXHALL

- PEUGEOT, CITROËN, DS
- TOYOTA, LEXUS
- FORD, MERCURY, LINCOLN
- SUBARU
- MITSUBISHI, FUSO
- JAGUAR, LANDROVER
- BMW, MINI
- FIAT, CHRYSLER, ABARTH, JEEP, DODGE, ALFA ROMEO, LANCIA, RAM, MASERATI
- HYUNDAI, SUZUKI, SSANGYONG, ISUZU, MG, MAXUS
- POLESTAR
- TESLA
- AIWAYS
- LYNK&CO
- LEVC

In 2021, according to FEBELAUTO, this represents 87,365 HEV batteries (original equipment or replacement) and 15,272 tonnes placed on the market, up 83% on 2020.
The manufacturers corresponding to 79% of the quantities of used batteries collected manage the collection and treatment themselves and only pay the administrative fee to FEBELAUTO which covers the costs of reporting to the authorities and prevention actions (RENAULT, STELLANTIS and TOYOTA in particular).
The manufacturers corresponding to 21% of the quantities of used batteries collected call on FEBELAUTO for management (collection and treatment) and therefore pay the actual management and administrative fees.

- BEBAT for all heavy mobility batteries including freight (N2-N3), buses (M2-M3), tractors, boats... MAZDA is a member of the BEBAT system.

OVAM states that the small number of actors on the market limits the problem of free riders. TESLA, which was a free rider, was approached by OVAM to encourage them to join the EPR system and has since joined FEBELAUTO. If a non-compliance persists, it will be reported to the government, which may take sanctions.

The model adopted by the two management bodies for the collection and processing fees is a "pay-as-you-collect" model, i.e., the collection and processing fees are charged on an annual basis. This system was chosen because it is very difficult to predict the future costs of managing traction batteries due to uncertainty about the waste stream, collection rate, life span, and value of batteries.

For BEBAT, above 20 kg, a piece rate is foreseen for the administrative part:

Weight	Fee scale 2022 (EUR/piece)
>20kg	0,053

The fee is an administrative fee that only includes the costs of reporting and prevention. If the producer decides to call on the PRO for management, an additional management fee is charged when the battery is taken over.

For FEBELAUTO, the administrative fee is invoiced by FEBIAC (Belgian Automobile and Cycle Federation) to the producers. It is calculated according to the total costs incurred for the management of the EPR ELV and EPR traction batteries, distributed in proportion to the market share of the manufacturers in year N-9 (2013 for 2022), which corresponds to the estimated life span of the vehicles and the batteries they contain. The market shares refer to all vehicles and not specifically to electric vehicles.

A guarantee fund for orphan batteries is supplied at 0.01 EUR/kg of battery placed on the market and is part of the FEBELAUTO administrative fee. The amount was determined by OVAM after consultation with FEBELAUTO and BEBAT. OVAM is responsible for monitoring the guarantee fund account and approves the allocation of the funds in consultation with BEBAT and FEBELAUTO.

This is a minimum reserve fund for management. This does not correspond to the assumed collection cost for batteries but incorporates the probability of manufacturer failure and orphan batteries (perceived to be low). At present, no unidentifiable or orphan batteries have been identified. It is therefore cheaper for members to pay into the guarantee fund than a pay-as-you-sell system.

In addition, FEBELAUTO shall compensate BEBAT for the collection of parts of electric mobility batteries that are dismantled and placed in the collection schemes managed by BEBAT.

Management of used batteries

FEBELAUTO has set up a network of take-back points made up of vehicle and battery retailers, ELV centres, garages, and car dealers. The approved ELV centres can accept all brands. Car and battery retailers, ELV centres, garages and end sellers can apply to be a take-back point for one brand, certain brands, or all brands. FEBELAUTO then selects the take-back points according to transparent criteria.

Holders of waste batteries are directed to their vendor to identify the collection systems associated with their battery. Producers designate take-back points for their own brand.

For batteries whose management has been entrusted to FEBELAUTO by the producers, collection is organised by FEBELAUTO free of charge for the PLUS approved ELV centres. On the other hand, the cost of collection is invoiced to the producers and to the non-approved centres. The aim is to encourage ELV centres to be approved and to respect the safety instructions. In practice, FEBELAUTO is not called upon by non-approved centres for collection.

The free take-back by the take-back points only takes place for complete batteries, and without any other waste except the vehicle. Batteries collected by FEBELAUTO collection points can be sent to:

- An external diagnostic centre;
- A producer's diagnostic centre, operating under warranty;
- A producer's diagnostic centre, operating out of warranty;
- A remanufacturing centre of a producer ;
- Another remanufacturing centre;
- A user for reuse in a vehicle ;
- A user for reuse in another application;
- A battery recycling company.

Currently, 98% of batteries come from producers via their car dealers and 2% from authorised ELV recycling centres.

Depending on the producer, either the producer or the management organisation organises the management of the used batteries by choosing the partner collectors and recyclers (hybrid system). In the case where the service providers are chosen by the member, the management organisation deals with the partners selected by the member for its reporting activities to the authorities. The member can choose to delegate certain steps to the management organisation (diagnosis, ADR transport, dismantling, treatment) which organises and invoices them (pay-as-you-collect). For the year 2021, the operational management costs of the batteries handled by FEBELAUTO represented 60,883 EUR.

BEBAT is the initiator of the European RENEOS network which aims to provide a service for several countries. The European RENEOS network aims at the management of Li-ion batteries, in particular from electric vehicles. Producers can choose to use RENEOS for dismantling, collection and/or recycling (à la carte). The service is offered throughout Europe through a network including BEBAT (Belgium), GRS BATTERIEN (Germany), COBAT (Italy), BATTERIRETUR (Norway) and STIBAT (Netherlands). The operational role of RENEOS and the current membership could not be clarified as RENEOS did not wish to participate in the study.

For TOYOTA batteries (NiMH, hybrid), SNAM (in France) has the recycling contract with TOYOTA and chooses its collection partner. BEBAT is a subcontractor for the organisation of the collection, but the collection is not necessarily carried out by the collection provider chosen by BEBAT for the other categories of batteries.

Batteries are systematically diagnosed. When used batteries are collected (e.g. from a car sales outlet), a simple diagnosis is carried out to check the performance of the batteries, which enables them to be directed either towards recycling or second life, and to define the safety procedures for the removal of the batteries. When a car dealer asks FEBELAUTO to collect a battery, FEBELAUTO requires the completion of an online diagnostic form which gives an idea of the battery's condition. Some brands require all batteries of a certain range to be returned to an international research centre (mainly outside Belgium, e.g. VOLVO has all batteries sent to Sweden). This type of return represents 61% of the quantities of batteries collected to date. The fate of the batteries after diagnosis is not clear, as the brands do not communicate this information for reasons of confidentiality. FEBELAUTO indicates that these batteries are either used for R&D tests or sent for remanufacturing or second life.

174 tonnes of batteries were collected in 2021 in Belgium. Manufacturers managed 137 tonnes directly, while FEBELAUTO collected 37 tonnes, i.e. 493 batteries. 35 tonnes were collected in the Flemish Region at a cost of 60833 EUR. The concentration of the activity in the Flemish Region is due to the higher market share of HEVs in this region.

According to FEBELAUTO[115] , the cost of managing batteries from HEVs is more than EUR 2,000/tonne. While collection costs are expected to decrease due to improved logistics, recycling costs are expected to increase in the short term due to the lack of outlets.

Safety - special features of mobility batteries

A take-back point must be authorised for storage and comply with the producer's or management organisation's instructions concerning training and equipment, especially for the removal, storage, and packaging of the battery for transport.

For electric and hybrid vehicle batteries, producers must inform establishments of safe and effective battery removal methods and the removal of batteries from cars may only be carried out by trained and authorised centres[116] .

BEBAT provides advice to all collection points that may receive high voltage batteries:

- The specific guidelines of each customer/brand are respected.
- The protective housing surrounding the battery is first unscrewed, and the glue and silicone are removed. Electrical components and ducts for coolant (cooling) or air (ventilation) must also be removed.
- The battery voltage is measured before and during dismantling. The modules/cells are gradually removed from the battery bank to reduce the voltage and ensure safe treatment. Finally, all cells are removed.
- In addition to the voltage, the temperature is also measured by a heat scan. When the heat exceeds the ambient temperature, this indicates that there is a problem. Cells that do not show any abnormalities in relation to the ambient temperature can be safely stored.
- After dismantling, the battery cells are packed again and - if necessary - stored in a special secure location that is constantly monitored. They are then sent to an authorised recycling company.

FEBELAUTO collects batteries free of charge from PLUS-approved ELV centres or PLUS-approved collection points. These points comply with the following PLUS approval conditions:

- They have the necessary environmental permits and insurance;
- They developed a battery management plan including a risk analysis, response procedures including worker protection measures, an indication of separate and secure storage areas (dry, cool, covered, monitored and under access control);
- Personnel working on the batteries are trained in the recognition of battery types and risks and have received associated clearance. A trained person is responsible for monitoring operations, checking compliance with safety conditions and their progress. A trained person is also the on-site safety contact and will be required to carry out an annual levelling test or on-site check for those who are cleared;
- Collection is only carried out if the points have the producer's instructions, the conditions imposed by the producer that are stricter than the PLUS standard must be respected;
- The point has CE marked equipment for removal (lift, handling device, voltage detector, safety locking plugs for batteries to isolate connectors), provides personal protective equipment (insulating gloves...) and has emergency equipment;
- Specific rules aim to avoid short circuits: use of safe equipment and defined work area, disconnected and isolated equipment, earthing for transport, etc.
- The point only removes the battery from the vehicle, or accepts it, and packs it for transport. It is not allowed to dismantle the battery and/or modules unless authorised by the producer.
- Diagnosis of the condition of the battery, with a view to its re-use in another application, is only carried out by diagnostic centres. Collection points that also act as diagnostic points must keep a record of the diagnostic method used and its result, which may be requested by FEBELAUTO for any shipment.
- The point is audited every two years by FEBELAUTO or by a third party appointed by FEBELAUTO. The public authorities play no role in this audit.
- The point ensures traceability of accepted, stored and shipped batteries and the destination of the batteries, as well as the recycling rates or the end of life of the batteries if the point carries out the shipping itself;
- The point can choose the outlets for the batteries, unless there is a specific agreement between FEBELAUTO and the producer;
- In case of second life, the point signs an agreement with the operator preparing for the re-use for another purpose, in view of the transfer of responsibility;
- The centres ensure traceability of the battery modules, the battery itself and the original vehicle. This traceability makes it possible to know which car the battery came from and, in the event of its dismantling, to know which battery the modules that may have been separated from it belonged to.

[115] The estimated cost from the financial balance sheet and the tonnages declared for 2021 is EUR 1644/tonne but it does not consider all the outstanding costs due to uninvoiced stocks at the balance sheet date.
[116] art. 11 of the Flemish Environmental Agreement, art 11§2 of the CBR Environmental Agreement

In practice, the audits of trade-in points outside ELV centres are carried out by the manufacturers themselves. FEBELAUTO therefore has less direct visibility on the conformity of the take-back points but has confidence in the fact that the manufacturers do not wish to be held responsible in the event of an incident. FEBELAUTO intends to carry out an awareness campaign aimed at trade-in points outside ELV centres with the aim of improving compliance with the PLUS standards.
To date, PLUS approval is not compulsory for handling electric and hybrid vehicles. Making it compulsory is a demand of FEBELAUTO.

Batteries are transported in accordance with the regulations governing transport, in particular ADR. Batteries belong to class 9 of the UN3480 classification. Their transport must comply with regulations on information, labelling, packaging, and declaration. Transport is stricter for batteries classified as hazardous waste, such as damaged batteries: individual and hermetic packaging of each battery, preventive measures to prevent the battery from moving in the packaging with insulating cushioning and absorbent material in case of electrolyte release.

Treatment

For recycling, BEBAT works with several operators: EURO DIEUZE INDUSTRIE (France, Li-ion) and ACCUREC (Germany, Li-ion), and SNAM (France, NiMH hybrid). BEBAT has expanded its number of recycling providers in recent years due to the lack of recycling capacity.

FEBELAUTO works with UMICORE (Belgium), SNAM (France) and NORTHVOLT (Sweden) for recycling.

Second life

- In Flanders, the Sunbat project led by MINISTRY OF SOLAR (a company that designs and installs PV panels) and ELECTA (a division of the KUL University[117]) concerns used batteries from electric buses. The aim is to reuse them to make a stationary battery that stores renewable energy from the sun and wind for SMEs that want to quickly recharge their electric vehicles.
- In Brussels, the Batpack Project of the start-up OCTAVE aims to manufacture modular batteries for industry and SMEs (production companies), schools and administrations, energy cooperatives and, eventually, for private individuals.
- In the absence of a second life project in Belgium for car batteries, FEBELAUTO created the WATT4EVER project with 4 private partners[118] who have knowledge in the field of ELV assembly, diagnosis, assembly of new stationary batteries, certification, and optimisation. It is still in the development stage.
  The WATT4EVER project consists of the reuse of battery modules for stationary energy storage for professionals with several possible applications (grid stabilisation, power increase, replacement of diesel generators in hospitals), but none is particularly dominant. The choice of application depends on customer demand.
  WATT4EVER does not intend to be in the market of energy storage batteries for private individuals because the competition with Chinese batteries is too high. The reuse carried out by WATT4EVER implies a transfer of responsibility from the car manufacturer to WATT4EVER.
  The reuse of batteries for the same purpose (remanufacturing) is currently done by car manufacturers. However, discussions with car manufacturers are underway to have WATT4EVER do this as well. WATT4EVER already has the know-how, equipment, and personnel to remanufacture batteries.

