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Joint Research Centre

# JRC technical assessment in relation to Article 71(5) of the Batteries Regulation

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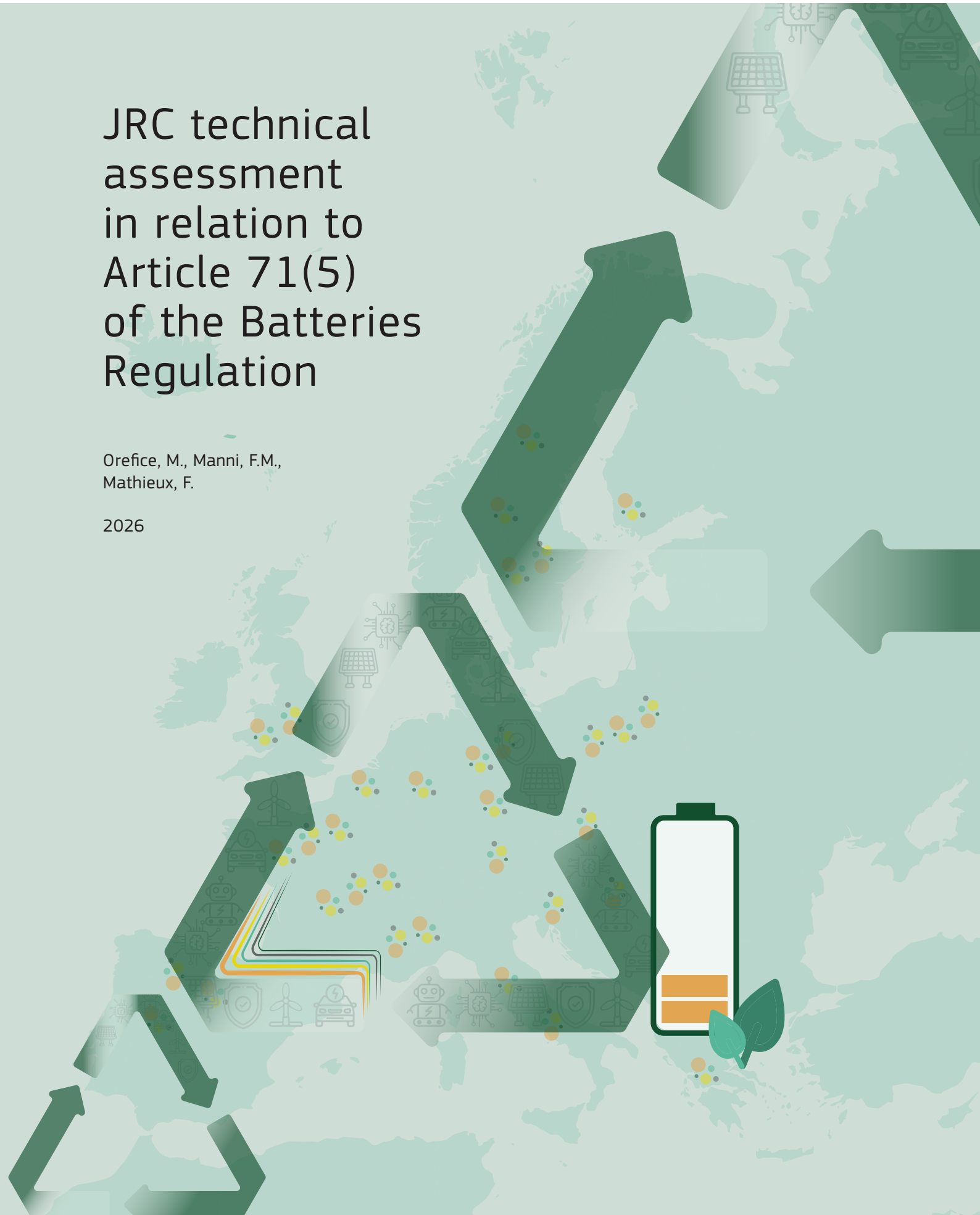

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## Contents

## Abstract

The Joint Research Centre (JRC) had been tasked by the Directorate-General of the Environment with the assessment of recycling efficiency (RE) and recovery of materials (RM) targets for waste batteries, in line with Article 71(5) of Regulation (EU) 2023/1542. The focus is on lithium-based batteries due to their more recent market development and the fast evolving technologies characterizing these batteries. Stakeholder feedback was collected and a JRC internal analysis was conducted to evaluate if it is appropriate to revise the targets in Part B and Part C of Annex XII of Regulation (EU) 2023/1542. Although challenging, the targets for RE and RM are supported by a flexible calculation methodology, allowing recyclers to exclude certain fractions temporarily. The assessment revealed no immediate need to amend any of the existing targets, as the existing requirements provide recyclers the necessary flexibility. However, monitoring scientific and technical progress resulted as crucial, especially regarding the recovery of fractions not currently recovered (e.g. graphite) or not yet fully implemented at industrial scale (e.g. lithium). The report suggests maintaining current targets to encourage industry innovation without prematurely altering investment strategies. The JRC emphasizes the importance of continued stakeholder engagement and data collection to ensure a sustainable and competitive battery recycling industry in the EU.

## Foreword

This report is the final Deliverable 7.2 “JRC technical assessment in relation to Article 71(5) of the Batteries Regulation (EU) 2023/1542” of the Administrative Agreement (AA) number “JRC N° AA Contract 36075 – 2020 ENV N° 090202/2021/855950/ENV.B.3” between DG ENVIRONMENT and JRC entitled “Support for the new Batteries Regulatory Framework”.

## Acknowledgements

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## Executive Summary

### *Policy Context*

The report supports the implementation of the Regulation (EU) 2023/1542 on batteries and waste batteries (or in brief "Batteries Regulation"), specifically addressing **Article 71(5)** concerning the **assessment of the targets** for the recycling efficiency and recovery of materials of waste batteries as set in the Annex XII, Parts B and C of the same regulation. It is conducted for the Directorate–General for the Environment (DG ENV) that has to assess by 18 August 2026 whether, due to market developments, in particular concerning battery technologies impacting the type of materials recovered and the existing and forecasted availability of cobalt, copper, lead, lithium or nickel or the lack thereof, and in view of technical and scientific progress, it is appropriate to revise the targets for recycling efficiency and recovery of materials from waste batteries.

The Batteries Regulation is the first product policy built on a comprehensive life-cycle perspective of the product itself, i.e. the battery, from material extraction to end-of-life management, including second life strategies. Targets for the recycling of waste batteries and recovery of their materials are defined in Article 71 and specified in Annex XII of the Batteries Regulation: the targets are ambitious and increasing over time, encouraging industry to pursue **competitiveness and innovations** with a view to support a more circular economy and to especially increase the availability of critical raw materials to the economy. In particular, the first targets for the recycling efficiency of waste PbA, Li-based, NiCd and other batteries had to be achieved by 31 December 2025 and will increase by 31 December 2030. Likewise, the targets for the recovery of materials cobalt, copper, lead, lithium and nickel will have to be achieved by 31 December 2027 and will increase by 31 December 2031. On 4 July 2025, the methodology for calculation and verification of the rates for recycling efficiency and recovery of materials was published in the Official Journal as Delegated Regulation (EU) 2025/606. This methodology provided a balance between ambition and flexibility to achieve the required level playing field for recyclers. Nonetheless, the calculation methodology in the (EU) 2025/606 is not in scope of this report, which is related to Article 71(5), and neither is in scope the introduction of new targets adding to those of Annex XII Part B and C, as the latter relates to Article 71(6).

Finally, batteries and their raw materials have been indicated in the ResourceEU Action Plan, published on December 3, 2025, as one of the value chains of attention for the EU. These value chains would, hence, require rapid actions for a boost as they might significantly contribute to the objectives of competitiveness, green and digital transitions (COM 945, 2025). Making sure that waste batteries can be properly recycled in the EU is part of the possible actions for the boost.

### *Main findings*

The work presented in this report led to the following main findings.

**Engagement of stakeholders** mainly came from the **Li-based battery** industry. This might be related to the fact that one of novelties of the Batteries Regulation and its secondary legislation is that Li-based batteries are defined as a new chemistry category in scope of batteries recycling, compared to the repealed Battery Directive 2006/66/EC. Also, the Li-based battery industry is very expanding and innovating in these years as the green and digital transitions are largely founded on these batteries. At the same time, in the stakeholders' consultation of January 2026, **the JRC**

particularly **invited experts of batteries different than lithium-based (Li-based)**, i.e. lead acid (PbA), nickel cadmium (NiCd) and 'others', to intervene and express their consensus with or rejection of the JRC findings and suggestions.

Furthermore**, under the umbrella of "Li-based chemistry", batteries of different recyclability** due to their composition, size and functionality (non-rechargeable and rechargeable) are grouped together. This different recyclability represents a concern for several stakeholders as emerged from the data collection carried out in the scope of this work. At the same time, the JRC, as well as DG ENV, were aware of this different recyclability already when drafting the methodology in the (EU) 2025/606 that, hence, provided the right level of flexibility facilitating the use of harmonised calculation and verification rules for the rates of the recycling efficiency and recovery of materials across all Li-based battery types.

In response to the challenges of recycling Li-based batteries and recovering lithium, the stakeholders did **not** provide **numerical suggestions** for the revision of the targets and seemed to suggest more to disaggregate the targets for Li-based batteries, looking for instance separately at lithium nickel manganese cobalt oxide (NMC) and lithium iron phosphate (LFP) batteries, rather than lowering the overall target for the recycling efficiency of Li-based batteries. However, this has not been evaluated in depth in this report, as it relates to Article 71(6) of the Batteries Regulation and is outside the scope of this assessment, which is limited to Article 71(5).

In general, stakeholders also expressly considered the assessment **exercise premature**, highlighting the gap between the timeline of this assessment of the targets and the timeline for reporting data from recyclers to competent authorities first, by mid-2027, and then from Member States to the Commission, by mid-2028 (as per Articles 75(7) and 76(1) of the Batteries Regulation).

JRC complemented the lack of quantitative data from stakeholders by carrying out a **modelling analysis based on the internal dataset**. The analysis showed that temporary exclusions of specific fractions in calculations, as permitted by the Delegated Regulation (EU) 2025/606, allow recyclers to meet the current targets. Analysis of the targets for the recovery of lithium showed that increasing targets may not significantly impact EU supply, given current treatment capacities in the Union.

***Key Suggestions***

The final suggestion outlined from this assessment exercise is that there is **no immediate need to amend any of the recycling efficiency and recovery of material targets** for batteries, including Li-based batteries, as the existing calculation methodology adopted with the Delegated Regulation (EU) 2025/606 provides enough flexibility to recyclers to adjust their calculations according to their input and reach the targets, in a technologically agnostic approach. The assumptions behind existing measures are confirmed, with no new problems identified that would justify an amendment of the targets provided in Regulation (EU) 2023/1542. Amendments may delay the industry investment strategies for no significant positive effects. Future monitoring is advised to assess scientific progress and market developments, as it is also foreseen in Article 71(5), which requires the Commission to assess the targets at least every five years after the first assessment.

According to the JRC, the policy options should include maintaining current targets, **monitoring scientific advancements, and supporting industry adaptation**. In fact, the topic remains of

high interest, as achieving these targets impacts the EU's strategic autonomy and circular economy objectives. The report outcomes added value by proposing monitoring of scientific progress, relevant to upcoming policy reviews, including those under the Clean Industrial Deal and the RESourcEU.

### *Related and future JRC work*

The JRC has a long-standing involvement in supporting the implementation of the Batteries Regulation along the life-cycle of the battery[1]. The work on the assessment of the targets for recycling particularly relates to:

- The technical suggestions for harmonised calculation and verification rules for the recycling efficiency and recovery of materials (Orefice et al., 2024) that were considered in the development of the Delegated Regulation (EU) 2025/606.
- The technical suggestions for calculation and verification rules of recycled content in batteries (work under publication) that will support the development of the related Delegated Regulation as per Article 8 of the (EU) 2023/1542.
- The study on Deep dive on Critical raw-material in batteries, to investigate the raw materials that are most strategic for battery production (Bobba et al., 2025).

The JRC will continue **monitoring battery recycling innovations** and market developments, especially **in the EU**, by keeping the interaction with stakeholders via data collection, bilateral and large consultation, and plant visits. This JRC knowledge might also contribute to the assessment of criticality of raw materials.

The ultimate objective is to **provide technical support for future policy assessments** related to Article 71(5) as well as other articles of the Batteries Regulation, including Article 71(4) on the methodology and Article 71(6) on adding further materials with specific targets for recovery of material or adding further battery chemistries with specific targets for recycling efficiency.

### *Quick Guide*

This report addresses the assessment of the targets for recycling efficiency and recovery of materials for all batteries, as set in Article 71 and Annex XII Part B and C of the Batteries Regulation (EU) 2023/1542. The JRC's approach involved a stakeholder consultation through a survey, launched in September 2025 to gather their feedback on the levels of the abovementioned targets. In parallel it was performed an internal modelling for a quantitative evaluation of the expected battery waste and battery materials flows in the EU market in the future. The draft results from the analysis had then been divulgated and discussed with Member States (MS), non-governmental organizations (NGO) and industrial stakeholders during a consultation carried out in January 2026. After the consultation, the additional feedback relevant to the work had been implemented to this final document. The whole process emphasizes continuous and ongoing monitoring, from the JRC, of the battery recycling industry to inform future policy decisions.

[1] JRC science-for-policy reports in support of the implementation of the Batteries Regulation available at. RMIS - JRC support to EU Batteries Regulation

In **Chapter 1**, an introduction of the work is given and structured in: 1.1 policy and technological contexts that led to the assessment exercise; 1.2 the structure of the project, which was built on the basis of the project carried out in (Orefice et al., 2024); 1.3 the methodology deployed for the study and divided in direct data collection from the stakeholders via EU survey and JRC modelling analysis based on an internal dataset.

**Chapter 2** presents the results of the **data collection via EU survey**, providing first a statistic overview of the results in terms of participation of EU and non-EU organisations, Li-based and different battery chemistries and also in terms of planned investments and expansions per plant capacities, treated chemistries or carried out operations. The survey supporting the data collection actually explored also topics that fall, at least in part, out of the scope of Article 71(5) (being rather in scope of the Article 71(6) or a feedback to the JRC report 137139), but Chapter 2 analysed in detail only the two questions closely inherent to the feasibility and implementability of the targets as per requirement of Article 71(5). For each of the two questions, first the stakeholders' responses and then the JRC analysis of the same responses are reported. A blank copy of the survey distributed via EU survey is also reported in **Annex 1**.

