ECaBaM 1st Workshop

Metals Conference Centre (MCC) - Brussels, 16-17 April 2024

Final Report

The first workshop of the Exchange & Capacity-building Group on Battery Materials (ECaBaM) was held on 16-17 April 2024. This workshop report covers the two days of discussions and should be read together with the slides provided for both days, since they provide more detailed information on the capacity-building session.

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Introduction

Guy Thiran (Eurometaux) welcomed the participants, ECHA, the JRC, the European Commission representatives, and the consultants working on the project for ECHA to the first ECaBaM workshop. He explained that with the adoption of the Battery Regulation last year, ECHA received new and important tasks on batteries, which are key to the metals sector. He recalled that batteries are key to our societal decarbonisation efforts, and instrumental for the strategic autonomy of Europe. The metal sector is a direct contributor to this market. Our sector will be involved in providing the materials needed to make and recycle batteries, and to promote full circularity. In respect to market access and regulatory acceptance, it will be our collective responsibility to comply with the new provisions, including providing adequate and relevant information needed to assure the demonstration of proper and safe manufacturing, use and recycling. And even if this is an EU exercise, supply chains move across borders and there is a global dimension that needs to be considered. There have been efforts at European level to update the existing legal framework to be fit for this new reality, but the success of the implementation also depends on industry supporting and accompanying the process.

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In this context, the ECaBaM project set up by Eurometaux will deliver the relevant information and provide a platform for capacity building, for regulators to better assess the complex and fast developing battery and recycling technologies, be focused on the materials used and for the sectors involved, to understand what information is needed to allow ECHA to define the potential need for risk management measures.

The recently published ECHA Strategy Statement 2024-2028 underlines the relevance and importance of co-operation with stakeholders to facilitate ECHA's tasks to demonstrate safe use, and this program also fits perfectly within ECHA's new strategic pillar and follows the spirit of the other collaboration programmes held previously. The implementation of the battery regulation will be a long, challenging task, and Eurometaux is proud to be able to offer a platform to share the right expertise, fostering fruitful exchanges in the spirit of good collaboration, to ultimately ensure that the process will deliver successfully.

Violaine Verougstraete (Eurometaux) explained the background of the workshop, the new tasks that were allocated to ECHA, and the key objectives of ECaBaM: defining relevant information, achieving a broader interaction than the formal communication channels in the ECHA/Committees in the restriction processes, promoting capacity transfer, etc. This will be a first workshop to get to know each other and to set the scene. To ensure the discussions run smoothly, participants are invited to speak on behalf of their associations, not to discuss specific substances, and to avoid "policy asks".

Francesco Gattiglio (Albemarle), as Chair of the day, also welcomed the participants and held a short tour de table (Attendance List – Annex 1). Antitrust rules were recalled. The slides are attached as Annex 2.

Session 1. ECHA and Commission responsibilities

Magdalini Topouzidou (DG ENV, European Commission) provided an introduction on the aim of the Battery Legislation, focusing on Article 6 dealing with the restriction of substances in batteries, providing a framework to ensure substances used in batteries or arising during subsequent lifecycle stages such as repurposing or the treatment of waste batteries do not pose an unacceptable risk to human health or environment. Magdalini read out the provision of Article 6 and explained how ECHA will provide services to the Commission.

The procedure will follow a 'REACH-approach', including also socioeconomics and assessment of alternatives. The Commission can mandate ECHA to prepare a Restriction dossier. In parallel, Member States are allowed to initiate restriction dossiers. Until December 2027, the Commission, assisted by ECHA, is required to prepare a report on Substances of Concern (SoC), i.e., substances with effects on human health or environment (ENV) or that hamper recycling. In Annex I of the Regulation, there are some existing restrictions, e.g., for Hg and Cd. In the new Regulation, Pb was added for portable batteries with a derogation until 2028. Once the report on SoC is finalised, the Commission will decide on further restrictions.

Augusto Di Bastiano (ECHA), after a brief presentation of ECHA, where he insisted on the importance of collaboration, explained the Batteries Regulation in a nutshell as well as the related tasks and roles for ECHA. Interesting to note is that the Regulation will take a full lifecycle approach in which sourcing, manufacturing, use and recycling are addressed in a single law, but also ensure that batteries have a low carbon footprint, use minimal harmful substances, and need less raw materials from non-EU countries, and finally are collected, reused and recycled to a high degree in

Europe. ECHA tries to be on pace to avoid regrettable substitution. The Regulation applies to all types of batteries.

The report on SoCs, referred to in Article 6(5) needs to be prepared by the European Commission assisted by ECHA, and submitted to the European Parliament and Council **by 31 December 2027**. It should cover substances present in batteries or used in their manufacturing and must contain considerations on follow-up measures, including restrictions.

The restriction process is outlined on slide 25 and involves ECHA, Member States, RAC and SEAC and the adoption of an opinion through delegated acts. A difference with the REACH restrictions is that the Batteries Regulation deals with the waste stage. It is worth noting that for batteries the Commission will be assisted by a Committee established by the Waste Framework Directive.

ECHA's aim is to **deliver a list of substances by the end of 2026** to give the Commission enough time to process it. A supporting study has been outsourced to a contractor (Ramboll) under ECHA's supervision, and it will include two phases: 1) Mapping of substances and processes (by June 2025) & investigation on use in batteries of Hg, Cr (VI), Cd, Pb (already restricted for some batteries); 2) List of substances of concern and prioritisation delivered to the Commission (by end 2026). Regarding the set-up of the actual process, they aim to have it done by Q4 2025, and this includes training but also templates, IT tools etc. (see slide 26). They make use as much as possible of existing expertise in ECHA.

Regarding phase 1, some steps have now been finalised and the information gathering from stakeholders has started. **The drafting by the consultant should start in June with a report to ECHA in March 2025 and a report to the Commission in June 2025.**

The main issue for the completion of these tasks is that only limited information on substances in batteries is available in the REACH registrations. **The information on quantities and technical function is missing** since the REACH dossier only contains information on all uses, with the technical function lacking. They have estimated that there are 6.500 substances used in batteries, but data is missing on a) substances in batteries including those used in manufacturing processes, b) amount and technical function, c) potential exposure to humans and environment in all lifecycle stages and d) availability of alternatives.

Augusto mentioned the **important role of Stakeholders** to fill those gaps and to increase the impact of ECHA's output as multipliers, but also to provide early feedback to improve quality and adapt to changes and build a trustworthy relationship.

Important: If you want to join ECHA's stakeholder list and keep yourself informed about batteries related events and activities subscribe from the following link. (or https://echa-elm.powerappsportals.com/batteriesregulationsubscriptionpage/). Or scan the QR code.

ECHA also has a functional mailbox dedicated fully to the Batteries team: Restriction-Batteries@echa.europa.eu. Please use it in case you would like to get in touch with ECHA's batteries team.

Augusto provided further sources of information, to remain up to date and explained how information is protected along the 'have your say' processes.

Take home messages:

- Good quality information for authorities is key for sound regulatory decisions.