93% of the quantities of batteries collected in 2021 in Belgium (FEBELAUTO scheme) were reused for research and development, testing, reconditioning, second life applications (e.g., energy storage) and recycling.

[117] Catholic University of Leuven (Flanders)
[118] ECO-LITHIUM / ECARACCU (manufacturer of energy storage systems from EV batteries in the Netherlands), OUT OF USE (company specialising in the reuse and recycling of devices), REVOLTA (energy storage systems), SHENCE MANAGEMENT (consultancy)

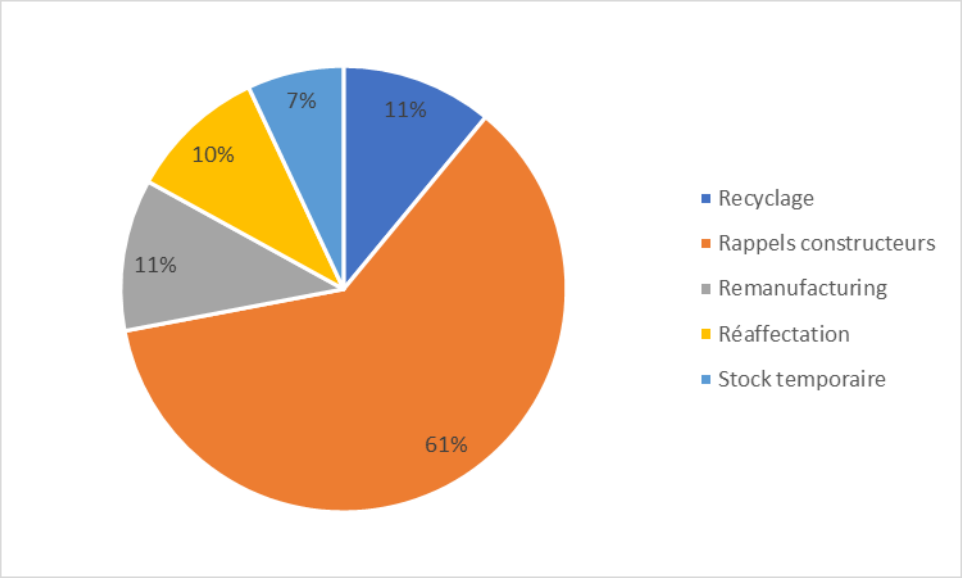


Figure 10 : Processing of batteries collected via the FEBELAUTO scheme

The remaining quantity of collected reusable and used HEV batteries (7%) was temporarily stored and not disposed of. This is due to the interruption of activity of recyclers during the pandemic or the refusal of quantities by recyclers until they have enough of the same type to process. Finally, the limited availability of processing slots at recyclers was another factor.

Recycling facilities have achieved over 50% recycling efficiency.

In case of second life for stationary storage applications, producers (reuse preparers) must join BEBAT (industrial batteries).
In the past, OVAM has noted exports of batteries to a Dutch company ECARACCU for stationary applications, but the batteries were eventually exported to Africa without any guarantee that the batteries were actually used for this purpose and not illegally disposed of. This is no longer the case through ECARACCU's participation in FEBELAUTO's WATT4EVER project. Data is requested on the destination of the second life batteries to verify this aspect.

5.3.2.6. Overall assessment

Strengths	**Weaknesses**
Regulations already adapted to the management of HEVs	Regulatory complexity (3 regions with variations in environmental agreements)
Detailed FEBELAUTO standard for the safety of ELV centres and a clear framework for the governance of the heavy mobility scheme	Weak traceability of HEV and soft mobility batteries (no specific reporting)
Support systems for second life	Lack of harmonisation in Belgium regarding the status of batteries (waste or non-waste)
End of Waste in case of re-use (Flanders)	Non-mandatory FEBELAUTO standard for HEV management
Complementarity of the BEBAT and FEBELAUTO schemes	
Opportunities	**Threats**
Many second life projects under construction	Hybrid system not allowed by the future EU Regulation?
Extension of the FEBELAUTO scheme to include heavy vehicles	Illegal exports of batteries, specifically for a second life that is not ultimately materialised (potentially escaping waste status)

5.3.3. Spain

5.3.3.1. Overview

Context	
Population	47 million inhabitants
Population density (inhab./km²)	94
Electric and hybrid vehicle registrations (/1000 inhab./year) - 2019	2.5 (Eurostat, 2019)
Market share of registered electric and hybrid vehicles per year (%)	9% (Eurostat, 2019)
Number of electric and hybrid vehicles registered	381 031 (Eurostat, 2019)
Number of registered electric and hybrid vehicles (/1000 inhabitants)	8 (Eurostat, 2019)
Extended producer responsibility	
End-of-life vehicles	Mandatory EPR - however, the system is self-financing and there is no collective system.
Light mobility batteries	Mandatory EPR - assimilated to the portable and industrial battery management system
Heavy mobility batteries	Mandatory EPR - similar to the industrial battery management system
Other batteries (portable, industrial, automotive)	Collective systems • ECOPILAS • EUROPEAN RECYCLING PLATFORM ESPAÑA (ERP) • FUNDACIÓN ECOLEC • UNIBAT
Regulations for mobility batteries	
Collection targets	Yes, but not specific to mobility • Portable batteries - 50% from 2020 • Industrial batteries - 70% from 2020
Treatment objectives	Non-specific, EU recycling efficiency targets of 50% for all batteries excluding acid Pb and NiCd.
Specific collection / safety regulations	Yes, framework for batteries, including electric mobility batteries, defined by Royal Decree 106/2008
Approval of ELV centres	Yes
Performance	
Collection rate (or quantities collected) - 2019	No data available at national level for electric mobility categories
Recycling rate	Information not available

Second life rate	Information not available

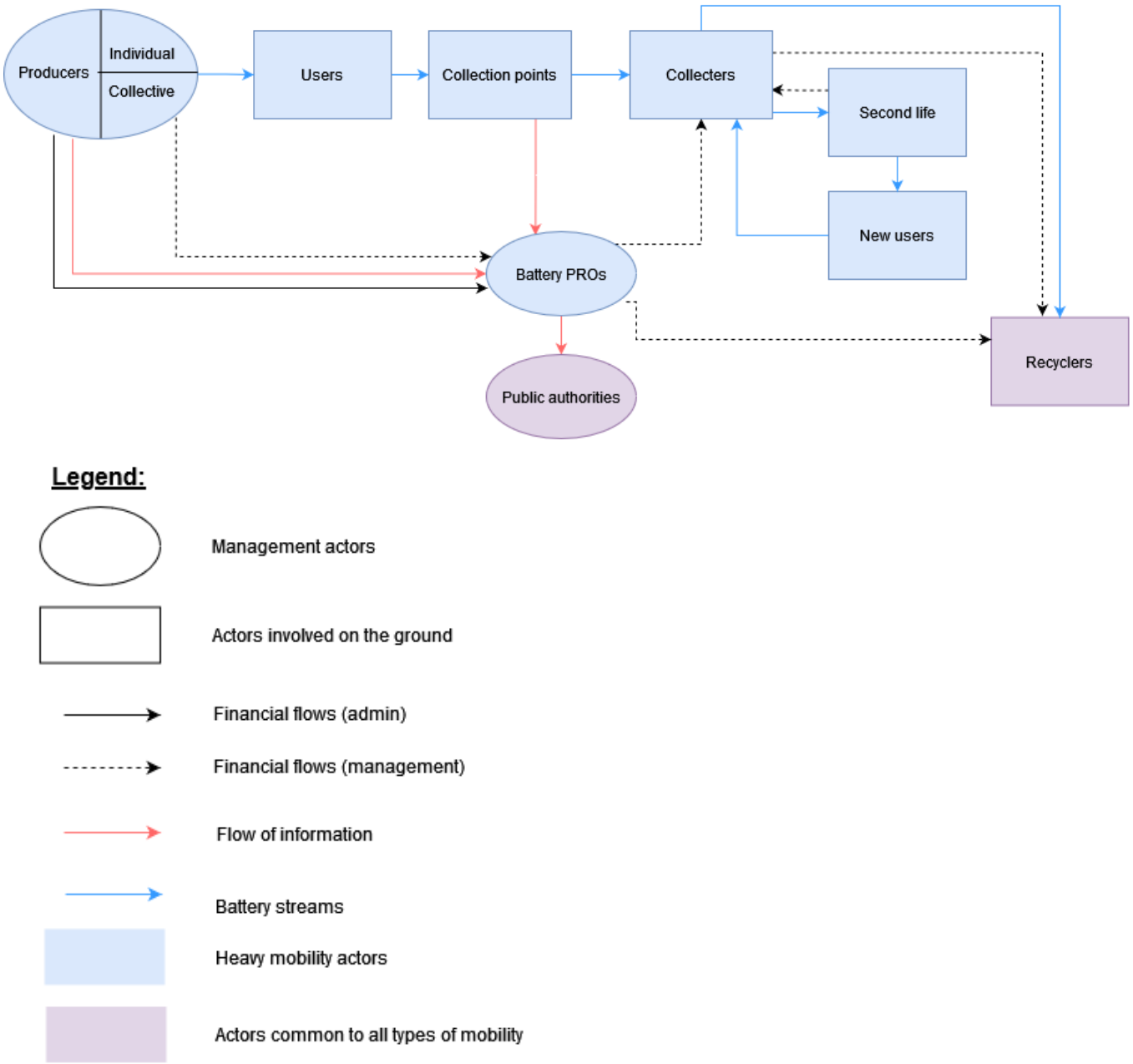


Figure 11 : Heavy mobility battery management in Spain

5.3.3.2. History

Context: The battery management scheme has started and evolved in concomitance with the regulatory changes at European level.

Past developments: Nothing specific to electric mobility batteries

Prospects: Significant changes are expected in the organisation of the scheme regarding the future European regulations on batteries and battery waste.

5.3.3.3. Regulatory framework

Status and classification of mobility batteries: there is no specific category for electric mobility batteries (this may change with the new European battery regulation). They are considered as industrial batteries if they are over 1 kg (in practice this concerns all mobility batteries) or portable batteries if less.

Furthermore, since the entry into force of Royal Decree 27/2021 of 19 January, all batteries containing lithium (i.e., the vast majority of electric mobility batteries) are considered dangerous.

Regulations governing the extended responsibility of battery producers:

- EPR for batteries is established in Article 5 of Royal Decree 106/2008 of 1 February on batteries and accumulators and the environmental management of their waste. The public authorities of the Spanish municipalities and Autonomous Communities must establish cooperation agreements with the producers[119] (organised in one of the ways provided for by the law, see below). The cooperation agreements define the waste management objectives, the conditions of collection, storage, treatment, and disposal of materials contained in spent batteries and accumulators.

- Specific elements foreseen according to the types of batteries:

  - **Individual system vs. collective system**: Producers can organise themselves in an individual system or in a collective system. Furthermore, in addition to these two organisational options, the Spanish regulation gives the possibility to producers to respect their responsibility by:
    - Setting up a deposit, return and take-back system for used batteries, accumulators, and battery packs that it has placed on the market, either in the form of an individual extended responsibility system or in collaboration with other producers in the framework of a collective extended responsibility system;
    - Contributing financially to the public management systems set up, in proportion to the quantities of products they place on the market and considering the actual costs of their management.

      Note: No producer has so far opted for an individual system or for the alternatives indicated above[120] .

  - **Pay-as-you-sell vs. pay-as-you-collect**: nothing is imposed by regulation.

  - **Types of batteries defined in the regulation:** the Royal Decree distinguishes, as a minimum, the following types of batteries
    - Button batteries
    - Standard batteries[121]
    - Portable batteries
    - Batteries, accumulators, and automotive batteries
    - Industrial batteries containing cadmium.
    - Industrial lead-acid batteries and accumulators.
    - Cadmium-free and lead-free industrial batteries and accumulators.

    Light electric mobility batteries can be found in standard, portable or industrial battery categories. Heavy duty electric mobility batteries are industrial batteries.

  - **Targets:** minimum collection targets are set at federal level for different types of batteries, as defined in Article 15 of the Royal Decree. From 2011 onwards, the targets correspond to a collection rate based on the European definition. This collection rate is used for all types of batteries. This implies that the lifetime of all batteries is assumed to be 3 years.
    - Waste batteries and portable batteries (which may include light mobility batteries if they weigh less than 1 kg):
      - 25% from 31 December 2011.
      - 45% from 31 December 2015 (EU target).
      - 50% from 31 December 2020 (national target).
    - Waste industrial batteries and accumulators (those generally applying to heavy mobility batteries) - national targets
      - 98% for industrial batteries containing cadmium or lead, from 31 December 2017.
      - 70% for industrial batteries and accumulators that do not contain cadmium or lead, from 31 December 2020.