**Chapter 3** develops the modelling analysis that the JRC built using the internal dataset and to compensate, as much as possible, the lack of quantitative suggestions in the collected data. Following the stakeholders' responses, the analysis of the recycling efficiency targets focused on Li-based batteries and the analysis of the recovery of material targets focused on lithium. In both cases, the research question was introduced and followed by the specific analysis of the methodology and of the results. The research questions focused on the heterogeneity of Li-based batteries and how this relates to the single recycling efficiency target for all Li-based batteries as well as on the expected supply of secondary lithium from the recycling of waste batteries.

Finally, **Chapter 4** provides the JRC final suggestions to the requirements of Article 71(5) on the assessment of the targets for recycling efficiency and recovery of materials for all batteries, in the context of EU policy ambitions also related to the availability of critical raw materials and industry competitiveness and closes with outlooks for future research work.

# 1. Introduction

## 1.1. Context

Batteries, and in particular Li-based ones, are a key technology to enable the green and digital transition as highlighted by different policy files, studies and communications (COM 640, 2019; EU 1542, 2023). The ResourceEU Action Plan, published on December 3, 2025, includes batteries and their raw materials among the value chains that require immediate focus for a boost of the EU industry to support the objectives of competitiveness, green and digital transitions (COM 945, 2025).

Two international associations, BEPA (Battery European Partnership Association) and Recharge (the Europe's industry association for advanced rechargeable and lithium batteries) published at the end of October 2025 a "Battery Deal for Europe" (BEPA and RECHARGE, 2025). The document has the objective of presenting a holistic approach to reinforce and boost the battery value chain in the EU building on four pillar actions of innovate, produce, buy and secure in Europe. Recycling and circularity of batteries and their materials are indicated in all the four pillars as a significant tool to implement the objectives of the deal. As Europe faces a scarcity of primary raw materials and a dependency from third countries(Carrara et al., 2023), the EU considers to support strategic autonomy also through the recycling of 'domestic' waste streams (COM 945, 2025; EU 1542, 2023). This is particularly true for waste batteries and raw materials for newly manufactured batteries (Bobba et al., 2025; EC-JRC, 2025). Circular economy, hence including recycling, has been mentioned in the Draghi Report (Draghi, 2024) as an essential driver of the EU competitiveness, while Prof. Draghi also indicated in the same document the key role of sustainable and competitive batteries for the automotive sector, "a longstanding pillar of the EU industry (Draghi, 2024).

The Regulation (EU) 2023/1542 on batteries and waste batteries introduced, in its Annex XII Part (B) and Part (C), new targets for the recycling efficiency (RE) of all batteries and for the recovery of cobalt, copper, lithium, nickel and lead. An overview of the targets and the year of their entry-into-force is given in Table 1.

**Table 1.** Overview of the targets for the recycling efficiency (RE) of all batteries and for the recovery of materials (RM) as set in Annex XII Part (B) and Part (C) of the Batteries Regulation, (EU) 2023/1542.

| **Annex XII, Part B Targets for recycling efficiency (RE)** | **RE** | **By 2025** | **RE** | **By 2030** |
|---|---|---|---|---|
| | PbA batteries | RE = 75% | PbA batteries | RE = 80% |
| | Li-based | RE = 65% | Li-based | 70% |
| | NiCd | RE = 80% | NiCd | RE = 80% |
| | Others | RE = 50% | Others | RE = 50% |
| **Annex XII, Part C Targets for recovery of materials (RMs)** | **RM** | **By 2027** | **RM** | **By 2031** |
| | Pb | 90% | Pb | 95% |
| | Co/Cu/Li/Ni | RM = 90%, 90%, 50% and 90% | Co/Cu/Li/Ni | 95%, 95%, 80% and 95% |

*Source: JRC own elaboration, based on (EU) 2023/1542*

The targets on recycling efficiency have been defined for lead-acid (PbA), nickel-cadmium (NiCd), lithium-based and other batteries. Article 71 of Regulation (EU) 2023/1542 defined the requirements for recycling and recovery of materials (RM) from waste batteries including the requirements for the assessment of the targets. In particular, Article 71(5) stated that by 18 August 2026 the Commission shall complete the first assessment about revising the targets for RE and RM set out in Parts B and C of Annex XII, based on market developments, particularly concerning the materials recovered and their availability, and the technical and scientifical development of the recycling industry.[2] The following assessment is due latest by 18 August 2031 (EU 1542, 2023).

Lithium-based batteries represented a new category in the targets for recycling efficiency and recovery of materials in the (EU) 2023/1542 compared to the previous Directive 2006/66 (EC) on batteries and waste batteries(EU 1542, 2023; EU 66, 2006). Since lithium-based batteries have been the main market innovation over the last 20 years, hence it is reasonable to expect that most of the market developments, as well as scientific developments and technical innovations, have focused on lithium-based batteries. Nonetheless, scope of the assessment presented here include all the batteries as the new targets might be challenging also for the recycling and recovery of materials from PbA and NiCd batteries, despite more stable market situations. Likewise, main chemistries, per market share, from the group of 'others' batteries as the alkaline-saline or nickel-metal-hydride (NiMH) can be framed within stable scenarios but are part of the assessment. New, emerging battery chemistries, falling under no other targets than those defined for 'others' batteries according to Annex XII of the (EU) 2023/1542, had to be monitored in the scope of this work to check whether they are compliant with the targets set in Annex XII of the (EU) 2023/1542 (EU 1542, 2023).

## 1.2. Project structure

### 1.2.1. Goal and objectives of the project

The scope of this JRC project is the **assessment of the review** of the targets for recycling efficiency (RE) and recovery of materials (RM) from waste batteries as set in Annex XII, Part B and C of the (EU) 2023/1542 and as per requirement of Article 71 of the same regulation. Article 71(5), specifically, requires an assessment completed by the Commission within 18 August 2026 on whether it is necessary to revise such targets **in terms of their ambition or, equivalently, of their numerical threshold**. The Directorate–General for the Environment (DG ENV) requested the Joint Research Centre (JRC) to provide, under the Administrative Arrangement N° 36075 – 2021, scientific evidence through analysis of first-hand data from industry, literature, or modelling to assess whether an adjustment of the targets is required and in which direction (i.e. if the targets have to be lowered or increased), or the targets should remain as they are.
It is not in scope of Article 71(5) neither of this JRC project the assessment of new targets for

[2] The full text of Article 71(5) of the (EU) 2023/1542 is: *"By 18 August 2026 and at least every five years thereafter, the Commission shall assess whether, due to market developments, in particular concerning battery technologies impacting the type of materials recovered and the existing and forecasted availability of cobalt, copper, lead, lithium or nickel or the lack thereof, and in view of technical and scientific progress, it is appropriate to revise the targets for recycling efficiency and recovery of materials set out in Parts B and C of Annex XII. Where justified and appropriate on the basis of that assessment, the Commission is empowered to adopt a delegated act in accordance with Article 89 to amend the targets for recycling efficiency and recovery of materials set out in Parts B and C of Annex XII."*

recycling efficiency nor recovery of materials, as it falls under scope of Article 71(6). Such assessment is expected only when appropriate due to market development and scientific and technical progress also related to waste management. Likewise, the methodology provided in the Delegated Regulation (EU) 2025/606 (EU 606, 2025) for calculation and verification for the rates of recycling efficiency and recovery of materials is not under scope of Article 71(5) but rather of Article 71(4).

The **goal** of the JRC work is to support the implementation of Article 71(5) and, consequently, the review of the Annex XII of the Batteries Regulation. The JRC work presented in this report has the following **objectives**:

1. Collection of stakeholders feedback about the targets concerning the recycling of all batteries and recovery of their materials as set in the Annex XII, Part B and C of the (EU) 2023/1542, especially after the methodology for calculation and verification has been adopted (EU 1542, 2023).
2. Monitoring of the state-of-art and technological innovations, ongoing or planned, in the battery recycling industry and particularly at EU level.
3. Analysis of the methodology for calculation and verification adopted in the (EU) 2025/606, in case that any change is suggested about the targets of Annex XII, Part B and C of the (EU) 2023/1542(EU 1542, 2023; EU 606, 2025).

Each of the objectives corresponded to a specific research question: **first**, **it was necessary to understand if the targets for recycling efficiency and recovery of materials from waste batteries were perceived by stakeholders as achievable**, hence considering also the increase of the level of these targets in the years. The feasibility of the RE and RM targets would depend not only on the target levels themselves, but also on other factors such as the market development and the scientific and technological progresses in the battery recycling industry and, overall, in the treatment of waste batteries. Therefore, **the second question** to be responded was to assess how the battery recycling industry reacted to the RE and RM targets and **if the ambitious RE and RM targets actually supported industry innovations as expected by the Commission when they were introduced**.

The assessment of the review of the targets could lead to different results

- Increasing, one or more, of the RE and RM targets.
- Decreasing, one or more, of the RE and RM targets.
- Leaving the targets unaltered until the next assessment under Article 71(5) in August 2031 or until conditions are met for changes under Article 71(6).

In the latter case, it could be assumed that the methodology for calculation and verification (adopted just few months before the beginning of this project, September 2025) would not need any change and, hence, the methodology analysis would not be required. However, in case changes to the targets were suggested, **an analysis on how the methodology would respond to the suggested changes could not be excluded** (see **1.3.3**), corresponding to the **third research question.** Finally, while going beyond the scope of the assessment according to Art 71(5), the data collection was also a good opportunity for the JRC to receive feedback on the report (Orefice et al., 2024) that supported the methodology in the (EU) 2025/606 (EU 606, 2025). The JRC was aware that the methodology is not in scope of Article 71(5) and, at the same time, the JRC was aware of

some questions left open in that report. The data collection seemed also a useful opportunity to collect, about one year later after publication, suggestions on the JRC work from stakeholders who already contributed to that work as well as from stakeholders new in the consultations.

### 1.2.2. Structure of the project

The project is part of an extension of a comprehensive **Administrative Agreement (AA 36075) between DG ENV, DG GROW and the JRC that supports**, with technical suggestions, the **implementation of different articles of the Batteries Regulation (EU) 2023/1542** from removability to carbon footprint, from safety to circularity requirements.

The project is, more specifically, a follow-up of the work carried out by JRC between 2021 and 2024 to support the implementation of Article 71 (Orefice et al., 2024) and it particularly concerns the implementation of Article 71(5) on the assessment of the targets for recycling efficiency and recovery of materials from waste batteries as set in Annex XII, Part B and C. As the previous project, this also stays related to other topics – upstream or downstream – of the life-cycle of the batteries with which any possibly suggested changes in the targets should keep coherence and alignment. The methodology of the project is explained in detail in section **1.3**.

## 1.3. Methodology deployed

### 1.3.1. Data collection from stakeholders

**The JRC launched in September 2025 a data collection** for the assessment of the review of the targets as set in Annex XII, Part B and C of the (EU) 2023/1542 through the EU survey service. Participation to the data collection was per invitation from the JRC and included a wide range of battery associations, industry players operating in the management of waste batteries and downstream steps (e.g. recyclers, refiners), non-governmental organisations (NGOs) or independent experts in the waste battery recycling. Member States were not included in this survey, as the objectives were **very technical and data related** and no data have been reported yet to competent authorities of Member States on the RE and RM of waste batteries, as per Article 75 of the (EU) 2023/1542. Invitees to the data collection were both EU and non-EU players, as waste batteries collected in the EU can also be recycled outside the Union under equivalent conditions. In addition, the invitees were both large companies and small-medium enterprises (SMEs) and startups, as well as both stakeholders who participated already to the first study of 2021-2024 (whose results are published in Orefice et al., 2024) and new players. Most importantly, the invited participants to the data collection covered all the battery chemistries as indicated in Annex XII, Part (B) of the (EU) 2023/1542 – i.e. PbA, Li-based, NiCd and 'others' – as well as all battery categories – i.e. portable, light means of transport (LMT), electric vehicles (EV), industrial and starting, lighting and ignition (SLI).

The distributed EU survey (see **Annex 1**) for the data collection was divided in the following sections:

(a) **'Information on your organisation'**, which included identification information of the participant such as organisation type (company, independent expert, etc.), geographical area of operation (one of the 27 Member States, pan-European, global), position in the value chain (recycler, refiner, battery manufacturer, ...), and more.

(b) **'Process information at the present'**, which included for instance requests on description of their processes, capacity and treated chemistries at the date of the data collection, possibly with flowsheets.

(c) **'Information on expected future process'**, which included information on ongoing and planned investments and ameliorations in the technology as indicators of the participants commitment to innovation and achievement of ambitious targets.

(d) **'Addressing pending issues from previous JRC work (JRC137139)'**, which included feedback requests on open questions from the JRC report (Orefice et al., 2024) such as calculation points and quality of recovered materials.

(e) **'Feedback on the targets in the batteries regulation and on previous JRC work (JRC137139)'**, which included feedback requests on the levels of the targets as set in Annex XII, Part B and C of the (EU) 2023/1542 and, generally, on anything that the JRC might have missed to capture in the distributed EU survey.

Responses from the section e) are analysed in detail, and anonymously, in Section **2.2** as they can be classified as direct input to the assessment of the level of the targets related to Article 71 of the

Batteries Regulation; on the contrary, responses from the sections a), b) and c) are not presented in detail as section a) had the only purpose of identification and the second and third sections contained the most confidential information from the participants. A summary based on aggregated data from the sections b) and c) of the distributed EU survey are presented in Sections **2** and **4** only in support of specific JRC statements and suggestions. In fact, an overview of the responses from sections a), b) and c) of the EU survey are presented in terms of statistics on participation to this JRC project from the invited experts. Following, a more in depth, yet anonymous, zoom on the feedback to the parts of the Batteries Regulation and of the previous JRC project related to the level of the targets under assessment was carried out: the analysis provided first a summary of the collected data and information and then the JRC analysis and comments to the summarised information and data.

Noticeably, official reporting data from companies to Member States and from those to the European Commission were not available yet at the time that this project was carried out (September 2025 – February 2026) as the first targets in Annex XII of the (EU) 2023/1542 entered into force only no later than 31 December 2025. In addition, given the timelines for implementation of Article 75, 'Minimum requirements for reporting to the competent authorities', and Article 76, 'Reporting to the Commission', of the Batteries Regulation, the Commission will receive the official reporting data only by mid-2028.

### 1.3.2. JRC internal analysis based on modelling of RE

Since the responses provided by stakeholders through the distributed EU survey lacked significant quantitative data, the **JRC** carried out an **analysis on achievable RE through the internally-available model on supply and demand of battery raw materials**. The analysis, referred to here and in the report as 'JRC internal analysis', particularly focused on the analysis of the RE for Li-based batteries, for which the target was newly introduced in the (EU) 2023/1542 compared to the previous Directive 2006/66 (EC) on batteries and waste batteries and for which an assessment might be particularly needed given the relatively young recycling industry in that area (EU 1542, 2023; EU 66, 2006).