- Sharing of information is also in the interest of stakeholders (to avoid decisions based on assumptions and precautionary principle)
- ECHA has robust processes in place to guarantee confidentiality of data in all regulatory processes.
- Cooperation with stakeholders is vital to understand the impact of regulatory decisions and find the right balance between risk reduction and impact mitigation.
- Input needed both from smaller companies (SMEs) as well as larger ones to accurately cover the entire sector and perspectives.

Comments & discussion

- It was stressed that there is a need to clarify the scope of the report/restrictions as those will focus on "Substances of Concern", which involves a broader spectrum of substances than REACH. The information needs for the different lifecycle stages will have to be clarified as well. It was clarified that SoCs also include substances that can hamper recycling, and this is a key step of the lifecycle. The recycling process should allow to safely recover secondary raw materials.
- It was recalled that the wording in Article 6(5) was introduced during the co-decision process and that the definition presents a small difference with the narrative of the Commission in the CSS document. In practical terms, SoC relates to CLP and substances hindering recycling. The text of the article needs to be seen with the development of other legislations, e.g., the ESPR. In the context of ESPR, the JRC developed a series of documents to define precisely what are the substances hindering recycling. There will be further guidance under the ESPR. ECHA will also develop criteria for substances hindering recycling in phase 2 of the project.
- It was clarified that the report needs to be submitted to EP and Council, following a request from the co-legislators. It is not the first time, it also happened for the packaging regulations. It makes sense to have a mapping before launching actions.
- Restrictions are to be seen as a safety net: they can have prescriptions not only based on the concentration, but also suggest risk management measures, e.g., to limit exposure by controlling how substances are managed. This is important to keep in mind in the case of batteries, as there is the recognition that some substances are essential for manufacturing an article such as a battery. Hence uses will be supported if there are some conditions of use, but those need to cover the lifecycle including the waste stage.

Questions

- What are the reasons for the metal sub-group in Annex I (already restricted substances)?
    - The Commission recognises existing restrictions but wants to understand whether the uses in other types of batteries should be restricted or if there is a good reason for the use.
- Will the effectiveness of existing legislations be taken into account?
    - ECHA recalled that Annex XV includes a section where this kind of information needs to be provided.
- What can be expected between now and 2027? Will restrictions be launched?
    - The Commission indicated that they are looking forward to the report to analyse it in detail before deciding on restrictions (unless unforeseen events like accidents that would require an earlier intervention). Member States can also initiate restrictions, but there seems to be no clear coordination of such initiatives up to now.
- Will the report be submitted to a Public Consultation?
    - ECHA does not foresee any PC as informal part of the report. They will see which part of the information they receive and there will be an exchange to see if the information

is correct or needs to be finetuned. They realise battery technologies change fast and the list of SoCs may quickly become outdated.

- Will this be a one-shot exercise, or will the list be kept as a dynamic one?
    - ECHA indicated that they are discussing this internally and this is one of the reasons they are dividing the process into two phases. In the second phase, they will review the list and if there is any significant change vs. the first phase, there will still be a possibility to include it. It was considered whether it could be a rolling substances list.

Enrique Garcia-John (Joint Research Center, JRC) presented the technical recommendations for the targeted amendment of the EU List of Waste entries relevant to batteries. He welcomed the ECaBaM initiative and highlighted the importance of the waste aspects in the context of the restructuring of the legislative framework for batteries and waste batteries. The overarching objectives include besides increasing circularity in the batteries' lifecycle; reducing the environmental footprint of batteries; minimising the emissions of harmful substances (specific provisions in batteries); also decreasing reliance on critical raw materials and encouraging the EU's strategic autonomy in the battery value chain. Updating the European List of Waste entries relevant to batteries will facilitate proper management, tracing, and reporting of battery-related waste.

The JRC is providing technical support to the preparation, implementation and accompanying measures related to new Batteries Regulation and particularly on Recital 116 that should be revised to reflect all battery chemistries, in particular the codes for lithium-based waste batteries, to enable proper sorting and reporting of such waste batteries. The JRC supports the development of targeted amendments of the European List of Waste (LoW) entries relevant to batteries. While the focus is on new battery chemistries, the scope of the JRC work is larger and touches a number of legislations summarised on slide 41. The definitions to keep in mind are summarised on slide 42.

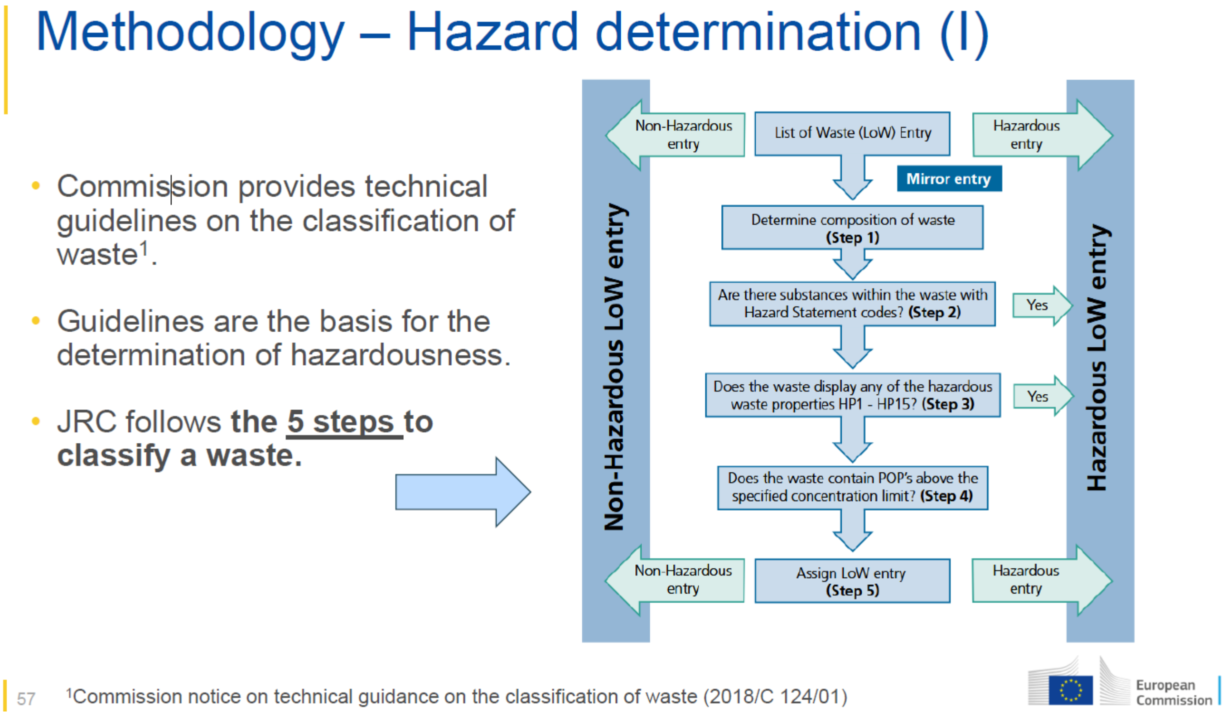
The JRC's work aims at delivering a technical report providing evidence to back up a potential targeted amendment of the List of Waste for entries relevant to batteries. The draft final report has been distributed to the Waste Expert Group, which had a meeting on 8 May 2024. The report is based on JRC research but also input received from Member States and stakeholders following a workshop held in November 2023. The Commission will propose a Delegated Act to amend the List of Waste.