[119] In Spanish: "*convenios de colaboración*", equivalent in France to "cahiers des charges d'agrément

[120] Source MITECO - Link: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/prevencion-y-gestion-residuos/flujos/pilas-y-acumuladores/Como-y-donde-se-recogen-2022.aspx

[121] Defined by Royal Decree 106/2008 as a battery weighing less than 1 kg, other than button cells, intended for installation in consumer or professional products.

Furthermore, in its Annex III, the decree transposes the minimum efficiencies that recycling processes must achieve (cf. Annex III of Directive 2006/66/EC on batteries and accumulators).

- **Second life:** there are no regulatory elements on second life.

- Approval systems:

Collective systems must be authorised by the competent body of the Autonomous Community where their headquarters are located at the time of application for authorisation. The authorisation is valid for the entire national territory. The minimum content of the application for authorisation by the PRO is indicated in Annex X of Law 22/2011 and in Article 8 of Royal Decree 106/2008.

The authorised PROs will then establish cooperation agreements with local authorities and autonomous communities. In addition to the waste management objectives, these agreements set out the conditions for the collection, storage, treatment, and disposal of the materials contained in spent batteries and accumulators.

- Active PROs:
  - ECOPILAS (all categories);
  - EUROPEAN RECYCLING PLATFORM ESPAÑA - ERP (all categories);
  - FUNDACIÓN ECOLEC (portable batteries);
  - UNIBAT (mainly industrial and automotive batteries).

Regulation on extended producer responsibility for vehicles:

- There is no collective system for vehicles in Spain. The scheme is regulated by Royal Decree 265/2021 of 13 April on end-of-life vehicles and amending the General Vehicle Regulation, approved by Royal Decree 2822/1998 of 23 December, which transposes the European ELV Directive.[122]
- **Active PRO**: no active PRO. SIGRAUTO is the only Spanish association to date for the environmental treatment of end-of-life vehicles (Asociación Española para el Tratamiento Medioambiental de los Vehículos Fuera de Uso). It acts as a platform for exchange and representation of the sectors involved in the end-of-life vehicle treatment scheme.
- **Framework for batteries in the regulation:** the Royal Decree provides conditions for the treatment of batteries from electric or hybrid vehicles (see Article 7). More specifically:
  - ELV centres[123] must have appropriate containers for the storage of batteries (with the possibility, in the event of an accident, of neutralising the electrolyte on site or nearby), filters and polychlorinated biphenyl/polychlorinated terphenyl (PCB/PCT) capacitors.
  - Use of personal protective equipment necessary for the safe handling of an electric and/or hybrid vehicle working under high voltage.
  - Staff must be trained in the handling of electric and hybrid vehicles (see Annex VI of the Royal Decree) and must either
    - Hold a vocational training qualification conferring competence in the installation, assembly or maintenance of electrical installations, lines or vehicles or an equivalent qualification.
    - Have a certification issued by an accredited body for the certification of persons.

Regulation on extended producer responsibility for EEE

- The scheme is regulated by Royal Decree 110/2015 of 20 February, on waste electrical and electronic equipment.[124]

- **PROs:**
  - REINICIA
  - ECOTIC
  - AMBILAMP
  - FUNDACIÓN ECOLEC
  - ECOFIMATICA
  - ECOLUM
  - ECOASIMELEC
  - EUROPEAN RECYCLING PLATFORM ESPAÑA (ERP)
  - ECO-RAEE'S
  - SUNREUSE
  - ECOECHE

[122] Link to the text of the law here
[123] Called CAT in Spanish for "Centros autorizados de tratamiento
[124] Link to the text of the law here

- **Framework for batteries in the regulation:**
    - In its Article 6, Royal Decree 110/2015 provides that the instructions for EEE indicate that before WEEE is deposited at WEEE collection sites, batteries must be removed and deposited separately. Batteries or accumulators that can be removed from WEEE must be removed from WEEE for separate collection, provided that no intervention by a qualified professional is required.
    - In its articles 43 and 44, the Decree provides that when the batteries incorporated in the EEE (professional or household) cannot be removed by the user, the EEE producers shall finance the collection and transport of these batteries until their removal from the WEEE, as well as their subsequent treatment.

5.3.3.4. Light mobility battery management

EPR scheme

Light mobility batteries fall within the scope of the EPR for batteries. This EPR is mandatory. The four PROs active in the management of light mobility batteries are

- ECOLEC;
- ECOPILAS;
- EUROPEAN RECYCLING PLATFORM ESPAÑA;
- UNIBA.

Description of the system:

Light mobility batteries are collected mainly at collection points located at retailers, repair shops and facilities provided by municipalities (in practice, these are voluntary drop-off points). Collection is free of charge for the holder[125] .

There are two possible situations for collection and processing:

- Light mobility batteries are collected with WEEE.

  The batteries are collected by a PRO in charge of WEEE and taken to a dismantling and sorting facility. The batteries are removed from the equipment and sent to recycling facilities outside Spain. The PROs in charge of WEEE receive financial compensation from the PROs in charge of batteries for the costs they have incurred for the transport of batteries between collection points, temporary storage facilities (if any) as well as for the treatment carried out in sorting facilities. There is no standard way to calculate this compensation. It can be a bilateral negotiation between the actors or the use of a method of calculating compensation in proportion to the quantities of batteries placed on the market by the members of the PROs in charge of batteries.

- Light mobility batteries are separated from WEEE and are collected separately.

  The PRO in charge of the batteries directly manages the transport of the batteries to a temporary storage warehouse where the batteries are collected and then sent to recycling facilities outside Spain.

Financing

In general, the financing system for the management of light-duty batteries is a "pay-as-you-sell" system; producers pay an EPR fee to the collective systems according to their placing on the market. The EPR fee is used to finance collection and recycling operations. All the actors in the scheme receive funding to compensate for the services provided (transport, sorting and processing).

The EPR fees applied are confidential as the scheme is in a competitive market.

Collection points

At national level in 2021, the number of collection points (all collection schemes and battery categories combined, i.e., not specific to mobility) is at least 51 612:

- 44,612 for ECOPILAS;
- Almost 7,000 for ERP ESPANA.

Note: the other PROs do not display the number of collection points.

[125] Article 10 of Royal Decree 106/2008.

According to Decree 106/2008[126] , the networks of collection points shall be distributed according to population density and in sufficient number, accessible and close to the holder or end user; the decree does not specify the method for calculating the "sufficient number" of collection points. The decree specifies that to facilitate collection operations, battery producers or PROs shall provide collection points with special containers suitable for the removal and sorting of used cells and batteries returned by the holder.

In 2020, ECOPILAS collected 10.4 tonnes of batteries from electric bikes and scooters. Information on the quantities collected by the other PROs is not available.

Safety - special features of mobility batteries

Procedures at collection points

There are no specific safety procedures for light duty battery collection points defined in the law. No specific procedures have been identified with the PROs.

Procedures at collection level

There are no specific safety procedures for the collection of light mobile batteries defined in the law. No specific procedures have been identified with the PROs.

Links with WEEE EPR

The PROs, which manage the various collective systems for the management of WEEE, receive financial compensation for the costs they have incurred for the management of light mobility batteries, which may end up being integrated into WEEE (e.g., electric bikes).

Treatment

Light mobility batteries are sent for recycling. Currently, there is no Li-ion battery recycling company in Spain. The collected batteries are therefore exported to Europe for recycling. Projects for recycling plants are being developed in Spain[127] .

According to ECOPILAS, there are market opportunities for the development of second life batteries and several projects are already under development.

5.3.3.5. Heavy mobility battery management

EPR scheme

Heavy mobility batteries fall within the scope of EPR for **batteries**. This EPR is mandatory. The three PROs active in the management of heavy mobility batteries are

- ECOPILAS;
- EUROPEAN RECYCLING PLATFORM ESPANA;
- UNIBAT.

Description of the system

Electric or hybrid vehicles with heavy mobility batteries can be collected through two schemes:

- By car dealers and repair shops authorised by the manufacturers.

Once the electric or hybrid vehicle is taken to a repairer or car dealer (due to an accident or breakdown), an initial diagnosis is made to determine the problem with the vehicle and/or the condition of the battery. They will either repair the vehicle and/or its battery or put the vehicle at the end of its life and remove the battery from the vehicle. After extracting the batteries, these actors call the PRO for batteries of which the car manufacturer/importer is a member, to come and collect the batteries for recycling. These are recycled outside Spain.

[126] decree 106/2008: https://www.boe.es/buscar/act.php?id=BOE-A-2008-2387

[127] Urbaser y Endesa project - Link: https://www.urbaser.com/2021/10/primera-planta-espana-reciclaje-baterias-vehiculos-electricos/

- By approved ELV centres.

  In Spain, the law requires all ELVs to be taken to an approved ELV centre, including electric or hybrid ELVs containing an electric traction battery. The approval is not specific to HEVs. The ELV centres therefore receive electric or hybrid ELVs with or without their batteries (unless the batteries have been deposited by the car dealers or repairers upstream). The batteries are removed and assessed. This is done to determine whether the battery still has a residual economic value. After an evaluation, the authorised ELV centre is faced with two situations:

  - The battery still has value: the approved ELV centre sells it to a second life actor.
  - The battery has no more value: the approved ELV centre sends it for recycling through the PROs.

  It should be noted that currently there are very few end-of-life electric/hybrid cars arriving at ELV centres.

Financing:

The PROs that manage these collective systems charge an EPR fee to the producers:

- When placing heavy mobility batteries on the market (on a "pay-as-you-sell" basis), the objective is to cover the administrative costs of the declaration of quantities placed on the market;
- When the battery is collected, the aim is to cover the operational costs of transport and recycling (on a "pay-as-you-collect" basis) covered by the PRO.

All costs for the collection and treatment of waste heavy mobility batteries are borne by the producers in accordance with the EPR regime for batteries.

The rates applied are confidential as the scheme is in a competitive market.

Link to ELV EPR

In Spain, there is no ELV EPR. The ELV management scheme is federated by SIGRAUTO, which acts as a platform for exchange between the actors and for defending the interests of the scheme. SIGRAUTO has no responsibility for battery management. In this sense, there is no transfer of money or transfer of waste streams between the battery PROs and SIGRAUTO.

Management of used batteries

In 2020, ECOPILAS collected 54 tonnes of electric mobility batteries, including 25 tonnes from electric cars and 19 tonnes from electric mopeds.

The other PROs do not publish figures for batteries from heavy electric mobility.

Safety - special features of mobility batteries

Procedures at the level of diagnostic centres or other actors involved

No information on procedures at car dealer or repair shop level.

Procedures at the level of ELV centres

Batteries are transported in dedicated containers in accordance with ADR regulations. According to SIGRAUTO, ADR regulations are not always applied because of the cost.

SIGRAUTO has created and delivers training courses to train the staff of ELV centres in the techniques of safe removal and storage of electric batteries:

- Training that teaches the specific skills needed to manage an electric or hybrid ELV and its battery. This training leads to an official certification for the workers of the approved treatment facilities. Since 2021 and in line with Royal Decree 265/2021, certification is now mandatory for workers who deal with electric vehicles.
- Training, using IDIS information[128] , on how to secure vehicles and remove the battery according to the vehicle manufacturers' instructions. This training applies to vehicles that are not damaged.

[128] The International Dismantling Information System (IDIS): a database of dismantling procedures for ELVs, including E- and H- ELVs and their batteries.

About 200 approved ELV centres have received training in the past and about 50 approved ELV centres have received the training set out in Royal Decree 265/2021. SIGRAUTO expects 900 approved ELV centres to be certified by the end of 2022.

SIGRAUTO provides financial support to authorised ELV centres that wish to follow this certification training. The training course has also been promoted by the association of ELV centres in Spain. The training is provided by organisations such as TUV SUD. Afterwards, the certification of the training is carried out by a test by a certifying body.

Treatment

Currently, there are no Li-ion recycling companies in Spain. The collected batteries are mainly exported to Europe for recycling. Projects for recycling plants are being developed in Spain[127].

There is a second life initiative called BEEPLANET FACTORY[129] already operating in Spain. This company is specialised in energy storage solutions for households and professionals.