The JRC internal analysis started from data based on the waste batteries generated in three years (2025, 2030, 2035), adjusted per their collection rates as per requirements of the (EU) 2023/1542 (e.g. for portable and LMT batteries). It was then assumed that all collected waste batteries were destined to recycling, with no losses in between and neglecting other circularity strategies (e.g. preparation for reuse or for repurposing, remanufacturing). From this modelled input fraction of waste batteries, an average rate of RE was calculated per battery chemistry and per collection year for each of the three possible structures (pack, model, cell). The results were presented and analysed as aggregated average per application (EV, industrial, LMT, portable-rechargeable) or per chemistries (NMC, LFP, LCO, LMO). An overall analysis per year, and averaged per both groups of applications and chemistries was performed too.

The calculation of the average rates of RE was performed **according to three possible rules**, outlined in (Orefice et al., 2024):

- **No exclusion of any fraction** from the input nor the output fractions of the calculations.
- **Exclusions of oxygen** from the fractions in input and output to the calculations, while graphite and solvents are considered recovered.

- **Exclusions of oxygen, solvent and graphite** from the fractions in input and output to the calculations. Noticeably, it is not possible to exclude solvent and graphite (and more generally carbon fractions) from the calculations starting 1 January 2030, according to the methodology set in the Delegated Regulation (EU) 2025/606.

In fact, this methodology for the calculation and verification of the rates of RE grants recyclers the flexibility – at least until 31 December 2029 – to exclude from the calculations also more chemistry-specific materials such as phosphorous or sulphur. However, having been the JRC internal analysis carried out per aggregated chemistries, a first approach only excluded those materials that are – even in different shares – present in all the analysed groups of Li-based battery chemistries.

The modelling analysis carried out by JRC using the internal dataset on batteries, that are put on the EU market, in use and available for collection (EC-JRC, 2025), provided useful insights about the forecasted distance, of the battery recycling industry, to the RE targets as set in Annex XII, Part (B) of the (EU) 2023/1542.

### 1.3.3. JRC internal analysis based on modelling of Li-RM

As for the RM analysis for lithium, the survey also lacked significant and relevant quantitative data, so the analysis was based on the JRC's internal dataset on batteries. To evaluate the effect of changing Li-RM targets on the EU lithium supply, the lithium content in waste batteries and manufacturing waste was estimated. The waste batteries were estimated using a Weibull distribution[3], while the manufacturing waste was estimated through a material flow analysis approach.

Three scenarios to estimate the total potential secondary lithium had been assumed:

i. base recycling, with no variation of the Li-RM targets

ii. high recycling, with targets increased both in 2027 and 2031 by 10 percentage points, e.g. from 50% to 60% in 2027;

iii. lower recycling, with targets decreased both in 2027 and 2031 by 10 percentage points, e.g. from 50% to 40% in 2027.

This information was then correlated with pretreatment and refining capacity to estimate the EU production of secondary lithium, which was added to the primary lithium production to obtain the total lithium availability. The total demand for lithium was estimated, and the percentage of coverage of supply in relation to demand was calculated for each scenario, allowing for an assessment of the effects of target variation.

[3] A **Weibull distribution** is a statistical model used to estimate **how the probability of a product failing changes over time**, based on how long similar products typically last and when they start being used. In this case, it is applied to estimate the battery waste generated on the basis of the quantity of batteries placed on the market in a given year and their expected lifetime. For further references to the methodology please check (Bobba et al. 2024)

### 1.3.4. Analysis of data and suggestions on the targets

Finally, a joint analysis of the first-hand data collected from stakeholders and data derived from the internal JRC modelling activity was performed. Where results from each analysis were mutually validating, aligned suggestions could be formulated by the JRC; in case of discrepancy between the two analyses, further information was required to particularly concerned stakeholders and/or further data was investigated in the JRC internal analysis.

The JRC provided the supporting study (Orefice et al., 2024) to the adopted methodology of the Delegated Regulation (EU) 2025/606 (EU 606, 2025): if on one hand, calculation and verification rules were formulated according to features of harmonisation, future-proof and technology neutrality (per chemistry treated and technology used), on the other hand, one of the criteria of the methodology is the distance to the targets. Hence, it was not excluded *a priori* that results of this assessment exercise could not affect the already adopted methodology in the Delegated Regulation (EU) 2025/606 and the JRC approach was to evaluate whether this methodology would work also under any possibly suggested amendment of the targets (EU 606, 2025).

### 1.3.5. Consultation and validation of stakeholders

The results of the joint analysis were presented in a stakeholders' consultation in January 2026 where the JRC suggestions for the assessment of the review of the targets in Annex XII, Part B and C of the (EU) 2023/1542 were presented to experts from industry and industrial associations, Member States and NGOs to validate them. After the consultation, all invitees had adequate time to provide their written feedback to and, possibly, evidence-based inputs to sustain their positions. The received feedback was then discussed with DG ENV and integrated in the JRC suggestions. This report contains, hence, also the feedback and final conclusions from the stakeholders' consultation of January 2026.

# 2. Data collection analysis

## 2.1. Overview of stakeholder responses to the data collection survey

A key pillar of the assessment of the review of the targets in Annex XII, Part B and C of the (EU) 2023/1542, was the **data collection** launched **in September 2025 via the EU survey portal**. Data collection was deemed necessary because officially reported data from Member States on RE and RM will only be available to the European Commission by mid-2028, considering the timelines of implementation of Article 75, 'Minimum requirements for reporting to the competent authorities', and Article 76, 'Reporting to the Commission'. Furthermore, through the data collection, the JRC could get from stakeholders not only results on the calculation of the rates for recycling efficiency and recovery of materials from waste batteries but also feedback on the targets and the methodology (although not inherent to the scope of Article 71(5)), as well as information on ongoing and planned investments to achieve the targets.

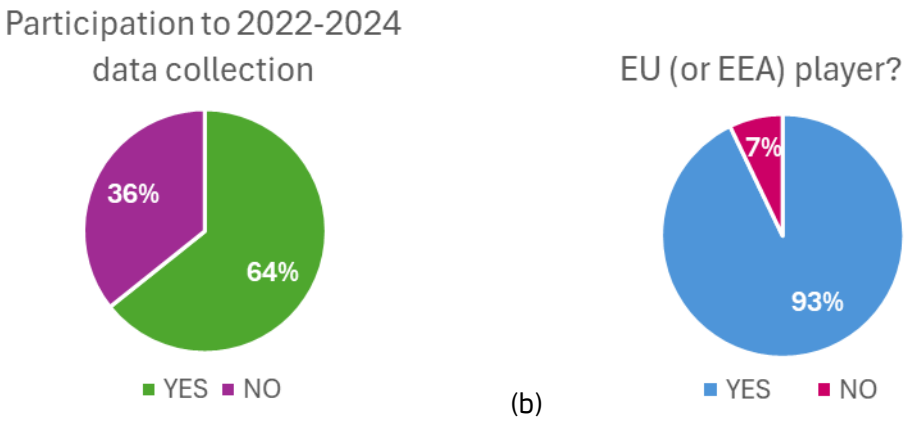
The data collection was open for one month and provided responses from 14 stakeholders, corresponding to only about 20% of the invited stakeholders. The JRC recognises the limits in terms of representativeness of the received responses. In addition, **none of the respondents treated only batteries different from Li-based batteries** (i.e. PbA, NiCd, 'others'). More specifically, while 36% of respondents treat, next to Li-based batteries, also other chemistries (e.g. NiCd and NiMH) none of the respondents provided specific quantitative data on different chemistries than those Li-based. The survey for the data collection was distributed, as explained in Section **1.3**, to stakeholders expert on all the four chemistry groups indicated in Annex XII of the Batteries Regulation – i.e. PbA, NiCd, Li-based and 'others'. The fact that the JRC received no data to assess a possible revision of the targets for PbA or NiCd or 'others' batteries could also be seen as an indication that stakeholders did not provide data as there might not be, according to them, need to review the targets for the recycling efficiency and recovery of materials of PbA, NiCd and 'others' batteries as indicated in Annex XII, Part B and C of the Batteries Regulation. **The JRC aimed at receiving particular confirmation** (or clarification) **on this** at the stakeholders' consultation of January 2026. In fact, **associations representing recyclers** stated that **the targets should not be amended** within this exercise as they are perceived as ambitious and this pushes for innovation in battery sectors that have been stable, both for the manufacturing than the recycling, in the last decades.

Considering the obtained responses, the remaining discussion of Section 2, as well as Section 3, focuses on Li-based batteries, the targets related to them for the recycling efficiency and recovery of materials, state-of-art and innovation in their recycling process and feedbacks on the JRC suggestions for the rules for calculation and verification of recycling efficiency and recovery of materials of waste batteries. In the next Section **2.2**, a detailed analysis is presented about the responses from the parts directly inherent to the review of the targets (i.e. 'Feedback on the targets in the batteries regulation and on previous JRC work (Orefice et al., 2024)' and 'Addressing pending issues from previous JRC work (Orefice et al., 2024)'. Before zooming in that analysis, insights on the international battery recycling industry can be gained from **a statistical analysis of the replies** provided throughout all the parts of the data collection survey.

Figures 1 to 3 depict key statistic results of the data collection. From the part on information about the participating organisations, it emerged that only one out of 14 respondents is a non-EU and non-EEA (European economic area) player and that one out of the 14 is an industry association, while the remaining 86% are players in the battery recycling industry, whether only recyclers or only

refiners or recyclers and refiners, or recyclers and technology developer. Other segments of the battery value chain, e.g. manufacturing or collection organisations, were not covered, the contribution of associations and/or material institutes was limited and no NGOs provided data and feedback to the EU survey. Interestingly, 36% of the collected responses were from stakeholders that did not participate in the previous JRC work (Orefice et al., 2024): this would also provide an indication of how dynamic the (Li-based) batteries recycling industry is at the moment of the data collection (Sept-Oct 2025).

**Figure 1** (a-b). Statistics about the participants to the data collection

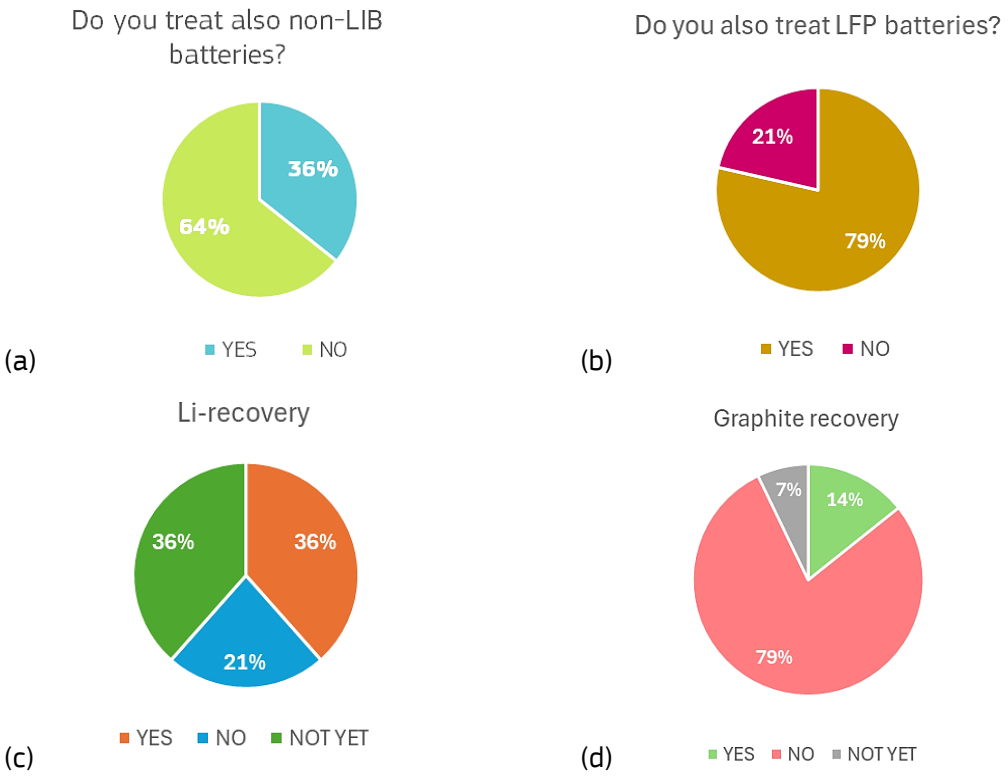



*Source: JRC own elaboration. (© European Union, 2026)*

As for the 'process information at the present', excluding the industry association, almost one fourth of the respondents operate at pilot or startup scales. As for the recycling technologies, the following declarations were collected:

- 64% of respondents do not treat batteries (PbA, NiCd, others) that are not Li-based;
- Around 80% of respondents declared to treat also LFP batteries.
- 58% of the respondents (whereas two of them did not reply to this question) declared to treat all categories of batteries (SLI, portable, LMT, EV, industrial).
- 36% of respondents declared to recover also lithium and another 36% declared that they are working on it.
- On the contrary, 79% of them responded that are not recovering graphite nor working on it.