The scope of the project is detailed on slides 43-48 and covers certain types of batteries and the following batteries related waste streams: waste batteries, battery manufacturing waste, intermediate material flows of battery waste treatment.

Regarding the methodology, it was agreed that there is no need to invent it as it exists but there was a need for deeper knowledge of chemistry and properties. Waste is hazardous or not depending on contents and amounts: they use the mixture rules overall even if there are some divergences with CLP. Since the latest LoW revision, novel battery types are being produced, enter the market, end up as waste, and are already recycled in some cases. Battery related wastes that do not have a specific waste code need to be assigned to existing waste codes from the EU LoW. Hence the current LoW may not reflect the characteristics (especially hazardous) of the battery waste stream under scope.

JRC looked at national implementations as a number of Member States publish their own LoW adapted to their needs. As part of the consultation of the Expert Group on Waste, Members States were asked among other things how battery related wastes are currently classified and whether the List of Waste has already been adapted or will be adapted in the near future. The consultation revealed an inhomogeneous picture in the EU as shown on slides 50-51. This was particularly evident for the lithium black mass: different waste codes are used.

Enrique presented the method for the hazard determination of the hazard. To prepare a potential amendment of the EU LoW, the current EU (and national) LoW entries are analysed. After the identification of the different battery waste relevant streams and their classification, the missing LoW entries for this waste are identified. Based on the classification of the battery waste, the JRC has issued recommendations for a potential amendment of the EU LoW in its draft final report.



For the Li batteries, seven different lithium battery chemistries are under scope to cover the broad variety and typically, the mineral composition of the cathode makes the difference between battery chemistries. The results of the exercise are summarised in the slides 56-60.

Wrapping up, 44 LoW entries were addressed – amended or new. The proposal of the JRC is quite granular. New codes for battery manufacturing waste for all chemistries are to be added to sub-chapter 16 06. There is also an alignment of the terminology with the Battery Regulation. New specific intermediate fraction (black mass) codes are proposed for all chemistries – hazardous. Slags and salts also addressed

Finally, he concluded with the next steps: the draft JRC report was shared with Waste Expert Group (WEG) on 10 April and will be discussed on 8 May**. The adoption by the Commission is envisaged by Q3 2024.**

Comments

- Comments were made on the Li batteries in scope: LCO, LMO, NMC, NCA, LTO, LFP, and LiSOCl. The latter is a primary battery while all others are rechargeable batteries. Why was the LiSOCl2 singled out?

  - JRC explained that there was no specific consideration of the application. They did a survey on the most relevant chemistries. These were elected as the 7 most relevant/relevant volumes. There was some disagreement on the relevance of the LiSOCl2 one – this will be checked. Also 6 codes describe the cathode chemistry but one of them refers to the anode: batteries can be both NMC and LTO- this is not a separate family but a description from different angles.
- Participants also enquired on the extent to which the JRC's work may be used in ECHA's report, whether it already addresses the needs and what its gaps are.
  - The Commission replied that these are two separate legislations and hence there is a need to check the categorisation, but ECHA will look at the report to assess what information is available and can be used. The JRC work contains a substantial amount of information on what is in waste and what is in waste batteries but does not touch on auxiliary chemicals. Process chemicals may not be adequately described and need to be addressed via industry surveys. This could also be an opportunity to review the JRC report and amend as technologies are evolving.

Session 2: Industry's knowledge relevant in helping ECHA to understand impacts and criticalities.

This session was intended as an active discussion between all participants to agree on guiding questions for industry to deliver on ECHA's information needs. Participants were invited to read questions and confirm their usefulness or provide further feedback and questions to ensure their completeness.

Guiding questions:

Chemicals used, emissions and end of life:

Question	Comments from participants
1. What chemicals are used in batteries and their production? Which is their hazard profile?	• Questions 1, 2, and 3 are interlinked and should be taken into account when processing the answers. • "Chemicals" is not the correct wording; substance is more appropriate, and it is so defined under REACH and CLP. • Suggestion to better differentiate hazard profiles rather than grouping everything under SoCs. • No need to ask for the hazard profile, everything should have been notified to ECHA. ○ ECHA agreed that well-known things (e.g., notifications in Annex VI) do not need to be repeated. Reduce input to aspects that are not known, also for self-classifications. • Most of that information is confidential business information. • In battery manufacturing, we have direct and indirect materials. Direct materials find their way into the product, indirect materials don't. Indirect materials are numberless (glues, lubricants, welding gases, welding electrodes,…). We need to delineate what indirect materials are to be considered. On the other hand, we already see that

	generic REACH restrictions regulate that: ECHA- as much as they can but they have to be practical (critical to the manufacturing of substances). ○ ECHA noted that we have to be pragmatic and see what is really relevant for the manufacturing. Focus would be on those substances that are critical to the manufacturing.
2. What technical functions do these substances play in the batteries and their production?	• Question 2 has to be split into two questions: substances used in production processes NOT ending up in batteries AND substances ending up in batteries. ○ Note by Eurometaux: If there are substances helping recycling not part of the battery cycle, that may not have been included in the JRC report. • "Chemical" as in formulation (highest level of detail). • To complement with: How critical are the materials for the battery functioning?
3. Where the substances will end up (e.g., electrodes, battery cells, electrolytes and battery casings/packaging, etc.)	• This is technology and market-segment related. • Packaging is not relevant for the batteries regulation, it is more for waste packaging regulation ○ Note by ECHA: the battery pack is part of the battery. If it is on the outside, it is not included. • To complement with: Where will the substances end up?
4. What are the generic volumes and trends?	
5. What are the generic emissions and exposure levels during manufacturing, use & end of life?	• Relevant, but needs to be further elaborated: emissions and exposure depend on substances used, techniques and abatement technologies. • Clarification that this question focuses on the materials directly used for the manufacturing of batteries and the emissions during the manufacturing of batteries, and those materials that are relevant to the recycling of the battery itself. • Include the possibility to provide information about existing risk management measures. • Restrict to battery lifecycle. • Need to cover second life applications. • "Use" could be deleted from the question since that phase may not be relevant (almost all are sealed and there are no emissions), except for conditions such as accidental releases, that for example REACH does not cover. ○ ECHA noted that they would follow similar approach to REACH, where these kinds of situations are not covered but only normal foreseeable working conditions. • This question is for manufacturers and recyclers, whereas questions 6 and 7 are only for recyclers.