5.3.3.6. Overall assessment

Strengths	Weaknesses
• Competition between battery PROs can enable the development of battery management services for producers and the development and continuous improvement of the scheme. • The collection system for light mobility batteries is already well developed throughout the country.	• The sector is evolving rapidly but Spanish and European legislation is changing slowly. • Currently, there are no recycling plants in Spain. • There is no legal framework for the second life of batteries. This is very important to address the issue of the transfer of responsibility for the battery (between the manufacturer, the authorised ELV treatment facility, the second life company and the buyer of the second life battery), especially for second life batteries that end up in households.
Opportunities	**Threats**
• The revision of the EU battery regulation is imminent and will clarify many issues, such as liability after preparation for reuse. • There are market opportunities for the development of second life batteries and several projects are already under development.	• No threat identified

[129] BEEPLANET factory: https://beeplanetfactory.com/en/

5.3.4. Netherlands

5.3.4.1. Overview

Context	
Population	17.5 million inhabitants (Eurostat, 2021)
Population density (inhab./km²)	507 (Eurostat, 2019)
Sales of electric and hybrid vehicles per capita (/year per 1000 inhabitants)	5.4 (Eurostat, 2019)
Market share of electric and hybrid vehicles (%)	23% (Eurostat, 2019)
Number of electric and hybrid vehicles registered	402,204 (Eurostat, -2019)
Number of registered electric and hybrid vehicles (/1000 inhabitants)	23
Extended producer responsibility	
End-of-life vehicles	Extended Producer Responsibility – Individual or collective system (ARN)
Light mobility batteries	Take-back obligation but no obligation to set up a collection system Collective solution for electric bike batteries offered only by STIBAT
Heavy mobility batteries	Take-back obligation but no obligation to set up a collection system Collective solution organised by ARN
Other batteries (portable, industrial, automotive)	Portable and industrial <1kg: mandatory collective solution (STIBAT) Automobiles: collective solution (ARN), collaboration with STIBAT Industrial > 1kg: individual system, STIBAT is obliged to offer a service
Regulations for mobility batteries	
Collection targets	No
Treatment objectives	Non-specific, EU recycling efficiency targets of 50% for all batteries excluding acid Pb and NiCd.
Specific collection / safety regulations	Li-ion batteries are hazardous waste in the Netherlands, subject to ADR and notification of transboundary shipments. Safety is ensured by guidelines. The PGS 37 safety standard is planned for 2022: it will provide a framework for the safety of commercial storage of Li-ion batteries, particularly in the second life. Batteries prepared for second life are no longer waste.

Approval of ELV centres	Yes, KZD quality standard mandatory for the network of affiliated ELV centres ARN Addition of specific provisions for battery dismantling from June 2022 in KZD, and dedicated training funded by ARN (optional)
Performance	
Collection rate (or quantities collected)	No information on collection rate Heavy mobility (2021): 127 tonnes of Li-ion propulsion batteries from ARN affiliated brands (90% of manufacturers) Light mobility (2020): 225 tonnes of electric bike batteries
Recycling rate	46% (heavy mobility) 100% (light mobility)
Second life rate	54% (heavy mobility)

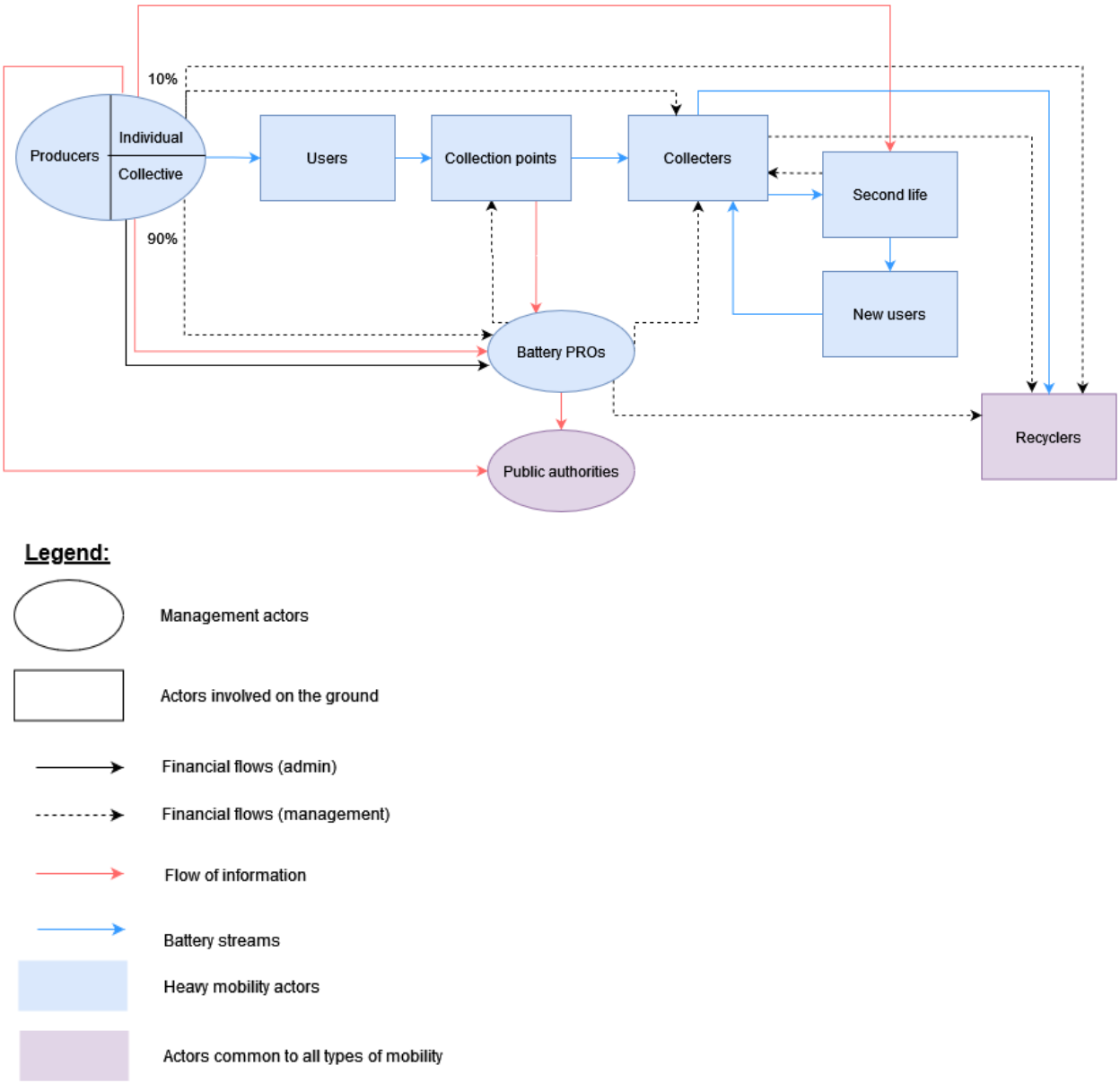


Figure 12 : Heavy mobility battery management in the Netherlands

5.3.4.2. History

Context:

ARN was created in 1995 for the management of ELVs in the Netherlands. Since 2008 ARN has been working together with STICHTING BATTERIJEN (STIBAT) to use the MyBATBASE battery registration system.

Electric vehicle producers had joined ARN for the management of lead acid starter batteries in the past. Increasing sales of Li-ion starter batteries and Li-ion propulsion batteries led them to develop a service via ARN for these batteries as well. ARN has therefore started thinking and researching about the management of mobility batteries since the end of the 2000s.

Past developments

As of 2018, portable battery and accumulator producers are obliged to join STIBAT (adoption of a decision called AVV for Generally Binding Declaration).

In 2021, ARN changed its conditions, so that producers who wish to join ARN must do so in a complete way, i.e., entrust both the administrative and the operational part. It is no longer possible to join ARN only for the administrative part. Several manufacturers (TESLA, RENAULT, VOLVO) have therefore left ARN to develop an individual system because they wish to control the collection and processing of their batteries themselves. The objective of this control is to ensure the arrival of a stream of materials for recycling to enable them to respect the European objectives of the rate of incorporation of recycled materials in new batteries provided for in the draft European regulation on batteries.

In 2021, ARN was also split into two foundations, one for vehicle recycling, STICHTING AUTO RECYCLING, and the other for vehicle battery recycling, STICHTING AUTOBATTERIJ RECYCLING, with the aim of separating the information flows and considering the separate regulations governing these activities.

Perspectives

According to RWS, the obligation to diagnose light mobility batteries for a second life should be introduced in future regulations.

5.3.4.3. Regulatory framework

Status and classification of mobility batteries: Batteries used in light or heavy-duty electric vehicles are industrial batteries[130] .

The batteries collected are considered as waste and are the property of the PRO in charge of their collection.

Since 2019, the Activities Decree and the Environmental Act Decree (Bor) specify that Li-ion batteries are hazardous products according to the following definition: “Substances and articles the carriage of which is prohibited in accordance with the ADR or is permitted only under the conditions laid down therein, or substances, materials and articles designated in the International Maritime Dangerous Goods Code”.

Li-ion batteries are designated with code 20 01 33*, which is stricter than the European waste nomenclature. An export notification procedure is in place for transboundary shipments (authorisation from the competent authorities required to validate the export). Trucks must visually indicate that they are transporting hazardous waste. Facilities that store and manage these batteries must comply with the regulations applicable to hazardous waste.

When a battery is only repaired to be reused for the same purpose, it does not pass through the waste status. Batteries prepared for a second life are no longer waste according to the legal opinions of the Ministry of the Environment granted to several companies active in the sector[131] . The arguments used in these opinions to assert compliance with the European conditions for End of Waste are as follows:

- There is a potential use and demand for second life batteries according to letters of intent from several customers;
- Second life batteries comply with technical requirements, legislation, and standards because:
    - Potential customers ensure compliance with technical requirements;
    - The cells are presumed to comply with the original product regulations and have been tested;
    - Batteries comply with EPR by re-registering via STIBAT. The former producer loses all obligations related to the product and the new producer (the second life operator) is responsible for the product.

[130] Article 1 of the Batteries and Accumulators Management Regulations 2008: https://wetten.overheid.nl/BWBR0024492/2017-01-01

[131] Notices granted to NPP Power Europe, Autobedrijf and Time Shift. https://www.afvalcirculair.nl/onderwerpen/afval/toetsing-afval/

- No environmental or health disadvantages have been identified in comparison to conventional stationary storage. Second life is a form of recycling that exceeds the 50% recycling performance required by the national sector plan for batteries and accumulators.

In the case of exports, the Department of the Environment's legal advice states that the Shipment of Waste Regulations apply if the receiving competent authority considers the batteries to be waste.

Regulation on extended producer responsibility for batteries

The regulation governing the management of batteries and accumulators in the Netherlands is the Batteries and Accumulators Management Regulations 2008.

- EPR scheme
    - **Collective or individual system:**
        - **Portable batteries**: mandatory collective system. Producers of portable and industrial batteries and accumulators≤ 1kg are obliged to join STIBAT and pay their financial contribution (adoption of a decision called AVV for Generally Binding Declaration or Algemeen Verbindend Verklaring) unless they apply for and receive an exemption. This decision aims to reduce free riders in the battery and accumulator EPR scheme. It was decided to include industrial batteries≤ 1 kg as these cannot be distinguished from portable batteries. This text[132] also specifies the rules applicable to the calculation of financial contributions and to the governance of the scheme.
        - **Mobility batteries:** no details
          All individual or collective management plans must be submitted to and approved by the RWS, the Environment Agency. Stakeholders wishing to form an individual or collective plan send a declaration to the RWS specifying the types of batteries they wish to manage. Each individual actor must explain to the RWS how it complies with EPR (collection and treatment structure in place, how the financing of collection and treatment of waste is organised and, for the categories of portable batteries and accumulators, how it complies with the collection and treatment targets). Reporting on the quantities placed on the market, collected and treatment arrangements for these categories must also be made to the RWS for the categories concerned. All these management plans can be found on the RWS website. Control and sanctions are the responsibility of the ILT (Inspectie Leefomgeving en Transport).
    - **Recovery system:**
        - Producers of industrial (including mobility) batteries and accumulators are obliged to take back spent batteries and accumulators from end-users (Article 5.5) and to bear the costs (Article 11).
        - However, there is no obligation for each producer to set up and promote a collection system for industrial batteries and accumulators, unlike for portable and automotive batteries and accumulators (Articles 5.1, 5.2, 5.3, 5.4 and 5.6). In contrast, the Batteries Contribution Agreement stipulates that STIBAT is obliged to offer a collection system to the producers of industrial batteries including > 1kg either from the producer who has taken back the batteries or from a third party designated on request. The management costs are then subsequently charged to STIBAT based on an estimate approved by the producer.
    - **Pay-as-you-sell or pay-as-you-collect:** the regulations do not specify how the payment of financial contributions should work.
    - **Objectives:**
        - The collection targets in the regulation are exclusively for portable batteries and accumulators (45%, as in the battery directive 2006/66/EC). There are no targets for mobility batteries.
        - No specific treatment targets (recycling targets of the EU Directive)
    - There is no specific framework for second life.

- Approval systems: Producers of portable, automotive, and industrial batteries and accumulators must register with the Ministry of Infrastructure and Environment and report the quantities placed on the market annually to the Ministry (Article 12) by category (portable, industrial, automotive) and by technology (nickel cadmium, lead acid, other). Reporting requirements with the same nomenclature exist for collected spent batteries and accumulators.
- Active PROs:
    - STIBAT for portable, industrial, and automotive batteries (including light mobility);

[132] AVV - generally binding declaration portable batteries: https://zoek.officielebekendmakingen.nl/stcrt-2018-59586.html

- ARN for heavy electric mobility batteries.