**Figure 2** (a-d). Visual representation of recycling processes at the present from the respondents to the data collection



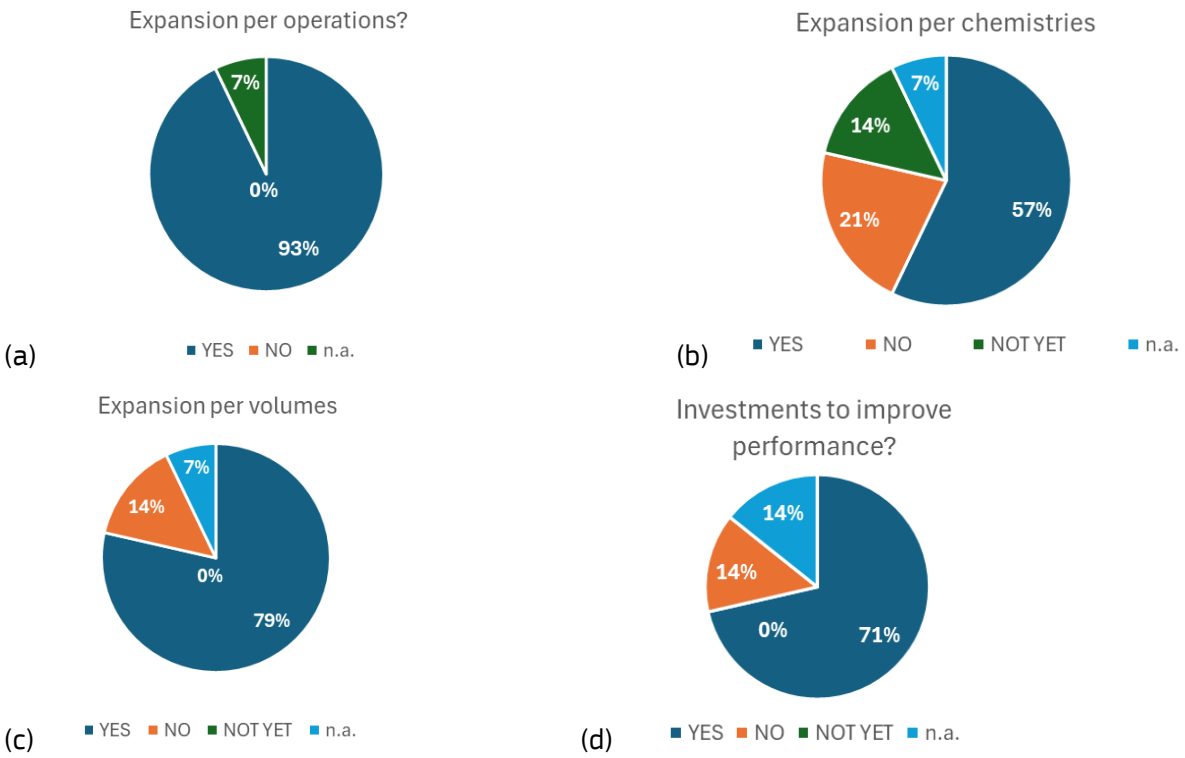

*Source: JRC own elaboration. (© European Union, 2026)*

The percentages extracted from the replies to the survey might be misinterpreted towards an overestimation of the recycling performance of the respondents. Indeed, while almost 60% of them declared to be treating all the battery categories and almost 80% also the less recyclable LFP batteries (compared to Co-rich chemistries as NMC, nickel cobalt aluminium (NCA), ...), it is a recognised fact that most recycling processes are developing, especially in the EU, around NMC batteries and (preferably) large ones. However, this fact and the information from the data collection survey are not in contrast considering that, in the survey, the operators considered as 'treatment' at least the operations of dismantling and mechanical treatment of waste batteries prepared for recycling (see Figure 4 of Orefice et al., 2024 for reference). The responses on the recovery of lithium and graphite are, on the contrary, aligned with what could be expected from the JRC background knowledge, as well as aligned with the target for the recovery of lithium by 2027 and the absence of a target for the recovery of graphite. However, although adding new targets was not in scope of the Article 71(5) nor of this project, the question on the recovery of graphite was posed to stakeholders because in case of already happening large-scale recovery of graphite (while the methodology in the (EU) 2025/606 allows to exclude it until 31 December 2029), the RE target potentially could have been revised for Li-based batteries.

Finally, the part on 'Information on expected future process' provided more consistent responses from the battery recycling industries, with >50% of the industrial operators investing to bring improvements to their processes and expansions to their processes, whether in terms of treated chemistries (57% of the respondents), plant capacity (79% of the respondents) and, most interestingly, process operations. On the latter, only one respondent (7%) declared not to being investing on expansions of operations. **These percentages look even more optimistic** if it is considered that the remaining share to 100% includes not only to "No" answers but also to "Not

yet" (meaning that they are maybe considering but not planning it yet) or blank answers. Such results, although from a limited sample of industry players, give a homogenous picture of investments in the sector of battery recycling, very largely at European level (considered the geographical distribution of the participants to the data collection). It might **not be excluded** that this push for investments derived also, but not only, **from the ambitious requirements** and targets set in the Batteries Regulation, in line with the goals of the Regulation itself for a more circular, sustainable and competitive battery value chain.

**Figure 3** (a-d). Visual representation of expected future processes from the respondents to the data collection




*Source: JRC own elaboration. (© European Union, 2026)*

## 2.2. Detailed analysis of the responses to the data collection survey about the recycling targets in the batteries regulation and the related previous JRC work

The following section presents a detailed analysis of the stakeholders' feedback to the questions of the data collection survey that have been considered by the JRC team more pivotal for the assessment of the review of the targets. The questions refer particularly to the parts of the survey 'Feedback on the targets in the batteries regulation and on previous JRC work (Orefice et al., 2024)' and 'Addressing pending issues from previous JRC work (Orefice et al., 2024)'. Each of the analysed questions is reported as title of the sub-section, for convenience of the reader. An anonymous, aggregated summary of stakeholders' responses is presented first, followed by the JRC analysis and comments to it.

### 2.2.1. Feasibility of the targets

The question posed in the survey was the following:
***<<Are the targets in Part B and Part C of Annex XII of the Regulation (EU) 2023/1542 adequately representative per type of battery chemistries, sizes and categories?>>***
It had the objectives of checking whether the numerical thresholds of the targets were considered well balanced in ambition and feasibility from stakeholders. It is to be noted that this question - at least in part – touches aspects which are out of scope of the work in this report, as they relate to aspects covered by Article 71(6) of the Batteries Regulation.

#### *2.2.1.1. Stakeholders' responses*

The stakeholders' replies to this question were consistent and aligned and could be divided in two main positions with regards to the RE and RM targets as set in Annex XII, Part B and C of the Batteries Regulation. First, most stakeholders stated that the RE targets are adequate for NMC batteries and, in particular, for NMC battery packs of EV or industrial batteries. On the contrary, they reported that the RE target is difficult to achieve for chemistries poor in metals to recover, such as LFP or non-rechargeable batteries, or for some categories such as portable batteries, poor in contributing fractions as the casing. Noticeably, the stakeholders mentioned that also some emerging battery chemistries as solid-state batteries (SSB) might not be adequately covered by the targets nor achieve the RE target required for Li-based batteries by the (EU) 2023/1542, although no data on possible rates of RE for SSB were provided. A recycler with experience in treating both non-rechargeable and rechargeable Li-based waste batteries, provided a detailed argumentation on the need of disaggregating the RE target of Li-based batteries according to their chemistries (e.g., NMC vs. LFP), size (button cells vs. large pack), and functioning (primary vs. rechargeable). This recycler explained the operational challenges derived by the heterogeneity and, also, suggested to have chemistry-appropriate targets to support the Regulation objectives of maximizing material recovery, while supporting industrial competitiveness and circular economy of key technologies as batteries. Such comment offered an insightful perspective but also suggestions that were out of scope of the work in this report related to Art 71(5), as they relate to aspects covered by Art 71(6) of the Batteries Regulation.

The other main position represented by stakeholders was the opinion that the assessment is premature at the end of 2025, as is the related recommendation to review the targets after at least one year of reporting performed according to the methodology in the Delegated Regulation (EU) 2025/606. In fact, according to Article 75(7) of the (EU) 2023/1542, waste management operators *shall report within six months of the end of the reporting year for which the data are collected*, which would be mid-2027. The stakeholders suggested to wait until this time to perform the assessment of the targets for the RE and RM from waste batteries. Interestingly, particularly the industry association, did not express this position referred to Li-based batteries alone and, hence, the review exercise might be considered premature for waste batteries as a whole, also PbA, NiCd and 'others'.

Finally, a recycling startup indicated that the first RM target for lithium of 50% in 2027 might be conservative, while the jump to 80% by 2031 might be too high, especially for companies busy in the same years with industrialising their processes. In addition, an (established) recycler commented on the possible difficulties for startups to achieve the targets while bringing the process to the relevant scale. None of the two comments, however, was completed with quantifications of the rates of RE and RM that startups might achieve at the time of the data collection (2025) or in the short-term future.

#### *2.2.1.2. JRC analysis of the stakeholders' responses*

The JRC as well as DG ENV are aware of the different recyclability of cobalt-rich chemistries (e.g., NMC) and cobalt-free chemistries as (e.g., LFP) and, similarly, of the different recyclability of small batteries (portable) vs. large ones (EV or industrial). A flexible methodology was first suggested in the JRC report (Orefice et al. 2024) and then adopted in the Delegated Regulation ((EU) 2025/606) exactly to mitigate the different recyclability of different battery chemistries and sizes.

Furthermore, stakeholders did not suggest lowering the RE, nor the RM, targets in the (EU) 2023/1542 but, at most, to disaggregate the RE targets for different Li-based batteries. This might be translated with expectations from industry to have different targets for different chemistries or types of Li-based batteries and consequent investments to develop recycling processes based on those disaggregated targets, but as indicated, these considerations lie outside the scope of Article 71(5). It might not be excluded, in fact, that disaggregated targets would incentivise investments more than lowering the RE targets for Li-based batteries of 2025, especially in the EU market where, compared, to other markets, the economy of scale is a relevant parameter to be considered. A lowered RE target for Li-based batteries is not seen as incentive for investments and technological innovation since this target can be reached, at least until 1 January 2030, with the flexible methodology without necessarily changing the business model of industrial players.

As for waiting for the official reports with data on RE and RM for the assessment, such data will also provide insights on the treated capacities per recycler. Nonetheless, the first reporting (of the RE rates) shall be completed by first recyclers by mid-2027 and the related data officially available to the Commission only by mid-2028, given the timelines of implementation of Article 75, 'Minimum requirements for reporting to the competent authorities', and Article 76, 'Reporting to the Commission'. This is somehow misaligned with the timeline for the implementation of Article 71(5), that should be completed by 18 August 2026. The official reporting data, that are expected to increase the availability and the quality of data on the rates of RE and RM of waste batteries in the EU, is therefore not available to be used in this assessment.

The comment on the lithium RM targets, referring to a too low target for 2027 and a too high jump to the target for 2030 reported in the previous section, is relevant and the scientific and technical developments on the recovery of lithium should be closely followed in the coming months. Nonetheless, no other comments were received regarding this and one single data point might be not sufficient to stir actions on reviewing the RM targets of lithium, also considering that the authors of the suggestion are not running the process at industrial scale yet. Nonetheless, the JRC carried out an analysis based on the internal dataset to assess how a variation of ±10 points percent in the RM targets of lithium might affect the EU supply of secondary material compared to the demand of the same material in the EU itself (section **3.2**).
A similar lack of quantitative data was observed for PbA, NiCd and other non-Li based so that it might be difficult to motivate a decision on amending RE and RM targets for those batteries. At the stakeholders' consultation of January 2026, JRC invited experts of those batteries and their recycling process to express their agreement, rejection or comments of the JRC suggestions for Article 71(5).

## 2.2.2. Implementability of the targets

The question posed in the survey was the following:
***<<Please provide your input on how the current targets work and/or anything that the JRC missed to capture in the questions above.>>***
It had the objectives of asking to stakeholders a more open answer on the workability of the targets and the experience of stakeholders about them. Being the last question of the survey, it was also added if anything was missed the previous questions. It is to be noted that this question - at least in part – touches aspects which are out of scope of the work in this report, as they relate to aspects covered by Article 71(6) of the Batteries Regulation.

### *2.2.2.1. Stakeholders' responses*

The stakeholders remarked the same difficulties as in the previous question to achieve the targets, but although not explicitly formulated in the question they focused their replies to this question on RM targets and replies to the previous question on RE targets. Stakeholders did not seem particularly concerned about the targets for the recovery of lithium (50% by 2027 and 80% by 2031), but rather about the targets on nickel and cobalt (90% by 2027 and 95% by 2031). This might be due to the fact that the 2031 target of 95% is, in particular, close to the technical limit, especially for large-scale, continuous processes.
One of the respondents argued that the targets set in Annex XII, Part B and C, of the Batteries Regulation are not technologically neutral as (very) high RM targets for nickel and cobalt (and copper) and lower RM targets for lithium seem to be closer to the performance of processes based on the pyrometallurgical separation of materials prior to the hydrometallurgical recovery; the same targets would seem less aligned with the current state-of-art performance of recycling processes based on mechanical separation followed by hydrometallurgical recovery. Stakeholders commented as well that the achievement of the targets would also depend on the calculation methodology and, more specifically, on any quality requirement for the recovered materials and on the points of calculation of the rates for RM. However, Article 71(5) only concerns the targets while the methodology for calculation and verification of the rates for the RE and RM is out of the scope of Article 71(5) and of this work of the JRC. Concerns on the achievement of the 2030 targets were expressed also regarding Li-based batteries low in cobalt content (as $LiSOCl_2$ or LFP batteries), as by 1 January 2030 the methodology for calculation and verification will no longer allow the flexibility to exclude some materials from the calculations.

Stakeholders also expressed concerns regarding the ability of startups and new processes to be able to reach the targets given the difficulties that they have to control their processes in the first 1-3 years of ramping-up operations. Indeed, in this range of time, the plants' RM rates are not optimised yet, meaning they may fail to achieve the RM target despite being in principle able to fulfil them once processes are established and optimised. Stakeholders hence highlight the need to deal with deviations from the targets in these first years, reassuring, at the same time, that this will not slow down efforts of recyclers to optimize metal recovery during black mass production since improving the metal yield will improve profitability.

Another remark concerned the need to clarify which are the calculation points for output fractions to increase the level of harmonisation of the calculation rules as set in the Delegated Regulation (EU) 2025/606, as well as the equivalent conditions that non-EU operators should follow when treating batteries collected in the Union. It is also suggested to define more clearly the endpoint of recycling after the refining step to retain the (critical) raw materials as long as possible in Europe and avoid that EU becomes a prime location for urban mining from third countries.

The responses reported above were formulated, independently, by several stakeholders. Other comments were expressed instead by a single respondent, and in particular they were, in non-preferential order:

— The suggestion to have a recovery rate for graphite.

— The suggestion of having targets specific for process stages to enable sustainable industrial growth and building a strong, competitive recycling value chain in Europe given the low prices of primary raw materials and the high investment and operational costs of refining facilities.