6. Recycling rates of the batteries and of the materials they contain?	• Relevant question, but it is perhaps already covered in the JRC report.
	• Suggestion to differentiate recycling rates of the batteries, potential recycling rates for the materials, and actual material recovery rates.
	• Suggestion to add a question on recycling processes to achieve specific recycling rates.
	• Suggestion to add re-use.
	• What about second life criteria? How to report it?
	  ○ Reply: it is the same composition but from the perspective of managing the risk and it is not so relevant because there is no exposure during use. From the carbon perspective it makes a difference.
	  ○ ECHA added that it is important from the SEA perspective and needs to be taken into account for a restriction.
	• Recycling rates for EV batteries will be low for now and probably until 2030.

7. What are the substances hampering the recycling of batteries and why?	• New question suggested: what are the substances used or generated in the recycling process (not related to the metals that are in)? • Not only ask about hampering recycling, but complement the question asking what substances also promote the recyclability of batteries, e.g., Pb. • New question could be added: what are the substances used or generated in the recycling process? What is their technical function? Volumes and trends? • There is no link between the cost to extract a material and its value on the market (e.g., LFP batteries, Phosphorus impedes recycling because of the low value of recovered material). The new question could read: is there an economic reason for a battery not to be recycled (e.g., the technology is too expensive)?
8. Others	• Keep focus on specific battery types. • How to enforce the information delivery for batteries that are only imported in the EU, not manufactured? Do we need to keep importers sufficiently involved?

Materials-availability:

Question	Comments
1. What is the availability of those materials in the EU?	• Suggestion to remove the question since it may not be relevant to the scope of Art. 6.5. ○ Eurometaux noted that self-sufficiency is part of EU objectives and should be recognised in all EU pieces of legislation, so it may be relevant. • Only relevant if focused on substance availability. • In formulations (many raw materials) this is a tricky question since some raw materials might come from global sources but are manufactured in the EU.

	• Suggestion to change TO the EU rather than IN the EU. • New question could be added: what are the risks for the domestic supply chain? • Need to take into account both primary and secondary materials (collection of portable used electronics) • Suggestion to add to the question processing capacity and not only availability of materials.
2. Connection with the Critical Raw Materials Act (e.g., CRM/SRM list)?	• Okay to include it but looking at the specification of the material. • More a question for the European Commission rather than an ECHA restriction process. • This is a political question. • Not for the core business of batteries, minor question but not unimportant.
3. Are the substances used in other Green Deal/Digital applications?	• To complement the question: how important/critical is the material for innovation in new battery technologies (and patents)? • What about future new technologies to promote innovation in the EU? • More a question for the European Commission rather than an ECHA restriction process. • Out of scope of the Batteries Regulation.

Risk control and substitution:

Question	Comments
1. What are the existing risk management measures in place throughout the lifecycle?	• Are physicochemical properties in scope? ○ They are because they link to all classifications – then the risk management measures to deal with flammability are also in scope (but only applies to certain batteries).
2. Within what boundaries are they substitutable?	• Risk control means boundaries in substitution focus maybe on what matters – in other words, you may want to risk manage something that is already obsolete due to fast technology change. • Need to reframe the question: What are the unintended consequences of substitution, looking at the full lifecycle? (regrettable substitution) • Need to adjust: are there alternatives available? Within what boundaries is substitution possible? • New question suggestion: What is the timeline of compensating for the substitution? And implications for users? ○ Eurometaux noted that this is a question for later.
Other	• Missing topic: socio-economic aspects such as skills, jobs, and knowledge. • Where is the context of relative emissions/risk compared to other users of that substance? (emissions from

	batteries of X substance may amount to 1% and they will be addressed. ○ Eurometaux noted the TNO study under preparation is looking into it: expected increases, main growth areas of the Green Deal and how much it will contribute to the regional background.

The chair Francesco Gattiglio (Albermarle) closed the session and the first day of the workshop thanking all the participants for their proactiveness and useful insights and feedback. The comments and recommendations from the interactive session will be transmitted to Ramboll to refine the questionnaire and have the right questions to feed the relevant information.

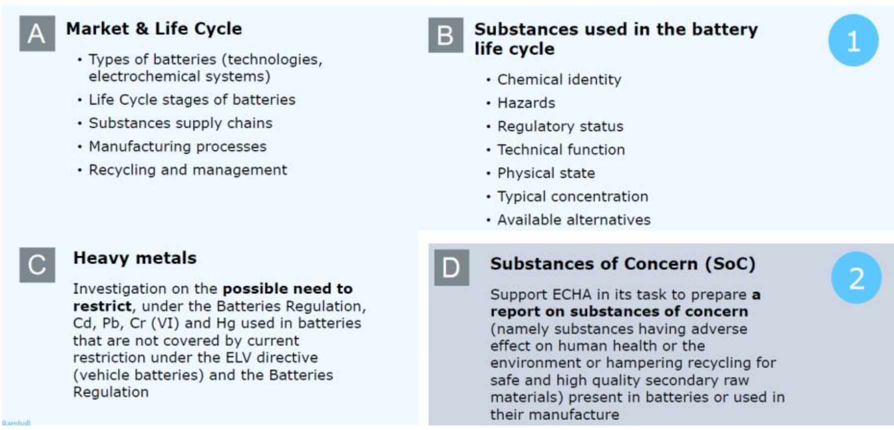
Session 3: capacity-building

The chair **Klaus Kamps** (ECFIA) opened the second day of the workshop reminding participants of the Eurometaux antitrust rules and explained that the objective of the second day would be (1) to learn more about the mapping work that Ramboll is conducting for the ECHA report and the information gaps they have so far identified, and (2) start the capacity-building on batteries, provided by different experts in the field. The capacity-building was divided into three sub-sessions: a) Overview of trends in battery technologies (and volumes), new cathodes, new anodes, new uses, b) Future of cell manufacturing in the EU and c) Overview of battery recycling processes and recycling operators in the EU.

Presentation 1: Study on substances of concern in batteries - Phase 1

Alexander Potrykus (Ramboll) opened the session by presenting the work that its consultancy is conducting to support ECHA's report.

As presented by ECHA on the first day, the first task will be the **identification and prioritisation of substances of concern.** Here the task for ECHA was to support the Commission in preparing the list and identifying some regulatory risk management options to control risks. The study has been outsourced to Ramboll, working under ECHA's supervision. Alexander Potrykus presented the scope of work and methodology, the information gaps in respect to substances used and in scope they have so far encountered and the questionnaire they are preparing to fill those information gaps. He recalled the scope and methodology of the work using this slide:



He referred to the information sources that will be used including the ECHA database, EU and national reports, open source and literature studies, stakeholder input. Day 1 of the workshop showed that the JRC report will be an important source of information.

The discussion started on the definition of SoCs as in the ESPR (shown on slide 12). The visual on slide 13 shows the broader scope vs. the Substances of Very High Concern (SVHCs), the CLP Annex VI to also include substances affecting recycling.

What are the information gaps?