Regulation on extended producer responsibility for vehicles

The regulatory framework for ELV management is set out in the ELV Management Decree[133] .

- EPR scheme and PRO: all vehicle producers are obliged to join the ARN system (existence of an AVV[134]).
- Specific provisions for batteries:
  - The ELV decree does not include any specific provision for batteries, whether they are automotive (thermal vehicles) or industrial (electric vehicles).
  - It is clarified in the Battery Regulation that the producers of vehicles covered by the ELV Management Decree do not have to bear the costs of managing a battery or accumulator present in an ELV, as the producer of the battery or accumulator must cover the costs (Article 11.3).
- Other provisions:
  - In addition, the ELV Decree stipulates that ELVs may only be handed over to a car dismantling company (ELV centre), a garage or a foreign company if the cross-border transfer is compliant (Article 6). Producers must ensure that a national collection system for ELVs is implemented, and that the handover can be at least free of charge.
  - All ELV centres (affiliated or not) must comply with the applicable regulations, including having a local environmental permit, a permit from the national registration authority to be able to de-register a car.

Regulation on extended producer responsibility for EEE

The regulatory framework for the management of EEE is provided by the EEE Management Regulation[135] . This Regulation also applies to unlicensed electrically powered two-wheeled means of transport for persons or goods, such as scooters and unlicensed electric bikes (see Article 2).

- EPR and PROs: since 2021 all producers must join the OPEN foundation (introduction of a mandatory general declaration AVV for Algemeen Verbindend Verklaring). STICHTING OPEN is made up of six product-based producer associations: STICHTING BRUINGOED, STICHTING LIGHTREC NEDERLAND, STICHTING METALEKTRO RECYCLING, STICHTING VERWIJDERING CENTRALE VENTILATOREN, STICHTING VERWIJDERING ELEKTRISCHE GEREEDSCHAPPEN and STICHTING WITGOED.
- Specific provisions for batteries:
  - This Regulation requires a design that allows for easy separation of integrated batteries and accumulators (Article 17), compliance with best available treatment techniques (including battery dismantling) (Article 11), and registration of producers with the national foundation for the EEE register (Article 18).
  - Producers are responsible for financing the collection and treatment of WEEE from households and professionals (Articles 13 and 14). EPR can be organised collectively or individually.
  - In addition, the Battery Regulation clarifies that the producers of EEE covered by the EEE Management Decree do not have to take responsibility for the end-of-life of batteries and accumulators incorporated into devices, as the producer of the batteries and accumulators must bear the costs (Article 11.2.).

Security

The guidelines for the safe storage and use of hazardous materials in the Netherlands are the PGS (Publicatiereeks Gevaarlijke Stoffen). They specify the risks and the best available techniques to reduce them. They are, as far as the Environmental Act is concerned, an important interpretation of the rules laid down in the Dutch Activities in the Living Environment Decree (Bal) regarding the handling of hazardous substances. In this context, the PGS publications provide guidance to the competent authorities for environmental permitting or the Netherlands Labour Inspectorate (NLA).

[133] Decree on ELV management https://wetten.overheid.nl/BWBR0013707/2018-01-01/
[134] VTA - generally binding declaration for ELVs: https://zoek.officielebekendmakingen.nl/stcrt-2021-20546.html
[135] Regulation on the management of EEA: https://wetten.overheid.nl/BWBR0034782/2020-12-10

Status of the black mass

Black mass is considered hazardous waste.

5.3.4.4. Light mobility battery management

EPR scheme

Description of the system

STICHTING BATTERIJEN (portable batteries) and STICHTING EPAC (electric bikes) are collective extended producer responsibility schemes. They have entrusted STIBAT with the operational management of EPR. The reporting is prepared by STIBAT and formally sent to the RWS via the collective STICHTING BATTERIJEN / EPAC plans.

The establishment of a collection system is mandatory for portable batteries but voluntary for industrial batteries. Producers of industrial batteries must comply with the extended producer responsibility individually and may choose to join a collective system.

STIBAT comprises two organisations:

- STIBAT BATTERIJEN, a collective solution for portable and industrial batteries. On 31 December 2020, 1168 producers were members.
- STICHTING EPAC, a collective solution for electric bike batteries founded in 2015. About 100 producers, representing 80-90% of the electrically assisted bike market and more than 75% of the e-bike market, have decided to join STIBAT. In 2020, this represented 1.6 million e-bike batteries put on the market.

STIBAT covers the obligations of producers of portable, automotive, and industrial batteries. STIBAT is the exclusive PRO for portable and industrial batteries weighing less than 1kg. Other organisations exist for other categories of batteries.
STICHTING EPAC entrusts STIBAT with the collection of bike batteries in a regulated and efficient manner. STIBAT takes care of the collection points, the collection of the bike batteries, the sorting, and the recycling of these batteries. STICHTING EPAC is supervised by an advisory board consisting of the RAI association (automobile and cycle federation) and BOVAG (federation of mobility companies).

There is another collective collection system for e-bike batteries managed by NOWOS, which includes 4 to 6 other producers.

The other producers are free riders who impact the collection system as there is no verification of battery brands at the collection points.

For personal motorised vehicles (scooters, etc.), producers can call on STIBAT (STICHTING Batterijen) for the operational management of personal motorised vehicles batteries, in which case this is invoiced separately as pay-as-you-collect. Some producers are affiliated with[136] but the market shares are not known.

Producer responsibility in the case of fleets of electric bikes and scooters is debated between the companies responsible for fleets (LIME, BIRD, DOTT) and the manufacturers of bikes and scooters, who refer to each other as the producer.

Financing

The STICHTING EPAC EPR fee scale for e-bike batteries is 1 EUR/kg placed on the market (2022).

Type: Pay-as-you-sell

Collection points

The collection points for electric bike batteries are located at waste collection centres or at electric bike retailers and repairers (the network had 1671 points at these professionals in 2020). Collection is in metal drums, separate from portable batteries.
In 2020, STIBAT collected 225 tonnes of electric bike batteries, compared to 251 tonnes in 2019 and 373 tonnes in 2018.
Since 2018, STIBAT has seen a decline in the total number of bike batteries collected. The explanations given are:

[136] List of STIBAT affiliates: https://www.stibat.nl/aangesloten-producenten/

- Better battery life;
- A growing market for the repair of batteries (replacement of defective cells) which extends their life;
- A growing market for reconditioning used batteries. Part of the supply is captured directly by electric bike retailers who buy batteries from owners who are no longer satisfied with their performance, check the performance of the batteries, and can resell them for reconditioning or a second life. There is therefore competition for the collection of batteries from retailers and repair shops.

Safety – special features of mobility batteries

In terms of safety measures, the PGS documents are the reference documents applicable to the Netherlands (see Regulations).

Lithium-ion batteries and accumulators are not formally covered by PGS 15, but are often included (interpretation by the competent authorities).

The measures described in the PGS 15[137] can be divided into three groups:

- Fire safety
- Safety at work
- Environmental safety

The measures concern, among other things, the area in which the packaged substances are stored. For example, the area must be equipped with fire detectors and fire extinguishers. In addition, some substances must be stored separately and out of the way of forklift trucks and other means of transport. Some substances can only be stored in special safety cabinets or with packaging and in isolation from others. Temperature management is also important. The amount of substance packed is also used to determine the applicable safety measures.

Currently, a separate PGS document for batteries and accumulators, PGS 37, is being prepared. It will address the commercial storage of lithium batteries and energy storage systems (ESS). The guidelines and measures of PGS-37 will be largely based on those of GSP 15.

In the summer of 2020, the "Circular on Risk Management for Lithium-Ion Energy Carriers[138] "was presented as a precursor to PGS-37. In this circular, guidance is given to increase safety in the vicinity of lithium-ion systems.

In anticipation of the regulations concerning the storage of lithium batteries, various fire tests were carried out by STIBAT with a new metal drum for bike batteries. Further development and implementation will take place in 2021.

Links with WEEE EPR

STIBAT also collaborates with STICHTING OPEN for the collection of small electrical devices (including mobility devices). STICHTING OPEN is obliged by regulation to remove batteries from collected electronic equipment without compensation from STIBAT.

Treatment

The recycling targets are in line with the targets of the Battery Directive 2006/66/EC.

The batteries collected via STIBAT are currently sent for recycling in their entirety. There is no recycling site in the Netherlands: batteries are mainly sent to Germany, France, and Switzerland.

STIBAT has started a programme to send batteries from electric bikes for second life (pilot phase). The quantities involved are marginal at this stage.

There is a growing interest from STIBAT for second life for stationary home storage but the scheme is less developed than for the recovery of heavy mobility batteries because the preparation for re-use is relatively more costly from smaller capacity batteries. There are no current projects.

5.3.4.5. Heavy mobility battery management

EPR scheme

Description of the system

[137] PGS 15: https://publicatiereeksgevaarlijkestoffen.nl/publicaties/PGS15.html
[138] Circular on risk management for lithium-ion energy carriers: https://www.infomil.nl/onderwerpen/veiligheid/nieuws/circulaire-risicobeheersing-lithium-ion-0/

Producers of industrial (including mobility) batteries and accumulators are obliged to take back spent batteries and accumulators from end-users and to bear the costs, but not to develop and promote a collection system. Producers have the choice between an individual and a collective system.

The main existing collective system is the ARN system which includes cars, light commercial vehicles, trucks, motorbikes[139] . ARN is a non-profit organisation that was founded by RAI (Federation of Automobile and Cycle Industries), BOVAG (Federation of Mobility Companies) and STIBAT. The member companies of RAI contribute financially to ARN. For ELVs, the contribution is a pay-as-you-sell contribution of EUR 25 per vehicle put on the market. For batteries, the rates are listed below.

Li-ion propulsion (industrial) and starter (automotive) batteries are covered by a voluntary scheme. 90% of the producers have joined the ARN collection system for batteries. The following brands participate in the ARN system:

- VW
- AUDI
- SEAT
- SKODA
- PORSCHE
- MAN
- BMW
- MINI
- MERCEDES BENZ, SMART
- FIAT
- JEEP
- CHRYSLER
- LEXUS
- LYNK & CO
- FUSO
- MITSUBISHI
- KIA
- HYUNDAI
- SUZUKI
- FORD
- MAZDA
- HONDA
- SUBARU
- AIXAM
- MG
- MAXUS
- RENAULT TRUCKS
- TOYOTA

TESLA, VOLVO, STELLANTIS and RENAULT have individual systems.

The declaration of batteries is done via the MyBATBASE system through a collaboration with STIBAT. ARN pays STIBAT for this service via a multi-year contract. In addition, ARN has an internal database containing the weights, chemistry, and sizes of the batteries, for operational reasons.

ARN is in discussion with truck manufacturers who have not yet joined the system for their propulsion batteries.

Financing

The system is organised on a pay-as-you-sell basis. This organisation is deplored by the RAI, which represents the manufacturers, because it was suitable when financial flows were limited (lead-acid batteries) but would no longer be suitable for Li-ion batteries because the operational management comes at a cost, thus requiring greater financing but difficult to forecast (uncertainty about future costs). It is not expected that this system will evolve in the near future.

The financial contributions form the same fee scale for the management of lithium-ion propulsion batteries and starter batteries (including VAT) in 2022. They have been reduced by 50% in 2022 because of lower management costs. The fee scale is not subject to eco-modulation.

[139] Scooter Recycling Nederland (SRN) is the Dutch recycling system for mopeds and light mopeds. SRN offers a national network of approved collection points and dismantling companies for mopeds and light mopeds. SRN is a partnership between RAI, BOVAG and ARN.

Weight	Fee scale (EUR/battery placed on the market) – VAT included
≤ 5kg	3 EUR
> 5 kg and ≤ 15 kg (new 48V category)	5 EUR
> 15 kg and ≤ 25 kg	8 EUR
> 25 kg and ≤ 100 kg	25 EUR
> 100 kg and ≤ 350 kg	45 EUR
> 350 kg and ≤ 600 kg	55 EUR
> 600 kg and ≤ 900 kg	65 EUR

Table 22 Scale of EPR fee scale – Heavy Mobility – The Netherlands

The declaration is made via the myBatBase system in collaboration with STIBAT.

Since 2020, ARN has developed a prediction model to estimate the quantities of batteries that will be placed on the market in the future and the quantities of batteries that will need to be managed. This model makes it possible to adapt the management and the amount of financial contributions.

Management of electrical ELVs

All ELV centres are authorised to receive electric and hybrid ELVs. There is no requirement to be equipped or trained in electric battery management. Insurance schemes should encourage electric and hybrid ELVs to go to specialised centres but there is no obligation to date.

Approximately 80% of the ELV centres in the Netherlands are ARN members. Membership of ARN offers several services: financing and organisation of the take-back of certain waste, especially hazardous and negative value waste such as tyres, a traceability system, financing of administrative costs up to EUR 10 per ELV collected, financing of training, etc. ARN also has an agreement with shredders for reporting.