#### *2.2.2.2. JRC analysis of the stakeholders' responses*

Several comments from stakeholders align between themselves and with the feedback provided to the question on the target levels (section **2.2.1**), namely the difficulty for some Li-based battery chemistries to achieve the RE targets and for some materials to achieve the RM targets. However, all the comments (with exception of one) lack data and evidence on what could be the possible numerical values of RE or RM targets for those batteries or materials. As for the comment that one recycling route, i.e. the combination of pyrometallurgical and hydrometallurgical, seems to be favoured by the targets as set in Annex XII, Part B and C, of the (EU) 2023/1542, this is intrinsically related to the processes carried out. This route, in fact, allows to have a first separation of the heavier transition metals nickel, cobalt and copper, from the remaining lighter matrix of waste Li-based batteries: the former three materials (mostly) end up in an alloy fraction from which they are then separated via hydrometallurgical steps. In the other very common recycling route, that is mechanical shredding followed by hydrometallurgical separation, the entry point to the hydrometallurgical process is the black mass, a fraction of waste batteries recycling usually richer in impurities (especially organics) than the Ni-Co-Cu alloy in entry from the pyrometallurgical process. At the time that the methodology for calculation and verification was adopted, in 2025, most of the processes developed by (EU) recyclers followed the route of mechanical separation and hydrometallurgical recovery, while at the time that the Regulation proposal was elaborated, in 2020, the other route was still the main one for waste batteries recycling. It might be argued that technical progress would suggest reviewing the level of RM targets for nickel, cobalt (and eventually lithium). However, the **JRC suggestion** would be to closely monitor the RM rates for nickel and cobalt before the target gets up to 95%, in 2031, as attested RM rates in 2025 are already achieving around 92-93% and it might be premature to consider revising the targets at this stage. Similarly, for lithium, it is advisable by the JRC to wait for reporting data, possibly made available by stakeholders confidentially before of any reporting by Member States to the Commission by mid-2028 and not to start any revision of the targets based on responses related to processes that are not consolidated yet at industrial scale. JRC remarks the commitment to monitor the scientific and technical progress of (EU) recycling processes of waste batteries to support policymakers and industry. The achievement of the targets would also depend on the methodology calculation and, more specifically, on any quality requirement for the recovered materials and on the points of calculation of the rates for RM. Nonetheless, Article 71(5) only concerns the levels of the targets while the methodology for calculation and verification of the rates for the RE and RM is out of the scope of Article 71(5) and of this work of the JRC.

Some stakeholders also commented that the challenge, especially in term of investments, is at the refining stage and hence also for that clear and harmonised definitions of the calculation points would be necessary. However, the suggestion of having stage-specific targets is out of the scope of Article 71(5) and of this work of the JRC; in addition, while it would more realistically take into account the losses along the process and it might deserve further investigation, it might not be

entirely technologically neutral. Furthermore, the JRC highlights that this might lead to a lack of harmonisation in the RE/RM targets as well as in the calculation and verification rules. The critical point about refining is that EU lacks refining capacity and there is the risk to de-localise the process steps, from the treatment of black mass onwards, outside of the Union market. The difficulty for startups to reach the targets, in the 1-3 years framework during which they ramp up their process to fully operational, might also lead to delocalisation of new processes out of the EU. This might be overcome if an exemption was possible on the targets to achieve by operators running new recycling processes to treat the waste batteries collected in the EU. However, while the arguments presented by stakeholders – from the introduction of new targets (on graphite or site-specific), to the need for clarifications on the quality of the recovered materials or on the calculation points, to mobilise support fundings for the EU refining industry – were welcomed and carefully analysed by the JRC,  they were out of the scope for the assessment of the review of the targets in Annex XII, Part B and C, of the (EU) 2023/1542 and, hence, of this JRC assessment.

# 3. JRC analysis based on modelling

After the analysis of the inputs provided by stakeholders, a further JRC analysis has been carried out through modelling to establish if an update of RM and RE targets, under the requirements of Article 71(5) of the EU Batteries Regulation, was indicated (EU 1542, 2023). The feedback analysis highlighted that a possible update could be considered for two targets:

- RE targets for Li-based batteries
- RM targets for lithium

For other RE or RM targets no feedback indicated the necessity of updating and no new relevant information that was received pointing to the necessity of reviewing the targets as required by Article 71(5) (EU 1542, 2023).

It is important to highlight that in the following sections the terminology "recycling" and RE, as in recycling efficiency, is intended and applied for the treatment operations concerning waste batteries and waste products containing batteries. The terminology "recovery" and RM, as in recovery of materials, is on the other hand referring to the extraction of specific materials (e.g. lithium, cobalt, graphite, …) from the waste batteries and waste products containing batteries. It should be noted that the recycling efficiency is the sum of the contribution of the recoveries of materials of all materials composing the batteries.

## 3.1. Analysis of current levels of RE targets for Li-based batteries

### 3.1.1. Introduction to the RE analysis

Feedback from stakeholders indicated that they have no particular issue with RE targets for Li-based batteries, but many indicated that these targets encompass a wide range of battery chemistries and applications, and that the targets might therefore not be reachable in all cases. A common example mentioned by stakeholders is the treatment of LFP batteries which, due to their chemical composition, do not allow to reach high levels of RE with current recovery processes, which in contrast can be reached by treating NMC batteries. While such comment is in the scope of Article 71(6) and not this assessment based on Article 71(5), similar issues can be found when comparing batteries of different applications and/or different sizes. Specifically, EV battery packs allow to reach higher RE compared to portable batteries. EV battery packs in the dismantling section of the pretreatment process allow to recover with minimal losses a relevant fraction of the battery (e.g. the casing), making the losses from the treatment of cells less relevant. This is not the case for portable batteries, that are often constituted of just a cell or have minimal casing, making the losses from the cells' treatment extremely relevant. Most of the losses can be caused by carbon (graphite) and oxygen (oxides) fractions usually not recovered as such in current recycling processes. There are also other fractions that are not commonly recovered and can be relevant for specific chemistries, such as iron (Fe) and phosphorus (P) in LFP batteries (Orefice et al., 2024).

To overcome this issue and allow a progressive adaptation by industry to the targets the Delegated Regulation establishing the methodology for calculation and verification of rates for RE and RM (EU 2025/606) introduced the possibility to temporarily exclude from calculations certain fractions that currently are not commonly recovered/recoverable. Specifically, point 2(7) of Delegated Regulation (EU) 2025/606 establishes that *"Until 31 December 2029, oxygen, carbon from carbon sources at cell level, iron from iron sources at cell level, phosphorus, chlorine, and sulphur **may** be taken into*

*account in calculating recycling efficiency, in $m_{input}$ and in $m_{output}$",* therefore allowing recyclers to adjust their calculations according to the input to their process.

Verification on the efficacy of this methodology was already assessed in the course of the work for the Delegated Regulation (EU 606, 2025) and previously for the JRC study on the methodology (Orefice et al., 2024) but after the feedback from recyclers it was decided to carry out an additional analysis.

### 3.1.2. Methodology of the RE analysis

Since the information provided by stakeholders was not backed up by significant quantitative data, the authors had to rely on the JRC internal modelling capacity to verify if an update of the Li-based RE targets was necessary, despite the fact that the new calculation methodology is applied.

The analysis relied on modelled data of waste generated from batteries in three years (2025, 2030, 2035), obtained as a forecast through Weibull distribution (EC-JRC, 2025). This, in turn, was based on data on batteries placed on the market (POM) in the EU that were divided per specific application, chemistry and expected lifetime (EC-JRC, 2025). **Table 2** reports all the applications and chemistries under scope of the analysis, selected to represent the vast majority of the EU Li-based battery market. It shall be noted that the analysis had been carried out at application group level and that all specific applications under the same application group had been assumed to be treated in the same way and to reach equivalent RE once treated.

**Table 2:** Applications and chemistries under scope of the analysis

| Application group | Specific application | Chemistries | Assumed structural composition |
|---|---|---|---|
| EV | BEV<br>PHEV<br>HEV | NMC<br>LFP<br>LMO | Pack |
| Industrial | Utility<br>BTM | NMC<br>LFP | Pack |
| LMT | emopeds<br>ebikes<br>escooters<br>small PLEV | NMC<br>LFP<br>LMO | Module |
| Portable Rechargeable | Portable PC<br>Cell phones<br>Cameras Games<br>Tablets<br>Cordless tools<br>Other Rechargeables | NMC<br>LCO | Cell |

*Source: JRC internal dataset, 2026*

The waste generated has been multiplied by a typical collection rate, a parameter specific for each application and analysed year, to estimate the number of batteries that are expected to be collected. For the purpose of this analysis, it was assumed that all the collected batteries are only addressed to recycling, and therefore other circularity strategies (reuse, remanufacturing, and repurposing) had not been taken into account. Subsequently an average estimation of the achievable RE by chemistry and application had been performed, based on structural and chemical composition of the batteries and expected rates of recovery of material. This estimation allowed for

the calculation of RE rates for three different calculation models, based on different structural compositions (pack, module, cell) for each analysed chemistry and year. The structural composition assigned to the analysed applications are reported in **Table 2**.

Finally, all this information had been combined as weighted averages to generate RE rates under an application specific and chemistry specific perspective, and a more general evaluation based on the overall market. Therefore, this exercise models an hypothetical scenario where a recycler would treat only one group of applications and all associated chemistries, when the focus is on applications, and one group of chemistries and all relevant applications, when the focus is on chemistries. Finally, the general overview refers to a recycling scenario where all applications and chemistries under analysis are recycled, treating the input as homogeneous to the collected waste batteries.

This analysis had been developed under three different calculation models to evaluate the different effect that exclusion of fractions may have in reaching the RE targets for all the applications and chemistries involved. Following the three analysed calculation models are reported:

- **Calculation model 1: No exclusion:** This scenario takes into account the possibility of recyclers to not exclude any fraction from the input (nor from the output) in the calculations, Although exclusion of fractions is allowed by the calculation rules set in Delegated Regulation (EU) 2025/606, here the 'no exclusion' is presented as a 'what if' scenario.
- **Calculation model 2: graphite and solvent recovery – O exclusion:** graphite and solvents are considered as recovered while oxygen is excluded. The RM assigned to graphite and solvents had been 0% in 2025, 50% in 2030 and 80% in 2035. These values had been set arbitrarily on the base of available information (Orefice et al., 2024) and in conformity with lithium targets.
- **Calculation model 3: C, O, Solvent exclusion:** graphite, oxygen and solvents are excluded from the calculation, although it should be noted that graphite will not be allowed for exclusion from calculations from 2030.

To maintain a generic approach and allow a better comparison among chemistries it was decided to not consider additional exclusions that would still be allowed by the Delegated Regulation (EU 606, 2025) and would allow additional increase of RE for specific batteries (e.g. Fe and P for LFP batteries).

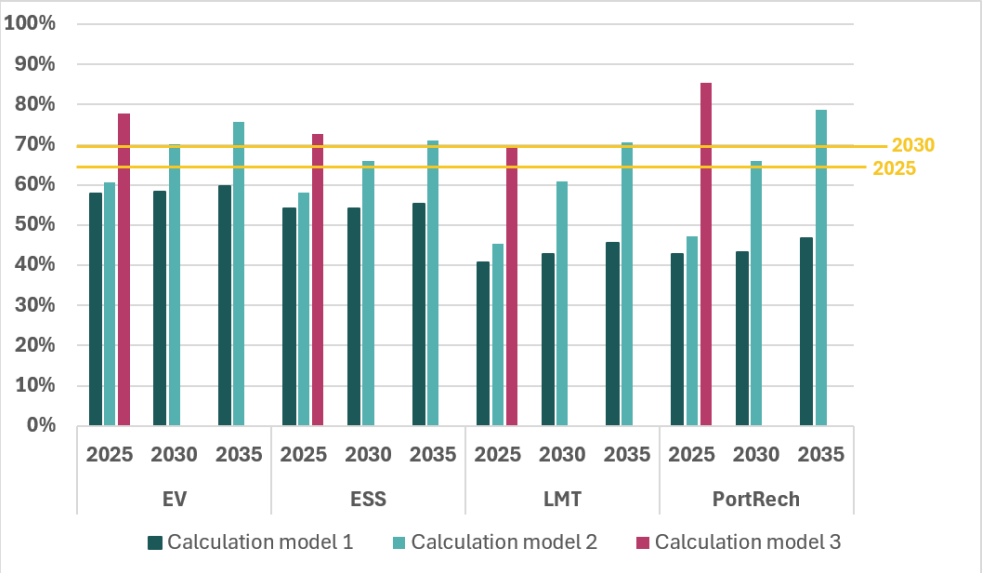
### 3.1.3. Results of the analysis on Li-based RE targets

As introduced in the **methodology of the RE analysis** the analysis had been carried out as weighted averages of the RE obtained by treating the waste batteries expected to be collected in EU.

**Figure 4** shows the effect of the different calculation methods when applied to a recycling scenario where just a specific group of applications, but all the chemistries used in such applications, is treated. It can be noted that:

- By not excluding any fraction from the calculations (**Calculation model 1: No exclusions**) reaching the target would be extremely challenging for all applications, since the presence of lesser recyclable chemistries (e.g. LFP, LMO) would lower the average RE. It is expected that the RE improves over time thanks to the increasing RM of fractions already recovered but this will not be sufficient to reach the target.
- Assuming the recovery of graphite and solvents are progressively implemented in recycling processes, and this action is combined with exclusion from calculations of oxygen and solvents (**Calculation model 2: graphite and solvents recovery – O exclusion**) the situation changes. Already in 2025 there is a slight improvement in efficiencies thanks to the oxygen exclusion, although this is not enough to reach the target for any of the analysed applications. By 2030, when the RM of graphite and solvents is assumed to be 50%, the situation is different, as BEV batteries would reach the 2030 target of 70% RE, while the other applications, although at significantly higher RE than in 2025, are not expected to reach the target. It can be noted that, differently form the no exclusion calculation method, the achievable RE grows significantly in the sequence of analysed years. This is naturally due to the fast increase in RM of graphite and solvents that represent a very relevant share of the battery weight (at cell level approximately 30-35%). In 2035, were the assumed RM for graphite and solvents is 80% all applications reach or exceed the 2030 target.
- Finally, if graphite, oxygen and solvents are excluded (**Calculation model 3: C, O, Solvent exclusion**) from the calculation the overall picture is very different, with all applications in principle already reaching both 2025 and 2030 targets, and in certain cases significantly exceeding them. Interestingly as in the no exclusion case, the improvement in time is expected to be reduced since the fractions already recovered by the industry have little room for improving the RM.