- Data gap 1: Identify substances used in batteries, within those that identify as SVHC, as SoC because of classification (this was helped by discussion on Day 1)
- Data gap 2: or because they negatively affect use and recycling materials (need for criteria)

Questions used to approach this:

- *Which substances are used in the batteries lifecycle?*
- *Which substances are present in batteries or used in their manufacture or recycling?*
- *In which lifecycle stage is the substance present?*
- *What is their technical function, physical state, typical concentration?*
- *What are available alternatives?*
- *In which compartments of the batteries are the substances used?*
- *Which substances negatively affect re-use and recycling of materials in the product in which they are present?*
- *What is their technical function, physical state, typical concentration?*
- *What are available alternatives?*

The questionnaire is still a draft version and in coordination with ECHA, needs to be revised to consider the JRC report. Key is to pose the relevant questions to close the information gaps. Slides 18-24 show how the questionnaire is organised and provide some screenshots. Some modifications will be included to consider comments made during Day 1 (CrVI to transform to CrIII, 4 metals in Annex 1, category reflects use etc.). There are 2 options to complete the data, with a preference for the Excel file that can be downloaded.

Comments:

- It was stressed that restrictions should identify risks, which requires exposure data. Does the questionnaire include information on risks and exposure, for all investigated substances?

Specific comments:

- Question D3 (Please indicate the capacity or the capacity range of this type of battery in Ah or mAh): this depends on the weight of material you put in the electrodes. Why use the milliampere hour (mAh) of each technology? This question may not be useful, as the capacity is not linked to composition.
- Question D1: Ramboll explained they need to provide a market overview, hence the question related to market types. Is it relevant when it comes to collecting information on substances?
- Questions D10-11-12: Why this question? Substances are embedded in batteries and eventually generate waste. One can distinguish the volumes A referring to the use in manufacturing of the batteries and volumes B corresponding to what is placed on the market (which will differ from A as there is export + import of batteries in the EU). What is the focus of the question: volumes that will become waste? Volumes ending on the EU market? Ramboll explained they do not aim to perform substance/materials flows. They would rather like to have

an idea of whether relevant quantities are in use. ECHA added that quantity used in manufacturing is important as possible exposure to workers and releases to the environment. It is true there are legislations, however there are cases where there is a need for restriction. Substances ending in waste from EU production and imports is important, but they won't be able to get this information from this forum. Could be done in phase 2.

- All Li batteries are rechargeable.

Next steps: it was agreed that **Ramboll would update the questionnaire considering the comments** made at the workshop and in follow-up. **In parallel they will revise the list of questions** after having checked the JRC report, where a lot of work has already been done on recycling efficiency, recovery, review of exposures, SEA etc. Comments should be sent to the functional mailbox ecabam@eurometaux.be to collect feedback and JRC report in parallel.

The questionnaire is now open until 21 June 2024 and available on: https://ec.europa.eu/eusurvey/runner/batteries_survey

Presentation 2: Overview of trends in battery technologies (and volumes), new cathodes, new anodes, new uses

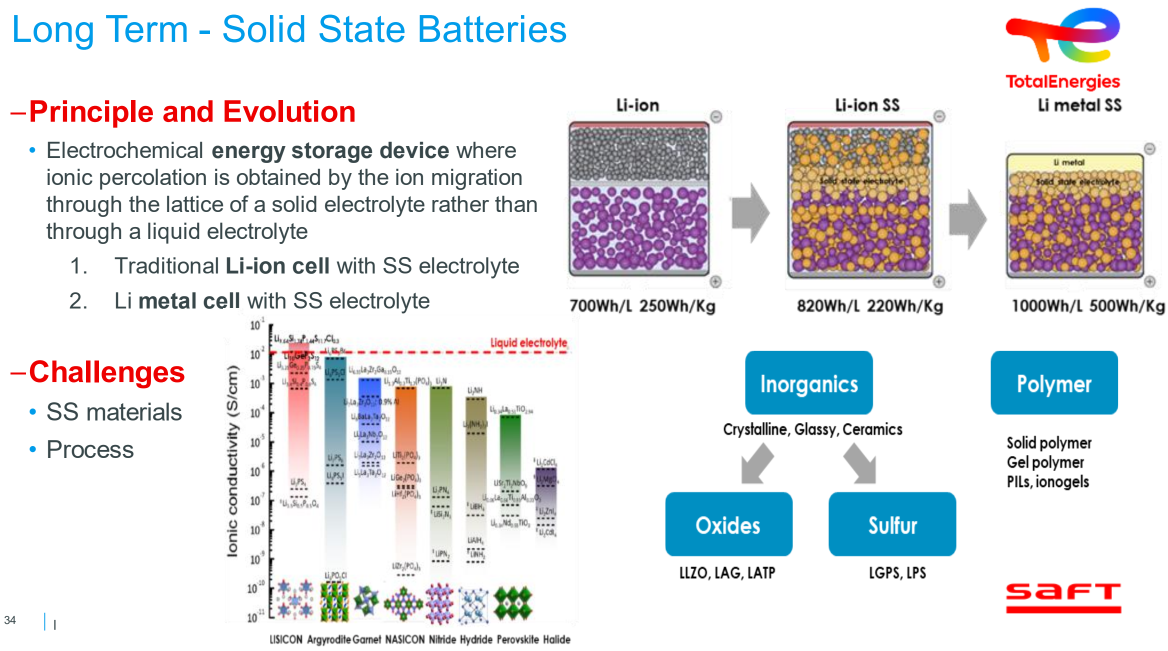
Bernard Simon (SAFT) presented an overview of trends in battery chemistries. He briefly recalled the history of batteries and the key elements in a battery, before providing an overview of the main battery technologies for primary and rechargeable batteries. In particular, he explained which materials can be found in which battery. A battery needs to include a mandatory trio "oxidant (wants electrons)/electrolyte/reductant (gives electrons)" that exchanges electrons & ions. An insulating separator forces the exchange of electrons through external circuit and the internal circuit is closed by an ionic conductor: the electrolyte. A battery will also contain a long list of "inactive" but unavoidable chemical materials (binder, collector, carbon additive, additives, cell container).

In terms of manufacturing process, there are two categories: the paste technology (mix of powder with some water, put on a collector)- typically Pb acid/Ni-Cd batteries; or paint/ink technology (using around 50% organic solvent) for Li batteries. Typically, from raw materials, you make cells and then assemble cells in parallel/series to make bigger batteries. A battery can be made with almost any material with different affinity with electrons, but we want a maximum of energy «in the box» (customer request), which depends on voltage and capacity (number of exchanged electrons). Still, not only energy counts: there are multiple other requirements that explain why so many battery technologies co-exist on the market (and the number will continue to grow). Requirements may be linked to applications: long life, low or intermittent current (primary batteries, non-rechargeable) or long life, high current, deep utilisation (secondary batteries, rechargeable). The batteries that remain on the market have the strongest features for an existing or emerging application. Looking at the global market, demand for all batteries grows, boosted by the EV (slides 47-49).

Slides 51-63 explain the different batteries technologies including the raise of the Li-ion batteries, showing for each of the technologies the active materials, electrolyte, collector, separator, binder, but also the advantages and drawbacks. Their status and future applications are listed as well. The choice of the materials is driven by performance but also safety (e.g., difficult to find a material resisting the electrolyte as well as PTFE for example).