The centres affiliated to ARN must comply with a quality standard called KZD[140] developed since 2001 by ARN and STIBA, the federation representing ELV centres. This standard distinguishes three levels of certification:

- KZD*: compliance with legal regulations and requirements (environmental permits, health, and safety, etc.) that apply to companies in the sector, as well as specific requirements around material recycling. In addition, these companies have a clear and orderly business process. This is the minimum level required for ARN affiliated ELV centres and STIBA members.
- KZD**: in addition, certifies the reliability for the purchase of second-hand parts (quality check, guarantee…).
- KZD***: includes additional requirements for quality management, traceability and requires a quality classification system for used parts.

An audit takes place every 3 years.

There are no particularities applicable to electric ELVs according to ARN, apart from battery management, based on the composition of the vehicles reported in the IDIS database.

Management of used batteries

In 2022, specific devices for battery dismantling will be added to the KZD standard for ELV centres (not yet published at the time of this report)

The end-of-life batteries of ARN's affiliated brands are mainly collected (95%) via vehicle retailers (cars, trucks, motorbikes). Only 5% of the batteries collected come from ELV centres. These are mainly batteries from vehicles that have been involved in accidents, not batteries that have reached the end of their life.

[140] ARN quality standard KZD: https://www.kzd.info/

ELV centres become the owners of the battery contained in the vehicles once the vehicle has become ELV and can decide on their end of life without notifying ARN. ARN would like to see a clearer legal framework to ensure the traceability of batteries in this case and is in discussion with the public authorities on the subject. When the battery is returned alone, the producer is the holder.

Battery collection is organised by ARN on request. ARN has direct contracts with collection, reuse, and recycling companies. If the producer wishes to have their battery sent to another collector or treatment operator than the one selected by ARN, they have the possibility to do so. If the selected operator is more expensive, the producer must pay the difference; if it is cheaper, the collective system benefits from the savings made. ARN can act as an intermediary between importers who are not members of the ARN system and the ELV centre for its affiliated ELV centres. ARN also offers the collection service to garages for their affiliated brand, but they do not use it at the moment.

127 tonnes of Li-ion mobility batteries were collected from ARN affiliated brands in 2021 (propulsion batteries), including from garages. Many more batteries would be collected by ELV centres based on the number of de-registrations of electric vehicles. ARN is currently collecting data on how batteries not reported to ARN are managed: they are sold for use in cars, for stationary use or are stored.

Battery casings are changing from metal to plastic, which will lead to a decrease in the value of batteries.

STIBAT offers a collection service for forklift trucks and motorbikes, on request.

Manufacturers who are not members of ARN can also join RENEOS, a European network for the collection and recycling of batteries from electric and hybrid vehicles.

Safety - special features of mobility batteries

Since 2015, in collaboration with INNOVAM, a training provider for the mobility sector, ARN has developed the training course "Safe dismantling of electric vehicles"[141] which is aimed at car dismantlers (ELV centres) to learn how to dismantle high-voltage batteries in accordance with the NEN 9140 standard. The training is chargeable (EUR 330 excl. VAT per person), but ARN reimburses the training costs of one person per affiliated car dismantling company and partial reimbursement applies for the second and third person. The training includes elements on:

- The use of the international IDIS database with disassembly instructions from manufacturers;
- The risks and safety measures at different levels, such as wearing PPE or securing the battery using the IDIS instructions.

Most of the ELV centres have followed the first training (from 2015) but few have followed the training since it was updated in 2019.

ARN conducted a survey of ELV centres and found that most ELV centres were not well equipped to handle electric vehicles. Therefore, ARN developed a starter kit with the necessary equipment for dismantling electric batteries (including a set of high voltage gloves). This kit is based on the recommendations of the training course for ELV centres version 2019. If ELV centres participate in the 2019 ELV centre training, they receive a preferential price on the starter kit.



Figure 13 : Electric and hybrid ELV management starter kit (Source: ARN)

For lithium-ion batteries, the following UN codes are involved: 3480, 3481 or 3536. Lithium-ion batteries are listed in the ADR in paragraph 2.2.9.1.7. This means that they fall under the definition of dangerous substance in the Activities Decree and the Bor.

[141] Training "Safe dismantling of electric vehicles": https://www.innovam.nl/e-voertuigen/veilig-werken-volgens-nen9140/training-veilig-demonteren-van-e-voertuigen

Li-ion batteries belong to ADR class 9, according to the classification code M4. The Activities Decree specifies the conditions for storage. When storing more than 2,500 kg, a safety distance of 20 metres applies. This distance can be reduced to 8 metres if storage takes place in a fire compartment.

The elements applicable to safety described in the light mobility part also apply to the heavy mobility part. A specific guidance for energy storage systems, especially stationary PGS 37, is currently being consulted[142] . It contains numerous safety measures based on a risk analysis.

Specifically for Li-ion batteries reused in second life, the conditions required are the transfer of the extended producer responsibility, as well as various technical conditions:

- The new producer has access to information on the original energy carrier;
- The new producer will have to use the cells within the parameters defined by the manufacturer including internal resistance ranges, heating and cell spillage must also be considered.
- The new producer uses the original BMS or a comparable BMS and considers the temperature sensors used by the original manufacturer.
- It is strongly recommended that the second user does not re-use other components such as switches and sensors unless the original manufacturer allows it.
- The results of the performance tests are in line with those of the original manufacturer.

Treatment

Recycling

In 2021, 59 tonnes of Li-ion starter and motion power batteries (46%) of ARN's affiliated brands were recycled. Among the batteries managed directly by ARN and coming mainly from ELV centres, the recycling share is higher (at least 60%) because the potential for second life is limited: the batteries must be reusable and the producers accept second life.

The recovery rate of 70% exceeds the recycling target of 50%. ARN verifies the recycling rate of foreign battery recovery facilities to report to the authorities on its compliance with the regulations.

Second life

In 2021, 68 tonnes of Li-ion starter and motion power batteries of ARN's affiliated brands (54%) were given a second life according to ARN, usually for stationary use. Among the batteries managed directly by ARN and mainly from ELV centres, only 40% of the batteries receive a second life because the potential is more limited.
Current second life performance cannot be extrapolated to the future of the scheme, given the small proportion of batteries from end-of-life vehicles collected to date (defective batteries from garages, prototypes). Compared to the current situation, the potential for second life is likely to decrease as the collection of batteries from end-of-life vehicles increases.

The batteries are sold for second life either directly by the dismantling companies or via ARN. If ARN takes care of the resale, the batteries are sold to the highest bidder.

There are three companies preparing stationary electricity storage systems from electric and hybrid vehicles:

- ECARACCU, a company created in 2015 from the car retailer URSEM BARTEN (retailer of the Mitsubishi, Nissan and Hyundai brands in the province of North Holland), dismantles batteries in order to extract and test the cells, which are either marketed on their own or used by partners for stationary energy storage uses at home or in companies, or for portable or mobile uses (ECARPOWER truck storing energy for back-up uses connected or not to the network)
- TIMESHIFT, a start-up founded in 2016 in the province of Gelderland, supplies energy storage systems for domestic energy storage, charging stations and stationary batteries for powering electric trolleybuses, based on dismantled, tested and reassembled electric vehicle cells.
- NPP Power Europe is the 2017 European subsidiary of a large Chinese lead acid, lithium, and solar panel battery manufacturing company with several production sites in Asia. The cells are disassembled, tested, and marketed for stationary systems such as emergency power systems, or to power industrial robots. The control units, wiring and battery casings are recycled. According to ARN, this company does not yet handle batteries in Europe and therefore does not yet cooperate with ARN.

These companies have an environmental permit which ensures traceability of the quantities of batteries managed and the change of ownership.

[142] PGS 37: https://publicatiereeksgevaarlijkestoffen.nl/publicaties/PGS37.html ; https://publicatiereeksgevaarlijkestoffen.nl/publicaties/online/pgs-37-1/2021/0-1-februari-2022#top

In case of second life for stationary use, the industrial battery is no longer concerned by the ARN scheme. The producer (second life operator) can join STIBAT, but only for the administrative part of the EPR. For example, ECARACCU has joined STIBAT, but they must handle the operational management individually.

These companies have a direct relationship with the user customers for whom they offer monitoring and maintenance services (secondment of specially trained staff), which makes it easier for them to take back the waste when it reaches the end of its second life.

RAI is not in favour of stimulating this market given the still limited supply and the difficulties of disassembly. The priority according to the federation is eco-design to facilitate the replacement of batteries in electric vehicles.

Second life is struggling to find a business model for four reasons according to research by RVO (Dutch Government Agency for Enterprise)[143] :

- High labour costs;
- The need to redesign batteries for stationary use;
- The increase in the lifespan of first life batteries (10-15 years), which leads to fears of a decrease in the reusable waste stream in the long term;
- The difficulty of providing a second life guarantee to energy companies consuming second life batteries, when they request it.

[143] RVO on second life: https://www.dnv.nl/Publications/second-life-toepassingen-autobatterijen-216962.

5.3.4.6. Overall assessment

Strengths	Weaknesses
Collection / EPR schemes for electric and hybrid vehicle batteries and electric bikes	EPR costs perceived as too high by producers (pay-as-you-sell)
ARN collective system: a service appreciated by importers who do not wish to manage EPR individually	No scheme for the management of light mobility batteries other than electric bikes
Waste status and responsibilities of actors clarified in case of second life	No recycling facilities in the area
Management of risks associated with batteries through hazardous waste status	Lack of traceability of batteries in ELV centres and of batteries repaired by independent operators
Several actors established in the second life sector	Difficulty in providing a guaranteed lifetime for second life batteries to energy company customers
Controlling exports of Li-ion battery waste via the mandatory export notification procedure (amber-listed hazardous waste)	

Opportunities	Threats
Clarification of the European Regulation (definitions, responsibilities...)	Loss of value of heavy mobility batteries through an expected change in case material from metal to plastic composite
Improved traceability regardless of battery ownership	
Decrease in the cost of recycling batteries, having already led to a decrease in financial contributions for batteries	

5.3.5. Norway

Note: It was not possible to arrange an interview with BATTERIRETUR, the main organisation in charge of battery management for electric vehicles in Norway, as part of the study. Despite exchanges with other actors, some points could not be clarified and therefore remain unclear in the report.

5.3.5.1. Overview

Context	
Population	5.4 million inhabitants
Population density (inhab./km²)	17
Electric and hybrid vehicle registrations per 1000 inhabitants (/yea–) - 2019	18 (Eurostat, 2019)
Market share of registered electric and hybrid vehicles per year (%)	68% (Eurostat, 2019)
Number of electric and hybrid vehicles registered	486,439 (Eurostat, 2019)
Number of registered electric and hybrid vehicles (/1000 inhabitants)	90 (Eurostat, 2019)
Extended producer responsibility	
End-of-life vehicles	PRO: AUTORETUR
Light mobility batteries	PRO: NORSIRK, BATTERIRETUR
Heavy mobility batteries	PRO: BATTERIRETUR HØYENERGI
Other batteries (portable, industrial, automotive)	Other battery PROs: NORSIRK, BATTERIRETUR WEEE PROs: NORSIRK, RENAS, SERVA, ERP and RECIPO
Regulations for mobility batteries	
Collection targets	At least 95% of the total import and production of automotive and industrial batteries. 30% of the total import and production of batteries sold alone ("bulk"). This is the quantity collected in the year in relation to the quantities placed on the market on the previous year.
Treatment objectives	Non-specific, EU recycling efficiency targets of 50% for all batteries excluding acid Pb and NiCd.
Specific collection / safety regulations	ADR regulations
Approval of ELV centres	Yes
Performance	
Collection rate (or quantities collected)	No information.

Recycling rate	Material recycling rate of batteries collected by NORSIRK in 2020[144] : • Li-ion batteries: 65.10 • NiMH batteries: 89.53 AUTORETUR recycling rate: 75%.
Second life rate	AUTORETUR second life rate: 25%.