**Figure 4.** Weighted average RE obtainable by aggregating by application group under the three different calculation methods




*Source: JRC own elaboration. (© European Union, 2026)*

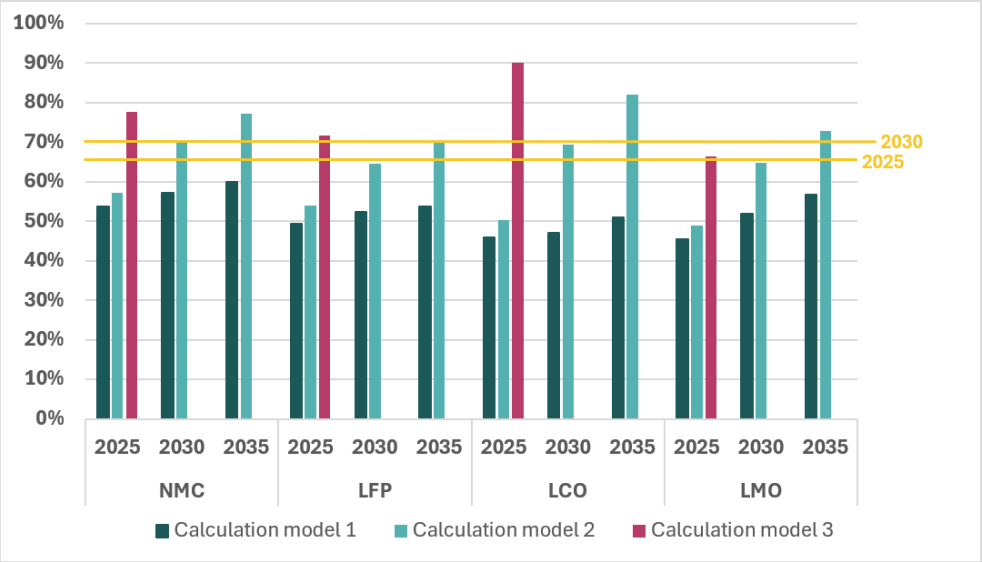
Figure 5 portrays a different approach with a different recycling scenario where only specific chemistries and all the applications under analysis that use such chemistries are treated. It can be noted that:

- By not excluding any fraction from the calculations (**Calculation model 1: No exclusions**) reaching the target would be very challenging for all chemistries and especially for LCO batteries that are predominantly (in this model exclusively) used in portable electronics. Interestingly in this analysis also NMC batteries would have relevant difficulties in reaching the targets, and this is due to the mixed applications approach. Indeed, if only EV packs would be treated the RE rate in 2025 would be approximately 60%, while the mixed input lowers the RE rate to 54%.
- If collection of graphite and solvents is progressively implemented in recycling processes, and this action is combined with exclusion from calculations of oxygen (**Calculation model 2: graphite and solvents recovery – O exclusion**) by 2030 NMC and LCO batteries are expected to reach the 2030 target at 70%, while for LFP and LMO batteries it is expected to be achieved only in 2035, if no additional exclusions are allowed. This is particularly relevant for LFP batteries since the Delegated Regulation (EU 2025/606) allows to not account also for Fe and P, and therefore by excluding these fractions from the calculations, or if these fractions are recovered (e.g. as iron phosphate (Yang et al., 2025)), an increase of 8-17%[4] could be obtained, bringing targets at reach already in 2030. For what concerns LMO batteries this would not help due to its composition, although it should be noted that LMO batteries are usually treated together with NMC and LCO batteries, and therefore the collective treatment of these three chemistries together should allow in 2030 to reach the target[5].
- Finally, if graphite, oxygen and solvents are excluded (**Calculation model 3: C, O, Solvent exclusion**) from the calculation the result is similar to the analysis above on applications and all targets can be met by 2025 for all chemistries.

[4] According to the structural composition of the analysed batteries the contribution of these fractions might vary significantly. Indeed in LFP battery packs the Fe and P fractions would account for approximately 8%, in modules 13% and in cells 17% of the total mass of the battery.

[5] With the graphite and solvents recovery – O exclusion calculation method if NMC, LMO and LCO batteries are treated together the calculated RE is 50% in 2025, 70% in 2030 and 76% in 2035.

**Figure 5.** Weighted average RE obtainable by aggregating by chemistry group under three different calculation methods

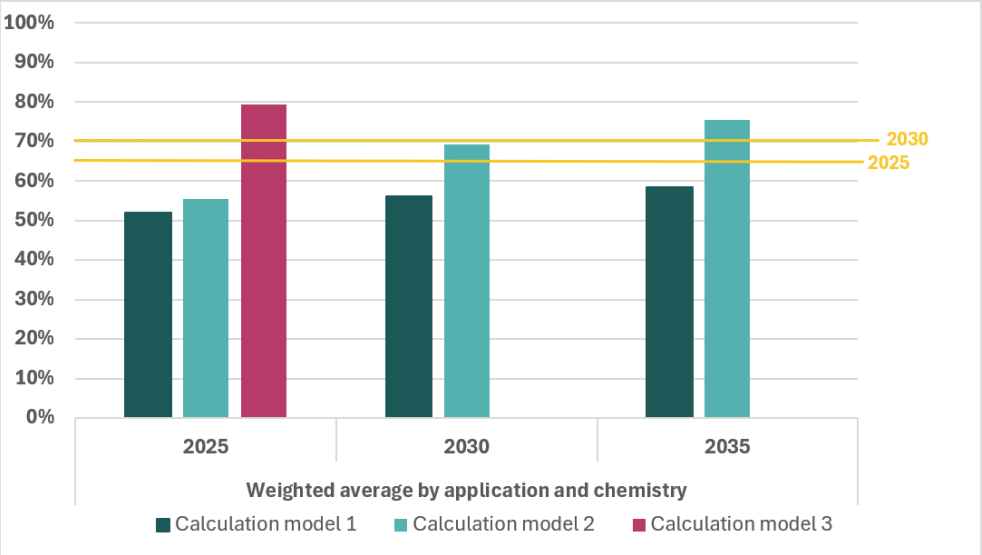



*Source: JRC own elaboration. (© European Union, 2026)*

Finally **Figure 6** brings a more general overview and in this case there is a recycling scenario where the input to recycling is homogeneous to the EU waste collected, treating all applications and all chemistries. It can be noted that:

- By not excluding any fraction from the calculations (**Calculation model 1: No exclusions**) reaching the target would be very challenging for all batteries if no additional fractions are recovered (e.g. graphite).
- If recovery of graphite and solvents are progressively implemented in recycling processes, and this action is combined with exclusion from calculations of oxygen (**Calculation model 2: graphite and solvents recovery – O exclusion**) the situation might still not allow to reach the targets in 2025 since graphite and solvents are accounted but not recovered, although the Delegated Regulation allows the exclusion (present just for comparison reasons). By 2030 when a recovery of graphite and solvents are assumed at 50% RM the target would be met at 70% RE.
- Finally, if graphite, oxygen and solvents are excluded (**Calculation model 3: C, O, Solvent exclusion**) from the calculation both the 2025 and 2030 targets would be easily reached.

**Figure 6.** Weighted average RE obtainable by aggregating by chemistry group under three different calculation methods




*Source: JRC own elaboration. (© European Union, 2026)*

The general result of the analysis is that although targets might currently be difficult to reach, the Delegated Regulation (EU) 2025/606 allows recyclers to mitigate the limitations of their input by temporarily excluding not recovered/recoverable fractions. This allows to reach and exceed the current targets until 31 December 2029, after that it will still be possible to exclude some fractions, but the list will be limited to oxygen, chlorine, and sulphur, therefore incentivising recyclers to recover graphite, iron and phosphorous. Therefore, the analysis highlights that a variation of the targets is not required since the Delegated Regulation already provides sufficient instruments to recyclers for adapting the calculation of the recycling rates to their input, and that the targets remain on average ambitious and balanced when the calculation method is correlated to the expected input to recycling processes.

It is important to note that this analysis has limitations. It is based on the JRC's forward looking modelling, which, although underpinned by solid and annually updated dataset development, obviously requires assumptions and estimations as any modelling activity. Therefore, it is important to complement these results with the feedback of the recyclers that, although have a view more focused on their business model, are more aware of the technical difficulties that emerge in the recycling practices.

## 3.2. Analysis of RM targets for lithium for Li-based batteries

### 3.2.1. Introduction of the RM analysis

Article 71(5) requires that a review of the objectives has to be considered on the basis of three main criteria:

- Development of the market
- Availability of materials
- Technical and scientific progress

From the available information gathered through the survey, during the development of the report on the RE and RM calculation methodology (Orefice et al., 2024) and in other relevant reports on batteries (Bobba et al., 2025, 2024) no new information indicated significant deviations in terms of development of the market and technical and scientific progress that would justify a revision of RM targets. Indeed the main chemistries used for batteries in EU are gradually shifting to cheaper options such as nickel-rich variants of the NMC chemistries (e.g. NMC622, NMC811, …) and LFP batteries but this shift is expected to be gradual and to have effect on the input to recycling processes just in the long term. On the other hand, due to the fast growth of the battery market, the availability of material is considered to be a relevant factor to be investigated.

For what concerns cobalt, nickel, copper and lead, these materials are currently recovered by recyclers at high rates and the targets are already at a high ambition, close to technical limits when 2031 targets are considered (95% RM). Therefore, for these materials, an increase of the targets would just put additional pressure on recyclers for a very limited impact on the EU raw materials supply capacity. On the other hand, decreasing the target is not seen as necessary since, as mentioned, no technological or circularity failure in their recovery processes were identified.

Lithium, on the other hand, is technically recoverable at high rates, but the current obstacle is the implementation at industrial scale of the required recovery processes. The information collected through the survey indicated that, at the end of 2025, there are currently very few recyclers that are able to recover lithium from batteries, but new Li-recovery processes are expected to be implemented in the upcoming years. The lack of feedback on the targets from most of the stakeholders possibly indicates that there are no particular issues with the current targets and that recyclers, although under pressure, seem to be confident on reaching the targets in due time. Few inputs from a minority of the stakeholders indicated that the ramp up of the targets of 30 points percent RM in 4 years, going from 50% in 2027 to 80% in 2031, might be too steep in terms of process efficiency.

This considered, the Li-RM targets are the only ones that could have still room to be increased and that, by increasing, might contribute to the availability of lithium in EU.

Therefore, it has been decided to carry out an assessment on what would be the effect of raising or lowering the Li-RM targets on the overall EU lithium supply.

### 3.2.2. Methodology of the RM analysis

Similarly to the **RE analysis**, the survey did not provide enough qualitative and quantitative information for the evaluation required by article 71(5) (EU 2023/1542). Therefore, it has been decided to base the analysis on the internal dataset on batteries of the JRC (EC-JRC, 2025).

To evaluate the effect of raising or lowering the Li-RM targets on the overall EU lithium supply the first step has been to estimate lithium content in the waste batteries available for recycling from the batteries under analysis (**Table 2**) and in the manufacturing waste of cells and cell components.

To estimate the material content in waste batteries, similarly to the **RE analysis**, a Weibull distribution was used, based on data on the material content of POM batteries in the EU and the lifetime of the batteries (EC-JRC, 2025). To estimate the material content, the tonnage of batteries POM (tons) had been converted to capacity (GWh) through gravimetric energy density (kWh/kg) values, specific for each application and chemistry, and then multiplied by a material intensity factor (kg of material/tons of batteries) specific for each analysed chemistry (**Table 1**). It had been assumed that all applications sharing the same chemistries would have the same material intensity factor. By doing so it had been estimated the material content in the waste generated for the analysed years (2027, 2031, 2035) and this had been multiplied by a typical collection rate parameter specific for each application group to obtain the collected batteries. For the purpose of this analysis, it was assumed that all the collected batteries would be addressed to recycling and that no other circular strategy would be used (i.e. reuse, remanufacturing repurposing).

To estimate the manufacturing waste, a material flow analysis approach was used, calculating the manufacturing waste from the POM and the estimated efficiency of the manufacturing of battery cells and the manufacturing of battery cells' components (EC-JRC, 2025). The POM had first been converted in lithium content (as for the waste batteries) and then the manufacturing waste had been estimated.

**Box 1.** Example of quantification of material in waste batteries available for recycling

An applied example of the methodology just described is provided to estimate the lithium content in BEV LFP batteries potentially addressed to recycling.

**1) Material content in batteries POM:**

Tonnage of LFP BEV batteries POM in 2020 = 1000 tons

Gravimetric energy density = 0.153 kWh/kg

➔ Capacity = 1000 tons * 0.153 kWh/kg * 1000 kg/ton * 1 GWh/$10^6$ kWh = 0.153 GWh

The capacity then can be converted in material content through the material intensity of lithium in LFP batteries.

Lithium material intensity in LFP batteries = 0.09 kg/kWh

➔ Lithium material content (2020) = 0.153 GWh * 0.09 kg/kWh *$10^6$ kWh/GWh 1 tons/1000 kg = 13.8 tons

This calculation has been performed for each individual application group and chemistry for all the historical data on materials in batteries POM.

**2) Material in waste generated (WG):**

The data on materials in batteries POM, in correlation with lifetime averages for each application/chemistry, has been then used to calculate, through a Weibull distribution, the WG in 2027, 2031 and 2035. For example, if in 2027 the estimated lithium material content in LFP BEV WG is of 1000 tons this would be the sum of the contribution of LFP BEV WG from all the historical data on lithium in LFP BEV POM.

**3) Materials in batteries addressed to recycling:**

The WG obtained for the analysed years (e. g. 2027) has been multiplied for the expected collection rate for BEV batteries in 2027, that is 95%. Since it was assumed that all batteries would be only addressed to recycling, the obtained value has been considered as the material in batteries available for recycling in that year. For example, for 1000 tons of lithium in LFP BEV WG, the lithium in the collected waste batteries would be 950 tons and this would correspond to the lithium in batteries available for recycling.

Once the waste generated and the manufacturing waste were estimated, three different scenarios were assumed:

- Scenario 1: Base recycling scenario: targets do not change, and recyclers reach exactly the targets in the analysed timeframe (Li-RM 50% in 2027, 80% in 2031)
- Scenario 2: High recycling scenario: both targets are 10 points percent higher, and recyclers reach exactly the targets in the analysed timeframe (Li-RM 60% in 2027, 90% in 2031)
- Scenario 3: Lower recycling scenario: both targets are 10 points percent lower, and recyclers reach exactly the targets in the analysed timeframe (Li-RM 40% in 2027, 70% in 2031)

By doing so the total potential secondary lithium had been estimated as sum of the lithium content in the waste batteries and in manufacturing waste available for recycling. This information had then been correlated with data on pretreatment capacity (for the waste batteries) and refining capacity

(for both waste batteries and manufacturing waste) to estimate what could be the EU production of secondary lithium (EC-JRC, 2025).

The estimated secondary lithium production had then been added to the EU primary lithium production to obtain the total lithium availability in EU for the analysed timeframe.

Finally, the total demand for lithium had been estimated for the analysed timeframe by converting the data on POM in lithium content (as for the waste batteries). It was possible to quantify the percentage of coverage of supply in relation to the demand by dividing the total availability of lithium in the EU by the total demand. The calculation was performed for all three scenarios and by confronting the obtained values it is possible to assess the effects of the variation of the targets.