He concluded with some words on the future: what are the perspectives? **The battery demand will continue to grow, with a share for every chemistry** (except pure EV: 100% Li-ion). New technologies (short-term) include: advanced Li-ion (higher energy phosphates, electrolytes at high voltage), Na-ion (already commercial, could compete with LFP for cost), lithium/sulfur (high Wh/kg, low Wh/l), Li metal with liquid, zinc new impulse: Ni/Zn progression shape change of zinc electrodes, Zinc ion...

Regarding long term-solid state batteries, he concluded with the following slide:



Comments:

Regarding the batteries classification/waste classification: LTO is the negative technology. The waste code is different from LMC battery waste code but actually you cannot select only according to one code. Slide 57: LiSOCl2: analysed by JRC, small volume. Solid cathode batteries should be reviewed to be categorised as such.

Presentation 3: Battery technologies in Europe

Parvin Adeli (Nickel Institute) provided a general rundown of the main battery technologies in the EU, an overview of battery capacity, and presented the next generation of batteries that could reach the market in the coming years.

Batteries have a history of more than 270 years, slide 71 showcases their timeline. The key technologies addressed in the overview by Dr Adeli include:

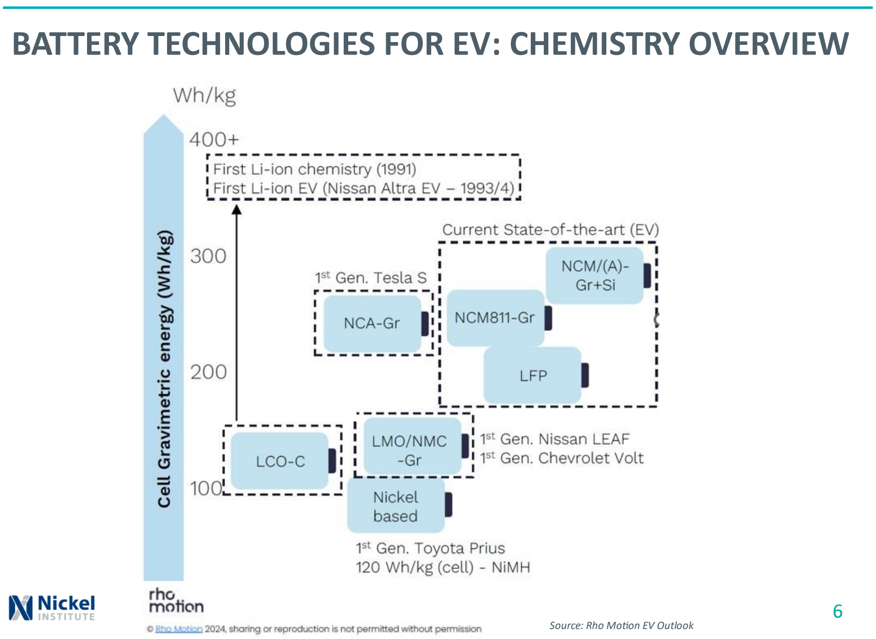
- **Ni-MH (slide 78)**: widely and extensively used in EVs and HEVs, limited-service life of about 200 full cycles. Environmentally friendly and replaced Ni-Cd in Europe by the battery directive.
- **Lithium-ion batteries (slides 75-77, 82-84)**: dominate active materials and have taken a central spot. Their cells come in different formats, cells, modules, or packs, acting as building blocks for each other. Examples of end applications for the different formats include:
  - Cells: portable electronics (phones, cameras)
  - Modules: micromobility (e-bike, scooters)
  - Packs: EVs and Battery Energy Storage System (BESS).

Energy density is dependent upon voltages and voltage profiles. Each technology has evolved, and performances have improved, but there remain fundamental differences in energy density, power density, safety, cycle life, temperature performance and cost.

Dominant cathode materials for Li-ion batteries include:

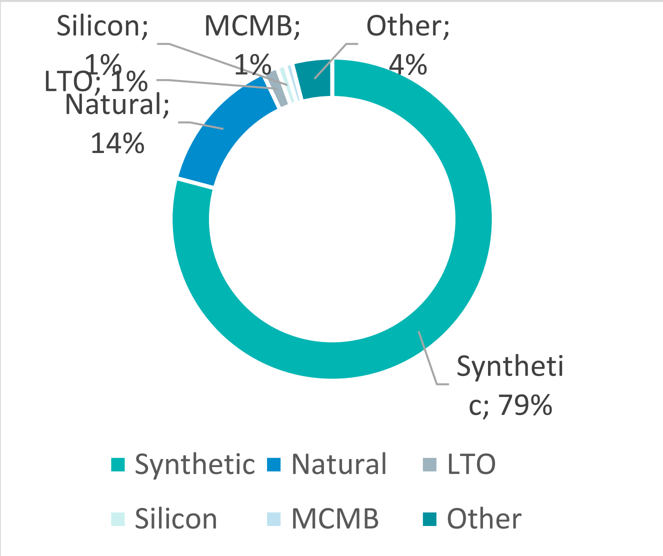
- **Lithium nickel manganese cobalt oxide (NMC):** The desire to reduce cobalt and increase energy density led to the discovery of partially substituting one transition metal oxide (MO2) with another. This maintains the overall layered structure but optimises the properties of nickel, manganese and cobalt as mixed oxide materials.
- **Lithium iron phosphate battery (LFP):** predominant technology and progressing very fast in China. This is a dynamic space, and the technologies keep on evolving.
    - The cathode material has 3D olivine structure. The key elements (Li, Fe, and P) sit in octahedral positions in the crystal lattice while oxygen atoms sit in hexagonal close-packed positions that are slightly distorted. This is a very different structure than high nickel cathodes e.g., NCA which are effectively 2D slabs and in which lithium ions can move around freely in and out of the slabs.
- **LXFP (X: Mn, V) cathodes**: Addition of certain elements (one or more of manganese, vanadium, cobalt, and nickel) to LFP has the potential to raise their specific capacities. These batteries operate at higher voltages and can therefore offer higher output and increased driving range or lighter battery packs.
- Looking at data for previous years, at some point LFP was more expensive than NMC.

Growing global interest in full size electric vehicles meant that energy density had to increase while maintaining unprecedented safety. This also meant increasing the amount of nickel in the battery from 33% to 50% to 80%.



Searching for the most relevant documents of patent literature published for LFP and LXFP retrieves in the region of 6,256 patent documents of which ~5,000 were published in China. As can be seen, most of these assignees are based in Asia. Albemarle and BASF are notable exceptions.

When it comes to **anodes**, **Graphite** has been the dominant choice of anode material since commercialisation of LIB in 1991:



As of August 2022, the 1.57-million-ton global anode materials capacity is made up of **synthetic and natural graphite (97%)** with emerging technologies such as lithium titanate (LTO), silicon and MesoCarbon MicroBeads (MCMB) collectively making up just 3%.