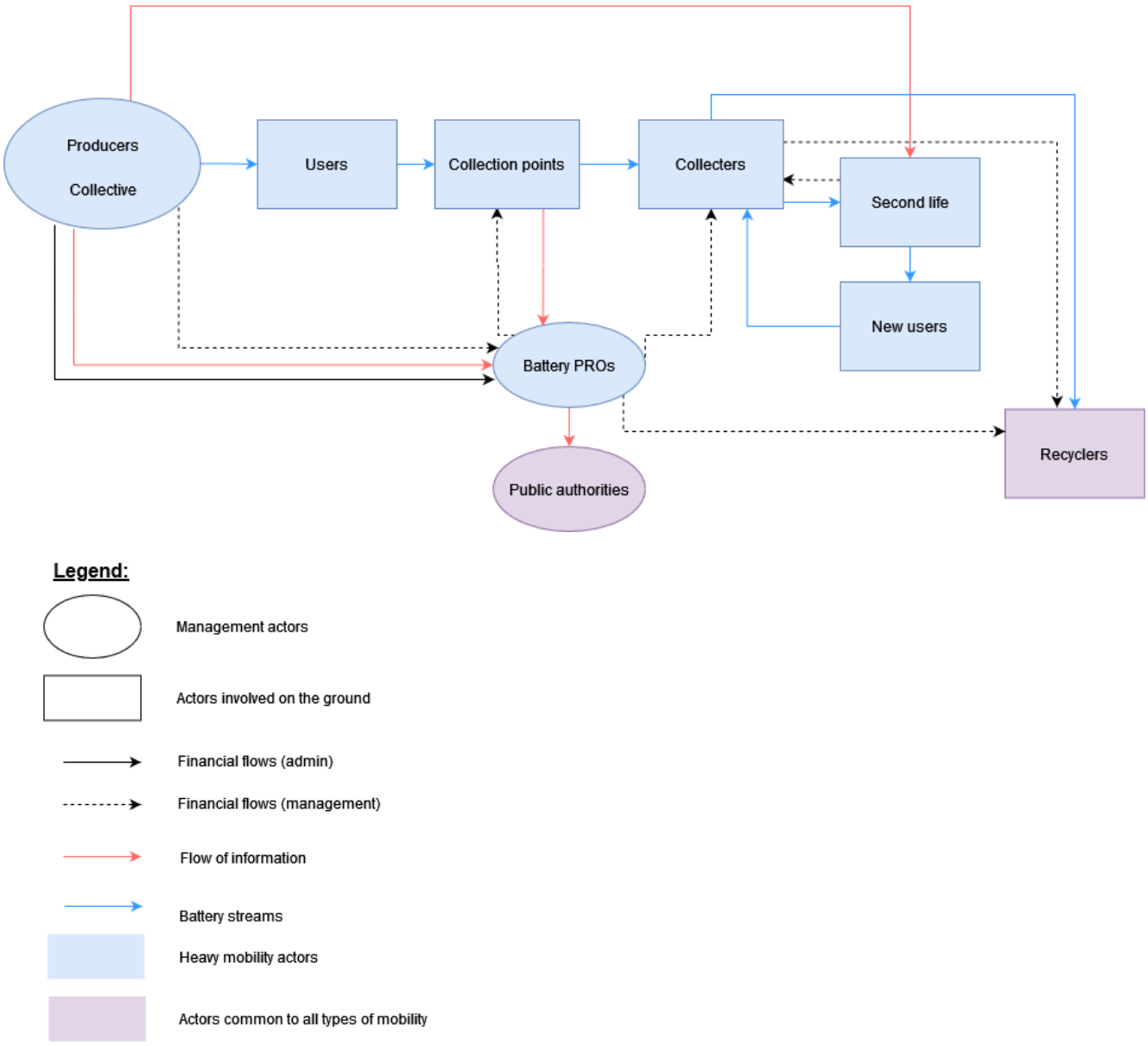


Figure 14 : Heavy mobility battery management in Norway

[144] NORSIRK Ren Verdi annual report 2021

5.3.5.2. History

Context

The regulatory framework for battery management in Norway is based on the Battery Directive 2006/66/EC. In line with the EU Directive, the current regulations in Norway do not distinguish electric mobility batteries from the categories of batteries set out in the Directive.

The Norwegian battery management system preceded the European Directive. Indeed, the PRO BATTERIRETUR (portable, starter and industrial batteries) was created in 1993 on the initiative of the Ministry of Climate and Environment, before the publication of the European text.

Past developments

On the initiative of the automotive industry, BATTERIRETUR established a dedicated branch for electric car batteries in 2014, BATTERIRETUR HØYENERGI. The latter aims to develop methods and expertise for the safe collection and handling of electric vehicle batteries.

Prospects: Norway plans to keep the national regulatory framework consistent with that of the European Union. They therefore plan to comply with the future EU Regulation on batteries and battery waste.

5.3.5.3. Regulatory framework

The Waste Recycling and Treatment Regulations 2004 (Waste Regulations)[145] is the Norwegian legislation governing the collection, recycling, and treatment of all waste, including batteries, end-of-life vehicles, and electrical and electronic products.

Status of mobility batteries

Like the framework applicable in the EU, electric vehicle batteries are considered as industrial batteries in Norway, and the regulatory framework applicable to industrial batteries applies undifferentiated to mobility batteries. Light mobility batteries are classified as portable batteries.

Used Li-ion batteries (main chemistry of electric mobility batteries) are considered as hazardous waste[146] . ADR transport safety rules apply. The handling of these batteries is governed by regulations issued by the Norwegian Directorate for Civil Protection (DSB).[147] The DSB is the national authority for electrical safety and administers regulations for the safe construction and use of electrical installations and equipment. The Directorate is also the national authority for fire safety, with requirements for preventive fire protection and firefighter training.

Regulation on extended producer responsibility for all categories of batteries

The rules for used batteries are set out in Chapter 3 of the Waste Regulation. EPR for batteries is set out in Article 3-7. The Waste Regulation also sets out various obligations relating to the management of waste batteries.

- Specific elements foreseen according to the types of batteries
  - **Individual vs. collective system**: the establishment of a collective system is mandatory (Article 3-7); producers must comply with the extended producer responsibility by joining an approved PRO. However, if the producers of batteries integrated in EEE or ELV are already members of an PRO for WEEE or ELV, then they do not have to join an PRO for batteries. The implementation of this regulatory obligation could not be clarified in the study. There is therefore a mandatory EPR and no possibility of an individual system.
  - **Take-back obligations**
    - **Retailers (Article 3-4 to 3-6)**: retailers are obliged to take back bulk batteries at the point of sale or in a nearby area for the categories of batteries they sell. The take-back obligation applies without any purchase obligation (one for one). The retailer must ensure that the bulk batteries received are separated from other waste and that storage is carried out in a suitable place that is not hazardous to the environment, health, or safety. The retailer also has an obligation to inform consumers about the separation of batteries. These obligations are of little relevance to mobility batteries as they are very rarely sold in bulk.
    - **Of the PRO** (§3-10): each approved PRO must ensure that an adequate collection system is established in the geographical areas of the country where the members'

[145] In Norwegian "Forskrift om gjenvinning og behandling av avfall (avfallsforskriften)". Link: https://lovdata.no/dokument/SF/forskrift/2004-06-01-930

[146] Link: https://www.avfallsdeklarering.no/Avfallskoder ; category 7094 lithium batteries.

[147] Exchange with Ole Thomas Thommesen from the Norwegian Environment Agency.

products are sold or delivered. The system may be limited to the categories of batteries that the members sell. Authorised PROs must ensure the free collection of batteries taken back by retailers.

- **Pay-as-you-sell vs pay-as-you-collect**: nothing is imposed by regulation

- Types of batteries defined in the Waste Regulation:

  - Industrial batteries, including heavy-duty mobility batteries.
  - Bulk batteries (§3-3) which are all batteries that are not included in products but are sold alone. This concept does not fully overlap with the concept of portable batteries (industrial batteries that can be sold alone, portable batteries that can be sold in devices).
  - Portable batteries, corresponds to portable batteries and accumulators of the European Directive 2006/66/EC, but including light mobility batteries.
  - Lead-acid batteries, corresponding to automotive batteries and accumulators in Directive 2006/66/EC.

- Collection, recycling, second life for mobility batteries, and life cycle management targets in the calculation of collection targets:
  - **Collection targets (Article 3-11):** Authorised PROs must collect each year:
    - at least 95% of the industrial batteries marketed by their members;
    - 30% of the portable batteries put on the market in bulk by their members. Once the quantities from WEEE are included, the collection rates achieved are higher.

    The collection rate (for both targets above) is calculated by dividing the weight of all batteries in the same category collected by the registered PRO during the current calendar year by the weight of the total number of members placed on the market in the same category during the previous calendar year. The calculation method is therefore different from the one in force in the European Union.[148]
  - **Treatment targets (Articles 3-12 and 3-17)**: Recycling processes must meet the efficiency targets set out in the Batteries Directive (50% for all batteries excluding acid Pb and NiCd).
    The approved PRO must ensure that all collected batteries are stored and processed in accordance with certain generic safety precautions such as storage in areas with impermeable surfaces and appropriate weatherproof cover or in appropriate containers. Pre-treatment at the recycling plant should at least include the removal of all liquids and acids, if any. Battery processing plants must report annually to the Norwegian Environment Agency on the quantities that have been processed and the recycling rate that has been achieved, and on the end-of-life in other facilities if applicable (Article 3-18). This reporting may be carried out by PROs on behalf of the treatment units.
  - **Second life:** there are no specific targets or regulatory provisions for second life.

- Approval systems:

Applicant PROs are required to obtain approval from the Norwegian Environment Agency (Miljødirektoratet) (Article 3-8). It is possible to apply for approval for all or some categories of batteries.
Authorised PROs must report annually, as a minimum, to the Norwegian Environment Agency. This report shall include data on quantities placed on the market and producers, collection rate, destination of batteries (treatment method, facilities), recycling performance and the basis for calculating financial contributions (Article 3-13).

- Active PROs:

  - Light mobility: NORSIRK, BATTERIRETUR
  - Heavy mobility: BATTERIRETUR HØYENERGI

Regulation on extended producer responsibility for vehicles:

The rules for ELVs are set out in Chapter 3 and Chapter 4 of the Waste Regulation. EPR for ELVs is set out in Article 4-4.

[148] Modality chosen a priori for ease of data availability. The data reported to Eurostat respect the definition of the European collection rate.

- Vehicle producers are obliged to ensure the collection and treatment of ELVs. The obligation must be fulfilled by participating in an approved take-back system (see Articles 4-5 and 4-6).
- **Active PRO**: AUTORETUR
- **Framework for batteries in the regulation:**
    - Article 3-15: Authorised ELV PROs are required to ensure the separation/disassembly of batteries from ELVs.
    - Article 4-7: ELV treatment centres must fulfil the following obligations regarding batteries (Chapter 4, Annex 1):
        - Areas for environmental remediation and preparation for further treatment must be equipped with [...] suitable containers for the storage of batteries (with electrolyte neutralisation on or off-site);
        - Environmental remediation requirements. To reduce possible contaminants during further processing, the [...] battery must be dismantled [...].
    - The reporting obligations (Article 3-13), treatment targets and conditions (§3-12 and §3-17) listed above apply to batteries from ELVs (electric or not).

Regulation on extended producer responsibility for EEE

The rules for WEEE are set out in Chapter 1 and Chapter 3 of the Waste Regulation. EPR for WEEE is set out in Article 1-10. The Waste Regulation also establishes the following obligations.

- **Obligation for producers (Article 1-10):** Producers shall finance the collection, sorting and treatment of WEEE by joining an PRO or via a system individually approved by the Norwegian Environment Agency. The obligation to join an approved PRO applies to producers of both components and stand-alone equipment that are EEE. If the components are used in the production of new EEE, membership is only required for new EEE.
- **PROs:** NORSIRK, RENAS, SERVA, ERP, RECIPO.
- **Framework for batteries in the regulation:**
    - (Article 1-22) Obligations for operators [149]
        - WEEE should be recovered, preferably by preparing it for re-use or recycling, unless this is justified based on a balance between environmental, resource and economic considerations.
        - In the treatment of WEEE, except for preparation for reuse, batteries should be separated manually as a first step in the treatment process (together with other components).
        - (Article 1-23) Obligation to keep accounts and declare:
            - Repairers/handlers who have a permit under the Pollution Control Act and who are the first to handle WEEE or who export WEEE must keep annual accounts. The accounts must include separate treatment and treatment in other facilities until the WEEE has been finally recycled or has undergone final treatment.
            - The accounts should show various data, including the quantity of WEEE processed, including WEEE prepared for reuse, divided into product groups with sub-groups and further divided into treatment method and country.
    - Obligations for approved WEEE PROs:
        - (§3-15): Authorised WEEE PROs are required to ensure the separation/disassembly of batteries.
        - The reporting obligations (Article 3-13), treatment targets and conditions (Articles 3-12 and 3-17) also apply to WEEE registered PROs.

5.3.5.4. Light mobility battery management

EPR scheme

Light mobility batteries fall within the scope of the EPR for batteries. This EPR is mandatory. The two PROs active in the management of light mobility batteries are

- BATTERIRETUR;
- NORSIRK.

[149] In Norwegian "behandlere": Any company that handles WEEE, including preparation for reuse.

Description of the system

Light mobility batteries are collected from retailers selling the same products (electrically assisted bikes, electric scooters, etc.) and from municipal civic amenity sites. Collection is free for the holder. These actors collect separate portable batteries and batteries that are part of a WEEE in different containers.

Secondly, those responsible for the collection points can call on:

- To a specialist waste collection company who will send the batteries either:
  - To STENA RECYCLING (Swedish company for collection and treatment of WEEE and batteries) for all types of batteries collected selectively for NORS'RK's partner collection points;
  - To the facilities of the WEEE PROs for batteries integrated into WEEE.
- To a WEEE PRO that will take care of the transport, dismantling, sorting, and sending to recycling; this option is only available to BATTERIRETUR members.
- Directly to STENA RECYCLING who transports the batteries to their sorting facility where the batteries included in the WEEE are first dismantled, sorted by chemistry and then exported to other European countries for recycling; this option is available for NORSIRK members.

Financing

At NORSIRK, the financing system for light mobility batteries is a "pay-as-you-sell" system. The EPR fee aims to cover the cost of collection and recycling.