### 3.2.3. Results of the analysis on lithium RM targets

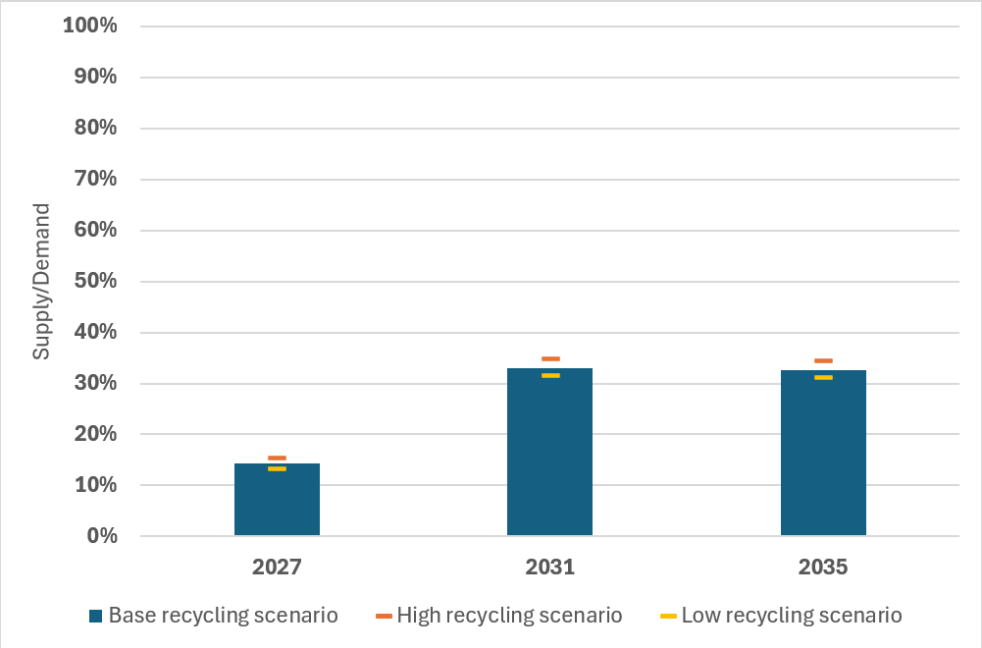
From the analysis it is clear, as it was expected, that an increase or decrease of the targets could potentially bring to an increase or decrease of the supply of lithium. Nonetheless this result is valid just under the assumption that recyclers recover lithium exactly at a RM rate equal to the target. This assumption is clearly a simplification for the analysis since the target does not represent a ceiling for recyclers but instead the bare minimum to be compliant with the batteries regulation. Therefore, recyclers are expected in any case to point at overachieving the targets whenever technically possible and economically profitable.

The results of the analysis interestingly indicate that if the targets are increased or decreased by 10% both in 2027 and 2031 only a limited increase/decrease of the total supply might be achieved, with ±7% by 2027 and ±5% in both 2031 and 2035. The counterintuitive decreasing of the value in time, from ±7% in 2027 to ±5% in 2031 and 2035, is due to the fast increase of the EU primary production of Li, expected to increase by 8 times in 2030 and 15 times by 2035 (if compared to the production in 2025) (EC-JRC, 2025). This increase of primary production at a higher rate than secondary raw material production therefore makes the effect of the contribution of secondary raw materials to the total supply appear to be smaller when it is expressed as percentages of the total supply, although the contribution of secondary raw materials is expected to increase in time.

Although this increase/decrease of the supply can be considered relevant, the variation is limited if compared to the demand of materials in batteries placed on the EU market. Indeed, as shown in **Figure 7**, if the total EU supply is compared to the total EU demand the percentual variation of supply coverage of the demand is very limited, being approximately ±1% in 2027 and ±1.6% in both 2031 and 2035.

This small impact is explained by the total EU supply that is expected to cover approximately 15% of the demand in 2027 and 33% in 2031 and 2035, therefore a relevant, although limited, variation of the supply would impact the material availability for the EU demand only in a limited way.

**Figure 7.** Total EU supply of lithium, as sum of primary production and secondary production from waste batteries and manufacturing waste, over total EU demand of lithium contained in Li-based batteries placed on the EU market taking into consideration the treatment capacity




Note that in the image above the 100% represents the total EU demand for lithium in batteries.

*Source: JRC own elaboration. (© European Union, 2026)*

From the analysis, it also emerged that in 2025 in EU there is an overcapacity of pretreatment facilities (mechanical treatment), although by 2031 and 2035 this will change with undercapacity of treatment of the expected collected waste batteries. This is expected to lead to many waste Li-based batteries to be exported for treatment. For what concerns the refining of the black mass it is still underdeveloped if compared to the potential production of black mass that could be generated by the pretreatment facilities. This is expected to change in the future with an increase of refining capacity, although correlated to a limited pretreatment capacity. In **Table 3** the results of the analysis on capacity are summarised.

**Table 3:** Estimated capacity of treatment of the relevant treated materials

| | **Pretreatment** | **Refining** |
|---|---|---|
| **Note** | Capacity/collected waste batteries | Capacity/(black mass + manufacturing waste) |
| **2027** | 175% | 50% |
| **2031** | 80% | 75% |
| **2035** | 35% | 95% |

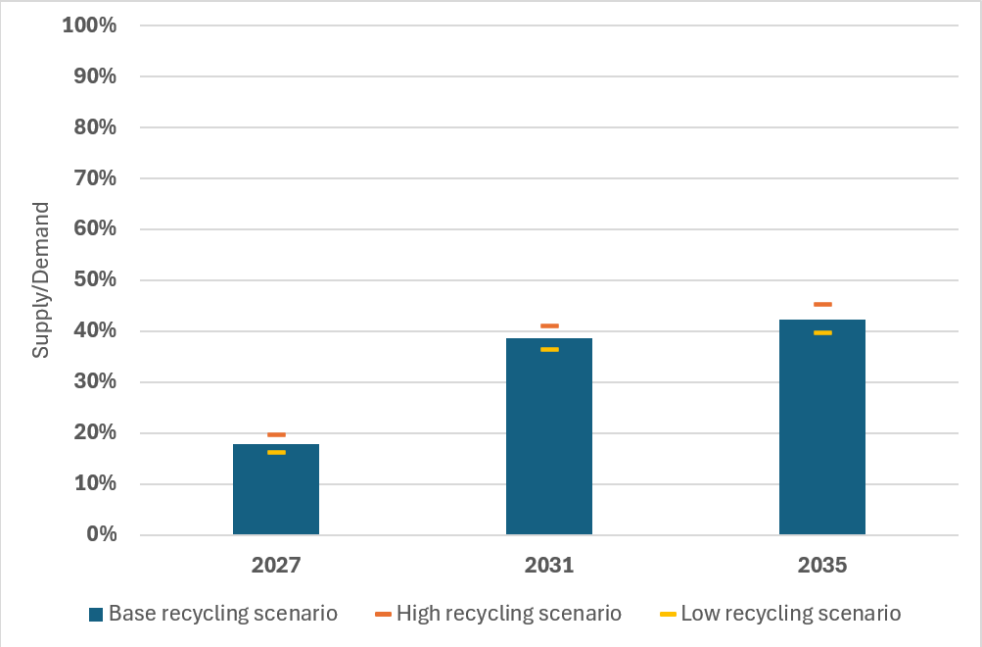
*Source: JRC internal analysis, 2026*

If the capacity of recycling plants is not considered in the analysis, and therefore all the lithium contained in the collected batteries is considered as treated by the recycling facilities in the EU, the potential effect of target variation would be more relevant, although still limited.

Indeed, as shown in **Figure 8**, the potential contribution of secondary raw materials to the total EU supply would be more relevant increasing the total supply to 18% in 2027, 39% in 2031 and 42%

in 2035 of the total EU demand. In this case the potential effect of increasing/decreasing the targets would be of approximately ± 2% in 2027, ± 2.5% in 2031 and ± 3% in 2035.

**Figure 8.** Total EU supply of lithium, as sum of primary production and secondary production from waste batteries and manufacturing waste, over total EU demand of lithium contained in Li-ion batteries placed on the EU market not taking into consideration the treatment capacity




Note that in the image above the 100% represents the total EU demand for lithium in batteries.

*Source: JRC own elaboration. (© European Union, 2026)*

The analysis therefore highlighted that, although a variation of the target would lead to a possible increase or decrease of the supply, the variation in terms of availability of materials for the EU demand would remain rather limited, and that the challenge in the EU is more correlated to capacity of treatment than the actual recycling efficiency in the treatment plants.

An increase of the target would therefore just further complicate the situation for recyclers with no relevant effect on the availability of materials, potentially hampering the efforts of new recyclers on starting their recycling processes. On the other hand, **decreasing the target** would possibly facilitate recyclers, but in contrast **could potentially undermine the already complicated situation of the supply of lithium in EU**. It must be highlighted that the 2027 lithium RM target has been set at the threshold of 50% not because of chemical-physical aspects related to the feasibility of the extraction processes, since very high extraction efficiency can in principle be obtained with all majorly used recycling technologies. This 50% threshold allows, however, for a progressive ramp up of the technology, since the process at starting of operations might not be used at the designed plant capacity given the needed time for optimization and overcoming possible initial engineering obstacles.

It is important to note that this analysis has limitations. It is based on the JRC's forward looking modelling, which, although underpinned by solid and annually updated dataset development, obviously requires assumptions and estimations as any modelling activity. Therefore, it is important to correlate these results to the feedback of the recyclers that have a view more focused on their business model, are more aware of the technical difficulties that emerge in the recycling practise.

# 4. Conclusions

## 4.1. Final considerations and suggestions from the analysis of data collected from stakeholders and data internal at JRC

The data collection carried out by the JRC through EU survey for the assessment of the RE and RM targets as set in the Annex XII, Part B and C, of the (EU) 2023/1542, brought valuable information and constructive feedback to the JRC analysis. The survey was distributed to experts covering the whole battery recycling industry per battery types (non-rechargeable and rechargeable), battery category (SLI, portable, LMT, EV and industrial) and battery chemistries (PbA, NiCd, Li-based and 'others'). Nonetheless, respondents to the EU survey only provided data and information about Li-based batteries and related materials (that means not on lead and negligibly on copper). It could be assumed that, for PbA, NiCd and 'others' (than those Li-based) batteries, any assessments of the targets lacked sufficient evidence-based and/or quantitative information to suggest any changes. The most recent JRC results (Orefice et al. 2024) support these conclusions since, based on a significant amount of data collected from stakeholders between 2021 and 2024, the targets appeared to be achievable, while increasing the level of ambition over the years (as for the rest of the batteries under assessment) keeps the interest in innovation from the industry.

As for Li-based batteries, responses from stakeholders clearly indicated that the RE targets for Li-based batteries, for 2025 and particularly for 2030, are perceived by the recycling industry as (very) challenging. Nevertheless, the problem is not attributed to the numerical value of the targets but rather to the approach that the RE targets have. Indeed the RE targets for Li-based batteries capture together batteries that, for their size (e.g. portable), functionality (rechargeable and non-rechargeable) and chemistry (e.g. Co-free LFP), could be treated differently and that, for their composition, especially related to recyclable materials with a high value, cannot grant the same results (Orefice et al., 2024). In the methodology adopted with the Delegated Regulation (EU) 2025/606, a temporary solution to mitigate this discrepancy is provided, giving to recyclers the choice to may or may not account, in the calculations, for some materials that currently are not commonly recovered/recoverable. In this way, recyclers are allowed to adjust the calculations for the RE and RM rates in relation to the input fractions that they are treating, while keeping harmonised calculation rules for all types of Li-based batteries, despite their heterogeneity. The analysis carried out by the JRC using the internal database confirms the robustness of the methodology in the (EU) 2025/606, a temporary solution to mitigate this discrepancy is provided by giving recyclers the choice to account or not, in the calculations, for some materials that are not recovered/recoverable. In this way, recyclers are allowed to adjust the calculations for the RE and RM rates in relation to the input fractions that they are treating, while keeping harmonised calculation rules for all types of Li-based batteries, despite their heterogeneity. The analysis carried out by the JRC using the internal dataset confirms the robustness of the methodology in the (EU) 2025/606 to provide to recyclers the required flexibility to adapt to the targets introduced in 2023. A different scenario, probably leading to different results, might occur after 1 January 2030 when there will be no longer a choice to account or not for some materials in the RE calculations. Additionally, and despite their comments, respondents to the questionnaire provided no quantitative information on how much, in their judgement, the level of any RE or RM targets of Annex XII, Part B and C, should be adjusted.

The **JRC suggests that revision of the RE targets for Li-based batteries is not necessary** since instruments to mitigate the effects of the generic approach of the regulation (EU) 2023/1542 were already provided through the methodology in the Delegated Regulation (EU) 2025/606.

Regarding the timeline of the assessment of these targets, stakeholders' considered this as a premature exercise suggesting waiting the official reporting data from companies. However, although first recyclers have the obligation to provide the first data on RE rates (RM targets only apply no later than 31 December 2027) to competent authorities in the Member States by mid-2027, data reported from Member States will be available to the Commission only by mid-2028. The JRC welcomes and acknowledges stakeholders willing to make such data available in advance as part of the mutual support to implement a sustainable and competitive battery industry; at the same time, the JRC recognises that recyclers are still implementing the changes to their processes to comply to the Batteries Regulation and are adapting to the new calculation methodology.

As for the RM targets, some comments emerged and less consolidated than those for the RE targets above. Some stakeholders suggested that the RM targets for lithium might be more ambitious; however, also they did not provide quantitative suggestions on the adjustment of the targets, and clear evidence for such an increase of the RM target. As for the RM targets for nickel and cobalt, concerns raised by the operators are reasonable according to the JRC since the targets for the year 2031 are very close to the technical limit of recovery. Nonetheless, considering the timeline of implementation of the targets as well, the **JRC suggests that monitoring the technical innovation of the related recycling processes might be sufficient and lowering the RM targets of nickel and cobalt at this stage is not required.**

At more general level, the JRC finds that any action taken now in regard to the targets would have limited impact on the industry in the short term. Indeed, investments and improvements of the recycling plants had been already established on the base of the targets entered into force in 2025 and/or those expected by 2027. Any early change in the targets, whether to a lower or higher ambition, might not fit with the planned investments. It might be even further challenging, especially for the EU battery industry, to plan new investments to comply with any changes in the targets, given the limited adaptation capacity of the industry in relation to the entry into force of the targets. Indeed, even a small change of the targets for recyclers might imply a long series of actions, such as securing investments and resources, planning and realization of new processes or adaptation of already existing ones. Hence, an increase of the targets might put additional pressure on EU recyclers without ensuring that the needed changes would be achieved in the short, required timeline despite any strong efforts for improvements and despite the possibly already ongoing investments. Unfortunately, a solid techno-economic assessment of the profitability of investments in the EU battery recycling industry is currently missing. Such assessment cold have been very useful to discuss, whether in order to improve the EU resilience and competitiveness, it would be more beneficial to push the recovery of materials to technological limits with the related investments from the industry or instead to support the expansion of the EU recycling capacity to treat as many waste batteries as possible in the EU, even with average performances. The question was raised at the stakeholder' consultation of January 2026 and, although out of scope for Article 71(5) is reported as an interesting perspective for further work. On the other hand, the contrary – and that is lowering the targets for the recovery of materials – is definitely not an incentive for competitiveness and investments in the EU: the RM targets as set in Annex XII, Part (C) of the (EU) 2023/1542, are in line with the technological feasibility of recovery of cobalt, nickel and copper and, as for lithium, 50% is assumed as the minimum (not the maximum) considering technological feasibility and economic profitability.
On the other hand, lowering the targets could be counterproductive since EU recyclers could still prefer to treat "more recyclable and more profitable" batteries at less ambitious targets for the Union, while mostly sending the rest of the batteries for treatment outside the Union as per the current scenario. This could potentially reduce the incentive for innovation promoted by the

Batteries Regulation while not ensuring that the lesser valuable/recyclable batteries will be recycled appropriately. These issues, whatever change of the targets, seem less relevant for non-EU recyclers given their larger capacity of treatment and higher speed of adaptation to new policy, market and industry scenarios.