There are currently 34,907 patent families (2012 – 2022). Over three-quarters of patent families have a Chinese priority patent and together with Japan and Korea, the figure is 93.7%.

Different types of **anodes** are displayed in slide 87:

1. **Intercalation:** Intercalation anodes possess intrinsic one-, two- or three-dimensional openings to facilitate lithium-ion transport without significant structural change e.g., graphite
2. **Alloying:** Alloy anodes allow for direct bonding between inserted lithium-ions and the host element
3. **Conversion:** Conversion anodes allow for insertion of lithium-ions into nanosized binary compounds as denoted by MX (M representing transitional metals and X for anions), resulting in reduction of M cations to M^0 and the formation of LiX

Top Commercial Current Owners of Anode-Related Patent Publications: 34,907 patent families, 2012 – 2022. Over three-quarters of patent families have a Chinese priority patent and together with Japan and Korea, the figure is 93.7%.

In terms of the **next generation** of anodes, **silicon technology** is gaining interest:

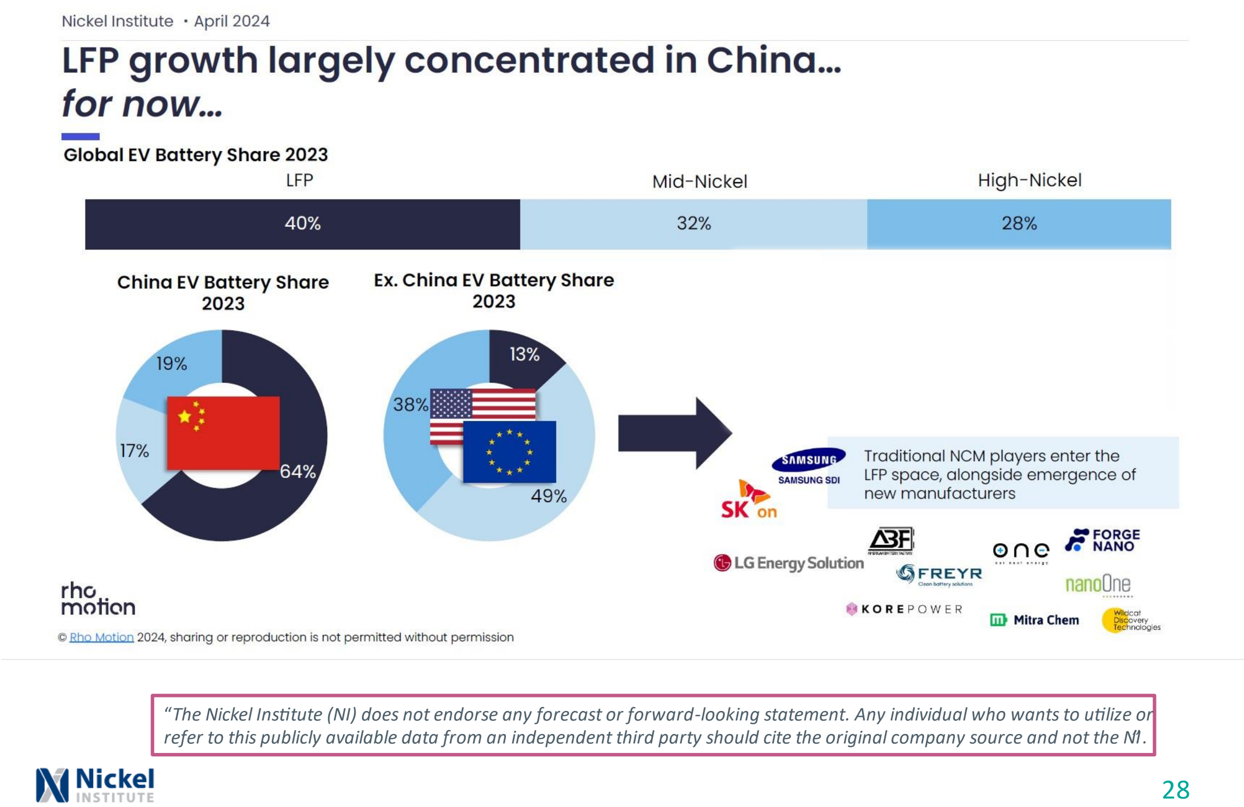
- Silicon's theoretical energy density is ~10x graphite. It raises the overall energy density in Li-ion battery anodes.
- Challenge: The lattice spacing in silicon expands as lithium ions are inserted, swelling to greater than 300% of the original. Swelling causes cracks and fractures and eventual disintegration of the electrode.
- Current solution: Use only a small percentage of silicon in the anode, thereby minimising the swelling but still resulting in improved energy density.
- High nickel NMC811 combined with a graphite/silicon has demonstrated a 20% increase in energy density.
- Silicon based anodes also have the potential for high power and fast charging.

Battery share by application & chemistry:

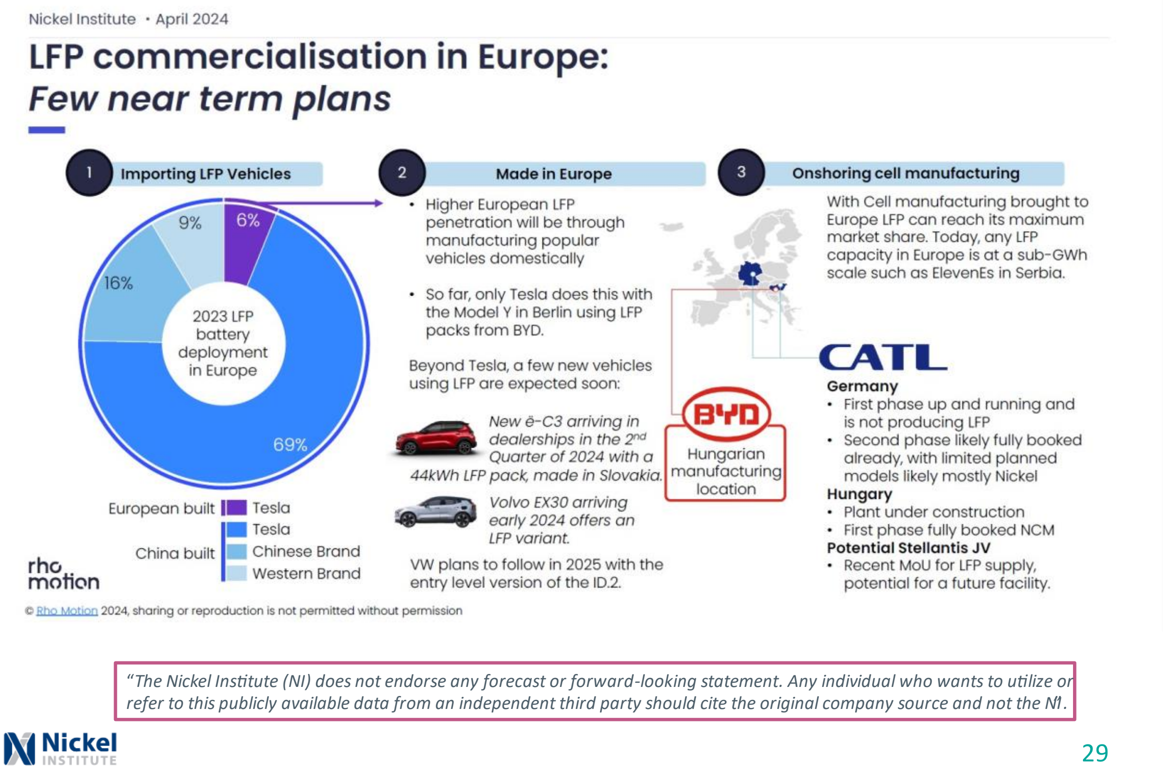
In 2023, EV sales in Europe exceeded 3 million units; 17% higher than the previous year. Around 155 GWh battery capacity was deployed in EVs in Europe in 2023; 31% higher than the previous year.