The rates applied are confidential as the scheme is in a competitive market.

Collection points

No information on the number of collection points in the area.

Safety - special features of light mobility batteries

Containers used at collection points

The containers used for collection and transport depend on the collection actor chosen:

- If the collection point is a member of NORSIRK, it can choose between two different UN 38.3 approved containers. The small red container (Figure 15) is usually used for handing in batteries by the holders behind the counter (with control of the input). The large purple container is often placed at battery retailers, waste disposal companies and municipalities.



Figure 15 : Collection containers used by NORSIRK member collection points

- If the battery waste is taken care of by a waste management company, they have their own collection solution.

Procedures at collection level

NORSIRK follows the ADR regulations and uses them as guidelines for storage. STENA RECYCLING has many internal systems to manage potential fire risks.

In addition, there is no mandatory training to deal with hazardous battery waste.

Links with WEEE EPR

As NORSIRK is also the PRO for EPR WEEE, the batteries included in the WEEE collected by STENA RECYCLING for NORSIRK members are separated and processed without collaboration with another actor.

BATTERIRETUR collaborates with the WEEE PRO RENAS.

Treatment

Currently, there are no companies involved in the recycling of light duty batteries in Norway. Batteries are mainly exported to Germany by ACCUREC or to France by EURODIEUZE INDUSTRIE.

For NORSIRK, it is their partner STENA RECYCLING that interacts and negotiates with the recycling companies.

However, since May 2022, the Norwegian company HYDROVOLT has been recycling batteries from electric vehicles, in partnership with BATTERIRETUR. Although HYDROVOLT targets the recycling of vehicle batteries, the company plans to eventually capture other categories of batteries (batteries from electric ferries, grid energy storage systems, etc.).)[150] . It is unclear whether the facility will accept light mobility batteries, as these have not been explicitly targeted.

There are some second life projects for the same purpose

- The BATTKOMP project (formerly called YEDLIK)[151] is a company with a light mobility battery repair workshop whose repairs typically include swapping cables, replacing connectors, replacing battery management systems, repairing broken connections, and rebuilding packs. In addition, they offer spare parts not available from manufacturers. Recently, they have entered partnerships with electric scooter companies (e.g., LIME, also present in France) or electric bike companies to develop the second life of these batteries.
- Various electric bike repair companies that collect batteries and try to repair them.

5.3.5.5. Heavy mobility battery management

EPR scheme

Heavy mobility batteries fall within the scope of EPR for batteries. This EPR is mandatory. The PRO active in the management of heavy mobility batteries is BATTERIRETUR HØYENERGI.

Description of the system

Electric or hybrid vehicles and their batteries can be collected through two schemes:

- Via the network of repairers and car dealers.
- The ELV centres, members of AUTORETUR, receive the electric ELVs with their batteries. They ensure the removal of the battery. The batteries are removed from the ELVs, analysed and:
    - If they have economic value, then the ELV centres can resell them for second life.
    - If they have no economic value, then the ELV centres call BATTERIRETUR HØYENERGI to collect them and send them for recycling.

Financing

The financing method is a "pay-as-you-sell" system where battery producers pay an EPR fee to BATTERIRETUR HØYENERGI when they put batteries on the market.

No information on the fee scales applied as this is confidential data.

Management of used batteries

NORSIRK is competent for the management of heavy mobility batteries. In practice, however, the PRO does not collect these batteries because BATTERIREUR HØYENERGI is 100% positioned on the market via repairers, car dealers and its collaboration with AUTORETUR.

[150] Source: Hydrovolt - Link: https://hydrovolt.com/
[151] https://www.yedlik.no/

In 2018, BATTERIRETUR collected 1,000 batteries from electric vehicles, a significant proportion of which came from vehicles damaged in collisions. Of these 1,000 batteries collected; 80% were recycled, while 20% were reconditioned[152] .

Battery management in used vehicles

In 2021, 1,200 electric/hybrid vehicles were delivered to ELV centres out of a total of 130,000 vehicles dismantled per year. ELV centres reported 1,010 heavy mobility batteries, of which 896 were reported for reuse (second life) and 114 for material recycling.

Safety - special features of mobility batteries

Procedures for collectors

BATTERIRETUR has developed manuals for collectors for handling different types of batteries.

In addition, BATTERIRETUR offers collectors various materials to facilitate and secure the sorting and packaging of used batteries[153] :

- UN-approved cardboard box for packaging used lithium / lithium-ion batteries. The outer dimensions of the box are 58 x 37 x 44 cm (W x D x H). The box can support a maximum of 70 kg.
- UN approved drums with belt lids for small batteries can be purchased from BATTERIRETUR. The drums have a capacity of 220 and 120 litres.
- Replacement caps for acid-filled batteries, with different sizes.
- Pallet caps: the pallet cap is shrunk around the stacked pallets, securing them during transport.
- Wedges (cardboard discs) used between the layers of batteries, to avoid short circuits when stacking the batteries on the pallets.
- Vermiculite, a mineral that absorbs shocks, has good insulating capacity, conducts heat poorly and absorbs liquids.
- The sorting posters can be hung above the different barrels to make sorting easier. The posters illustrate the different types of batteries, what they can be labelled with and what their UN number, EAL code and waste number are.
- Stickers to be attached to drums containing small batteries before they are sent to BATTERIRETUR. They are designed for the different types of batteries and bear the corresponding UN number, EAL code and waste number. The weight and date must be applied to the drum by the waste collector / owner.

Procedures at the level of diagnostic centres or other actors involved

No information.

Procedures at the level of ELV centres

ELV centres that receive ELVs with electric batteries have an approved system for the method of dismantling these batteries. Indeed, most ELV centres have staff who have undergone approved training in the handling of electric/hybrid cars with electric batteries.

This training is mandatory for handling electric batteries. The training focuses on how to remove an undamaged battery from an electric car. The training does not include the handling of batteries from crashed vehicles or if the condition of the battery is unknown. For this type of battery, there are currently no regulations or procedures on how to handle this situation.

Procedures for fire and rescue services

The Norwegian Directorate for Civil Protection (DSB) published guidelines for fire and rescue services on risk assessment and fire treatment of lithium-ion batteries in November 2021[154] .

Treatment

Until recently, heavy duty batteries were mainly exported to Germany by ACCUREC or to France by EURODIEUZE INDUSTRIE.

[152] Nordic Council of Ministers (2019), Mapping of lithium-ion batteries for vehicles: A study of their fate in the Nordic countries
[153] Source - link : https://batteriretur.no/en/hjelpemidler/
[154] https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/risk-assessment-and-handling-of-fire-in-lithium-ion-batteries/

Norway has launched the largest Li-ion battery recycling facility in Europe. Since May 2022, the Norwegian company HYDROVOLT has been recycling lithium-ion batteries from electric vehicles and marine applications. The company is in collaboration with BATTERIRETUR. This is a joint venture between the aluminium company HYDRO and the Swedish battery producer NORTHVOLT. The company is located at the BATTERIRETUR site[155] . The processing capacity amounts to 12,000 tonnes of batteries per year, which would be equivalent to 25,000 electric vehicle batteries[156] . HYDROVOLT claims to be able to recover 95% of the materials used in an electric vehicle battery. By 2025, the company estimates that it will produce more than 2,000 tonnes of black mass per year. The black mass will be sent to NORTHVOLT for further recycling. A unit with hydro-metallurgical treatment to recycle black mass is being built at NORTHVOLT's REVOLT ETT recycling plant in Skellefteå, Sweden[157]. It will be operational in 2023. Furthermore, HYDROVOLT's ambition is to open to the European market and to reach a capacity of 70,000 tonnes of batteries by 2025, and 300,000 tonnes by 2030.[158]

In addition, in 2022, Li-Cycle, Morrow Batteries, and ECO STOR have formed a joint venture to establish a battery recycling facility in southern Norway, in collaboration with BATTERIRETUR. The recycling facility will have the capacity to process up to 10,000 tonnes of lithium-ion batteries per year, including battery manufacturing waste, electric vehicle batteries and other energy storage systems. The facility is expected to be operational in early 2023[159] .

Processing rate of heavy mobility batteries[160] :

- 75% are sent for recycling (with a loss rate of 20%, recovered as energy)[161]
- 25% reuse (mainly as a stationary battery)

At present, many batteries from heavy mobility go through the second life cycle. A few start-ups have developed, and reuse used electric vehicle batteries to create energy storage systems (stationary batteries): ECO STOR[162] (NISSAN Leaf battery), EYVON, HAGAL[163] , CHAINPRO ENERGY[164] , EATON[165] (Nissan battery). Car manufacturers are involved in these projects, providing access to information to prepare batteries for reuse.

[155] Source - BATTERIRETUR link: https://batteriretur.no/fremtiden-er-elektrisk/
[156] Source - HYDROVOLT link: https://hydrovolt.com/recycling/
[157] Source - link : https://elbil.no/i-dag-starter-gjenvinningen-av-elbilbatterier-i-fredrikstad/
[158] Information on the HYDROVOLT project: https://electrek.co/2022/05/16/largest-eu-battery-recycling-plant-comes-online-enough-for-all-of-norways-batteries/
[159] https://www.morrowbatteries.com/post/morrow-batteries-li-cycle-and-eco-stor-forms-a-jv-to-build-a-lithium-ion-battery-recycling-facility
[160] Source: exchange with AUTORETUR.
[161] AUTORETUR indicates a reuse rate of 25%, an energy recovery rate for batteries of 15% and a recycling rate of 60%, since energy recovery of batteries is prohibited in Norway, this rate is likely to correspond to the non-recyclable fractions of the post-shredding (paper and plastics). To allow a more adequate comparison with the other countries studied, we indicate a recycling rate of 80% with a loss rate of 20%.
[162] http://www.eco-stor.com/
[163] https://hagal.com/
[164] https://chainpro.no/
[165] https://www.eaton.com

5.3.5.6. Overall assessment

Strengths	Weaknesses
• Multiple actors active in the second life of the heavy mobility battery. • Opening of a battery recycling plant in Norway in 2022.	• Limited collaboration: as this is a competitive market, NORSIRK and BATTERIRETUR cannot collaborate on an awareness/communication campaign aimed at consumers and increase the collection rate of light mobility batteries. • Incomplete monitoring of the scheme data: those responsible for the collection points for light mobility batteries may contact a waste management company directly, which in turn may deliver these battery wastes to actors not approved by the EPR scheme. This implies that a proportion of batteries is processed outside the official scheme and therefore, for these waste streams, the quantities processed and the outlets are not known. • The organisation of the scheme is not fully regulated, which generates "grey areas" that can lead to situations as described in the previous point. • When the batteries have a positive economic value, the ELV centres can use them economically and make a profit. If the batteries have no economic value, the ELV centres must call on BATTERIRETUR, which must bear the costs of transport and recycling. This creates an imbalance between the ELV centres, which retain the gains in favourable situations, and the producers, who suffer the costs without recovering the gains.
Opportunities	**Threats**
• New Norwegian legislation that will clarify certain points for second life.	-

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ABBREVIATIONS AND ACRONYMS

ADEME	French Agency for Ecological Transition
WEEE	Waste Electrical and Electronic Equipment
PRO	Producer Responsibility Organisation
PBA	Portable Batteries and Accumulators
EV	Electric Vehicles including passenger cars and light commercial vehicles (LCVs)
HEV	Hybrid and Electric Vehicles
ELV	End of life vehicle

ADEME IN BRIEF

At ADEME - the French Agency for Ecological Transition - we are firmly committed to the fight against global warming and degradation of natural resources.

On all fronts, we are mobilising citizens, economic actors and regions, giving them the means to move towards a resource-efficient, low-carbon, fairer and more harmonious society.

In all areas - energy, circular economy, food, mobility, air quality, adaptation to climate change, soil, etc. - we advise, facilitate, and help finance many projects, from research to sharing solutions.

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EXPERTISES

EUROPEAN BENCHMARK OF THE BATTERIES AND ACCUMULATORS EPR SCHEME

The Batteries and Accumulators (BA) Extended Producer Responsibility (EPR) scheme is one of the first European EPR schemes, established in Europe in 1991. Several Member States have fulfilled the targets set by the Directive 2006/66/EC on batteries and accumulators, and waste batteries and accumulators. The new European Battery Regulation currently being negotiated between the European Commission, Parliament, and European Council, which repeals the latter, is about to set new ambitious targets, particularly in terms of collection rates and management of mobility batteries.

ADEME commissioned RDC Environment to conduct a benchmark concerning the management of this scheme in the various Member States of the European Union, focusing on two points:

- The methods for calculating the average unit weights of portable batteries and accumulators, which influence the calculation of the EU collection rate.
- The management of batteries used for light and heavy electric mobility.

After an appropriation of the French scheme and a transversal analysis of the two themes studied in different European Member States, recommendations were proposed for the French scheme.

Direction de la supervision des filières REP

Responsabilité élargie du producteur

The study provides recommendations for the development of a harmonised reference system of average unit weights at a French level.

The study describes the functioning of the light and heavy mobility management schemes in several Member States and identifies the key issues for the construction of a regulatory framework and a management scheme in France.