The JRC presented these final suggestions at a consultation workshop with experts from industry and industrial associations, NGOs and Member States in January 2026 2026 receiving broad support from all the involved categories of experts.

**Therefore, based on the assessment presented in this report, it is suggested not to amend the targets for recycling efficiency and recovery of materials set out in Part B and C of Annex XII of the Batteries Regulation.**

## 4.2. Outlook

The JRC suggests as well to further monitor the situation in particular:

- The scientific and technical progress in the recovery of nickel, cobalt and lithium from waste batteries, with a focus on the assessment of the review of RM targets.
- The market development of batteries placed on the market, *in particular concerning battery technologies impacting the type of materials recovered*, with a focus on the assessment of the review of RE targets also related to the flexible methodology in the delegated act (EU) 2025/606. This would be relevant not only to the Li-based batteries, for which aligned and numerous feedback were received from respondents to the data collection survey, but also to batteries emerging on the market that might fall in the group of 'others'.

Some stakeholders found the assessment exercise premature as the first targets (on RE) entered into force only in 2025 and official reporting data will be available to competent authorities by mid-2027. In addition, giving the timelines for implementation of Article 76, 'Reporting to the Commission', of the Batteries Regulation, the Commission will receive the official reporting data from Member States only by mid-2028. The JRC invites stakeholders to make data available to the JRC team working on batteries recycling, so that the JRC can continue the exercise of assessment and monitoring based on reliable, updated, first-hand data from recyclers and other waste management operators of the battery industry. With the REsourceEU Action Plan also highlighting the key role of batteries for the EU competitiveness and green and digital transitions, the JRC will work thoroughly to update the internal dataset and knowledge to have as complete as possible figures about innovation and development in the waste battery recycling industry.

The JRC does not exclude to use such data in the future also to assess the feasibility of new targets as per scope of Article 71(6) Batteries Regulation.

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## List of abbreviations and definitions

| Abbreviations | Definitions |
|---|---|
| BEV | Battery electric vehicles |
| C | Carbon |
| EC | European Commission |
| EEA | European economic area |
| EU | European Union |
| EV | Electric vehicles |
| HEV | Hybrid electric vehicles |
| JRC | Joint Research Centre |
| LCO | Lithium cobalt oxide |
| LFP | Lithium iron phosphate |
| LMO | Lithium manganese oxide |
| LMT | Light means of transport |
| NGO | Non-governmental organisation |
| NiCd | Nickel-cadmium (battery) |
| NiMH | Nickel-metal hydride (battery) |
| NMC | Nickel manganese cobalt |
| O | Oxygen |
| PbA | Lead-acid (battery) |
| PHEV | Plug-in hybrid electric vehicles |
| RE | Recycling efficiency |
| RM | Recovery of materials |
| SLI | Starting, lighting and ignition |
| SMEs | Small-medium enterprises |
| SSB | Solid-state battery |

## List of boxes

## List of figures

## List of tables

## Annexes

### *Annex 1.* EU survey distributed for data collection in support of the assessment as per Article 71(5) of the (EU) 2023/1542

The following is a copy of the EU survey distributed to invited stakeholders between September and October 2025 for the data collection of the assessment of the review of the targets for recycling efficiency (RE) and recovery of materials (RM) from waste batteries as set in Annex XII, Part B and C of the (EU) 2023/1542 and as per requirement of Article 71 of the same regulation.

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# [BatReg][Art.71Review] Data collection for the assessment of the review of the targets as per Article 71(5) of the EU Batteries Regulation 2023/1542. First round, Q4 2025.

Fields marked with * are mandatory.

## Context and objectives of the JRC study

You might be aware that the Joint Research Centre (JRC, the European Commission's in-house science and knowledge service) is technically supporting DG ENV and DG GROW in the implementation of the (EU) 2023/1542 Regulation on batteries and waste batteries.

In this context, the JRC team on batteries recycling is launching the **assessment of the review of the targets for the recycling efficiency and recovery of materials** from waste batteries, set out in Annex XII Part B and C, according to Article 71(5) which reads out as:

*"By 18 August 2026 and at least every five years thereafter, the Commission shall assess whether, due to market developments, in particular concerning battery technologies impacting the type of materials recovered and the existing and forecasted availability of cobalt, copper, lead, lithium or nickel or the lack thereof, and in view of technical and scientific progress, it is appropriate to revise the targets for recycling efficiency and recovery of materials set out in Parts B and C of Annex XII. Where justified and appropriate on the basis of that assessment, the Commission is empowered to adopt a delegated act in accordance with Article 89 to amend the targets for recycling efficiency and recovery of materials set out in Parts B and C of Annex XII."*

For that purpose, we would like to invite you to the following **data collection** exercise that will support the JRC work. The main point of the data collection would be to understand what has changed compared to the data collected for the JRC137139 for the development of technical suggestions for calculation and verification rules for the rate of recycling efficiency and recovery of materials. **This EU survey will stay open until October 17.** The JRC intend to organize a stakeholders' consultation workshop around mid-November to present the conclusions elaborated through this data collection on the assessment of the review of the targets of Article 71, set out in Annex XII Part B and C. Moreover, recognizing of not having organized a consultation to launch this data collection, the JRC remarks their availability for bilateral exchange if any clarifications is needed. Bilateral exchanges with associations, who could coordinate the communication for more stakeholders at the time, might be prioritized.

The JRC invites you to contact this team at JRC-BATT-MATERIALS-RECYCLING@ec.europa.eu in case you might have any questions or communication, or would need to support the replies in the EU survey with additional material.

**Any information shared through this EU survey will be treated by JRC absolutely confidentially.** We kindly invite you to also read the below paragraph 'Privacy statement'.

Thanks a lot for all the collaboration.
We look forward to exchanging (again) with you,
the JRC team on batteries recycling

## Introduction to the survey

The deadline for completing the survey is **17 October 2025**. Please complete the survey by providing relevant data wherever your organisation can contribute, while we understand that questions not relevant to your organization might be left unanswered. We deeply appreciate the efforts of your organisation in sharing valuable information with the JRC: your collaboration contributes significantly to our collective pursuit of knowledge and informed decision-making.

The survey has been divided into distinct parts, encompassing (a) Present information on your process,

(b) future perspectives in your process, (c) pending issues from previous JRC work, (d) feedback on Art.71 targets and on previous JRC work. This structured approach ensures a comprehensive examination of the relevant topics for the assessment of the review of the targets of Article 71(5).

The feedback shared with JRC will be used for publicly outputs (e.g. JRC reports, support to legislation) but **the JRC will treat all the data absolutely confidentially**. JRC will diligently ensure that the data are aggregated and anonymised as it was also in the previous report JRC137139.

Further information on how to save and edit the survey are given at the bottom of this page.

****Disclaimer: the examples after the questions to clarify them refer to any companies or associations but are generic example of possible cases that might take place in the scenario of waste batteries recycling****

## Information on your organisation

* We kindly request the submission of one consolidated reply per organisation.

* Organisation name

* Name and surname of the organisation representative

* Contact of the organisation representative

MartyOr

* Geographical scope of your organisation

At most 1 choice. For more sites, please just indicate the headquarter location or use the 'others' button.

| | | | |
|---|---|---|---|
| AT - Austria | FI - Finland | LT - Lithuania | SI - Slovenia |
| BE - Belgium | FR - France | LU - Luxembourg | ES - Spain |
| BG - Bulgaria | DE - Germany | MT - Malta | SE - Sweden |
| HR - Croatia | EL - Greece | NL - Netherlands | Europe |
| CY - Cyprus | HU - Hungary | PL - Poland | Global |
| CZ - Czech Republic | IE - Ireland | PT - Portugal | Other(s) - please specify |
| DK - Denmark | IT - Italy | RO - Romania | |

EE - Estonia LV - Latvia SK - Slovak Republic

Other:

* Type of organisation:

*Maximum 2 selections*

Industry - battery recycler

Industry - battery materials refiner

Industry association

Non-governmental organisation

Non-associated expert

Other - please specify below

Other - please specify

* The stakeholder consultation will feed the final report. Please indicate if you would like your organisation to be acknowledged in the final report.

Yes

No

* I agree to be further contacted by the JRC to potentially expand on the answers provided, if deemed suitable and feasible.

Yes

N
o

* Did your organisation participate to the data collection and stakeholder consultation for the JRC work for the development of calculation and verification rules for Article 71, in the years 2022-2024?

Y
e
s

N
o

## Process information at the present

**1. Which type of batteries do you treat in each of your process?**

Please indicate both the chemistry (PbA, NiCd, Li-based, others) and the category (SLI, portable, EV, LMT, industrial). Moreover, for the Li-based batteries, please also indicate which specific chemistry do you treat, e.

g. NMC, LFP, LMO, ...

**2. Please, provide a description of your treatment process(es), by indicating the current rate of recycling efficiency and listing the operations that make it up and/or by providing a flowsheets.** You might refer to Figure 4 of the report JRC137139 to label the operations.

If you would like, please upload here your flowsheet(s)

**3. Which type of materials do you recover from recycling of waste batteries? Please indicate them by listing in which form do you recover them and the current rate of recovery.**

E.g. for cobalt, indicate: RM(Co) = 92% as CoSO4.

**4. Which is the current capacity of treatment for the overall process (**from input fraction to output fraction**)? Do you have, in your process, operations with different capacities (**e.g. in the case that you also treat materials from third parties for a middle-stage operation**)?**

**5. Are there operations that you outsource? Might you please indicate also which are the chemistries treated and the materials recovered in the outsourced operations?**

Please, indicate also if the outsourced operations are carried out, at the best of your knowledge, in your same economic area or not, particularly indicating if the outsourcing correspond to inbound or outbound flows for the European Union. In case of operations outsourced from one Member State to another, please indicate the Member State of origin and that of destination.

**6. Are you a European industry?**

- Yes
- No

**8. In conclusion, are there changes that happened in the last 2 years, that were not covered in the questions above and would relate, particularly but not limited, to the last responses provided for the JRC137139?** The question might particularly refer to stakeholders who participated to the consultations for the JRC work for Article 71 in the years 2022-2024. However, would you been new in the consultation and feel that remarkable changes or understanding came after that first JRC work, we would appreciate you for sharing them.

## Information on expected future process

**9. Considering also the (dynamic) targets of the batteries regulation, are you planning any expansions in terms of operations/treated chemistries/treated capacity within the next 10 years?** Please, detail your reply below.

a. **Please indicate any expansions of operations planned by 2036, specifying also the foreseen year**

**(s) in which the expansion(s) should be operational.** 'Expansion of operations' is intended as, but not only, the implementation of new process steps (e.g. graphite recovery) or the acquisition of currently outsourced operations (e.g. black mass treatment) or the installation of a new process (but if the process is to treat new chemistries, e.g. a dedicated LFP recycling process, please indicate it in the next question).

b. **Please indicate any expansions in the treated chemistries planned by 2036, specifying also the foreseen year(s) in which the expansion(s) should be operational.** Please indicate if the treatment of new chemistries will involve a new process or optimization an existing one.

c. **Please indicate any expansions in the treated capacity planned by 2036, indicating also the foreseen year(s) in which the expansion(s) should be operational.**

Please indicate if the capacity expansion is related to the expansion of new chemistries and/or the start of new operations.

10. **Without installing new operations, would you have in mind investments for the amelioration of the existing technologies in your process?** An example might be developing a process for co- precipitation of active materials precursor to replace the current single-metal precipitation process.

## Addressing pending issues from previous JRC work (JRC137139)

**11.** One of the suggestions to the previous work, JRC137139, was the lack of a clear indication of the calculation points both for the recycling efficiency and the recovery of materials. **Might you please indicate the calculation points for the rates of recycling efficiency as well as the recovery of materials in your process?** Or, also in case you are not calculating those yet, **would you have any suggestions on the most appropriate calculation points both for the recycling efficiency and the recovery of materials?**

**12.** In the previous work, JRC137139, it was not possible the quality of recovered materials for a lack of data about that, although it is commonly acknowledged that defining quality contributes to build a more level playing field among recyclers. **Would you be able to indicate the quality of the recovered materials at your process? And might you clarify how this is calculated?** Or, also in case you are not calculating it yet, **wo uld you have any suggestions about?**

## Feedback on the targets in the batteries regulation and on previous JRC work (JRC137139)

**13. Would you consider the targets in Part B and Part C of Annex XII of the Regulation (EU) 2023**

**/1542 as adequately representative per type of battery chemistries, sizes and categories? Would you suggest that one or more battery chemistries, sizes and categories are not captured appropriately in the targets?**

**14. Please provide your input on how the current targets work and/or anything that the JRC missed to capture in the questions above. Let JRC know if you'd like to have a bilateral call to explain this input.**

## Supporting material (evidence-based data, position papers, ...)

Please upload here any further evidence, data and information relevant to the survey.

## Further instruction on saving and editing the survey

Respondents have the possibility to save the contact form as draft and edit it at a later moment. When saving the contributions as draft, a link will be automatically generated. You will have two options:

i) send this link by E-mail
ii) copy to clipboard

We would strongly recommend option i) to make sure you do not lose the link. You can also save a PDF copy of the draft.

Kindly note that after submitting a survey, any subsequent edits can only be made using the Contribution ID. Therefore, it is necessary to either document this identification number or request a PDF containing the same ID via email (using the 'Get PDF' options available on the confirmation screen).

With this contribution ID, you will have the ability to make edits to your submission on the following webpage: https://ec.europa.eu/eusurvey/home/editcontribution

(note: not before a minimum of 5 minutes has elapsed since the initial submission).

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## Contacts

For any further questions related to this survey, please contact us via the Contact form

**Contact**

Contact Form

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