There is obviously a growing interest in battery capacity for EVs as a result. The main demand by application comes from EVs, followed by stationary storage, portables, and finally micromobility. Demand by chemistry shows that the demand increases mainly for Nickel-based chemistries (NMC), but LFP is growing (more than anticipated thanks to EVs, see the graph on slide 92 and 93).

Based on publicly available announcements, LGES (Poland), Samsung (Hungary), CATL (Germany) and SK On (Hungary) are the top current NCM battery producers in Europe. Northvolth (Sweden) will enter the picture by 2030 (see slide 94). CATL is the only player planning to start producing LFP in Europe



Commercialisation: CATL and BYO have announcements in Europe

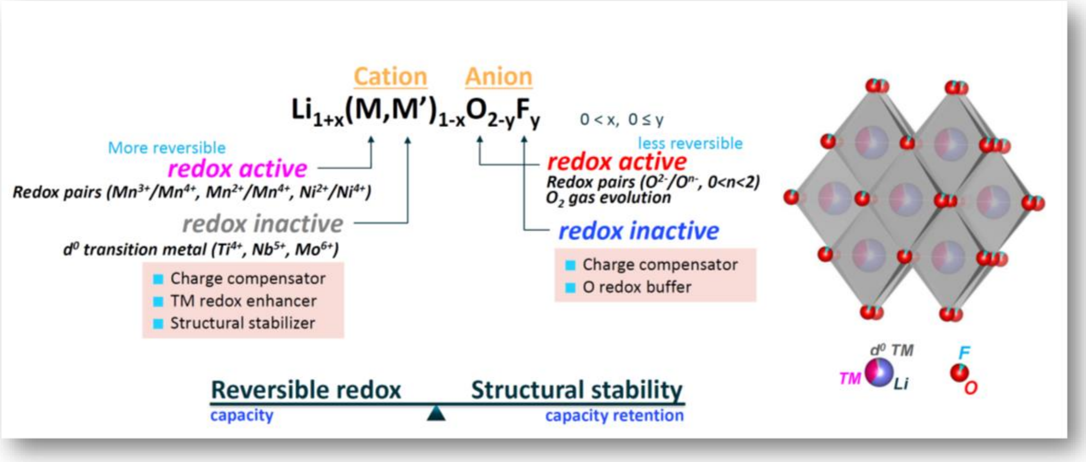


On stationary storage, dominated by LFP since there are less concerns for energy density. This is about Battery Energy Storage System (BESS), an advanced technological solution that allows to store energy in multiple ways for later use (see slide 98).

Parvin Adeli concluded her presentation by presenting the **next-generation battery technologies** that will be reaching the market. These include:

- **LNMO/Gr+Si:** there are several projects funded by the EU working on lithium-ion EV batteries "made in Europe" (e.g., the COBRA consortium project, slide 102).
- **Sodium ion and molten Sodium batteries:** are growing but at a slower pace than expected, faced with cheaper LFP cells, poor cycle life and lower energy compared to CLP and the immaturity of the supply chain. Nevertheless, they could serve the lower end of the EV market 200-300km range (slides 104-106).
- **Solid-state batteries**: these are seen as the "holy grail" for batteries, but they are some years apart from their widespread adoption. Despite enhancing battery safety (replace organic electrolyte with a solid one) and enabling higher volumetric energy density (and thus less stringent packaging demands), solid state batteries suffer from thermal instability, the surface interface integrations damage cell cyclability and are sensitive to overcharge and self-discharge. We have one commercial solid-state from Bolloré/Blue solutions (used in buses).
- **Disordered Rock Salt batteries**.

CATION-DISORDERED ROCKSALT (DRX) CATHODE



Comments

A participant noted that the four-million-mile battery is not 3,000 cycles, but 16,000 cycles, wanting to highlight that an average person is driving less than 80 kilometres a day. That means, theoretically, the four-million-mile battery would last more than 300 years in operation. Now we are talking about batteries that that will easily last 50 years, probably 100 years. That means that you could build a new car around that battery pack 3 or 5 times, which shows how good the technology of lithium ion is with only existing components. The only thing that the lab did was make the right combination of existing readily available components to the battery.

Presentation 4: Lead Battery Overview

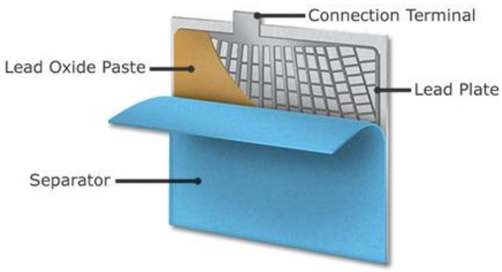
Steve Binks (Consortium for Battery Innovation) presented the overview of Lead batteries. He opened his overview by explaining that choosing the right battery for the right application is key, using some criteria for the selection. It is up to the customer to choose. There are a certain number of Lead-based batteries on the market, taking a second leading position after Lithium:

- **Flooded batteries** – traditional lead-acid batteries consisting of positive and negative plates immersed in electrolyte solution.
- **EFB** – enhanced flooded batteries providing superior performance (e.g. high DCA)
  - They can be used as starting-lighting-ignition (SLI)
  - Grid alloys often with PbCaSn.
- **VRLA** – Valve regulated lead-acid batteries which do not require regular maintenance.
  - They can be gel and the absorptive-glass-mat (AGM)
  - Oxygen evolved at the positive electrode transfers through gas spaces in the separator (gel or AGM) – this is the main difference to EFB.
  - They improve performance characteristics of the flooded battery.
- **Bipolar** (Recent introduction on the market – higher charger density)– highly advanced form of lead batteries.
  - Uses a new design for higher utilisation.
  - Less lead, more plastic – long life at a cheaper cost, much high energy density.

All these available battery types are based more or less on the similar construction: a Lead alloy anode, cathode Lead grid, and a fibre glass separator, immersed in a sulphuric acid electrolyte inside a battery box. Bipolar batteries are more complex in their manufacture but based on a similar structure (slide 119).

Electrodes:

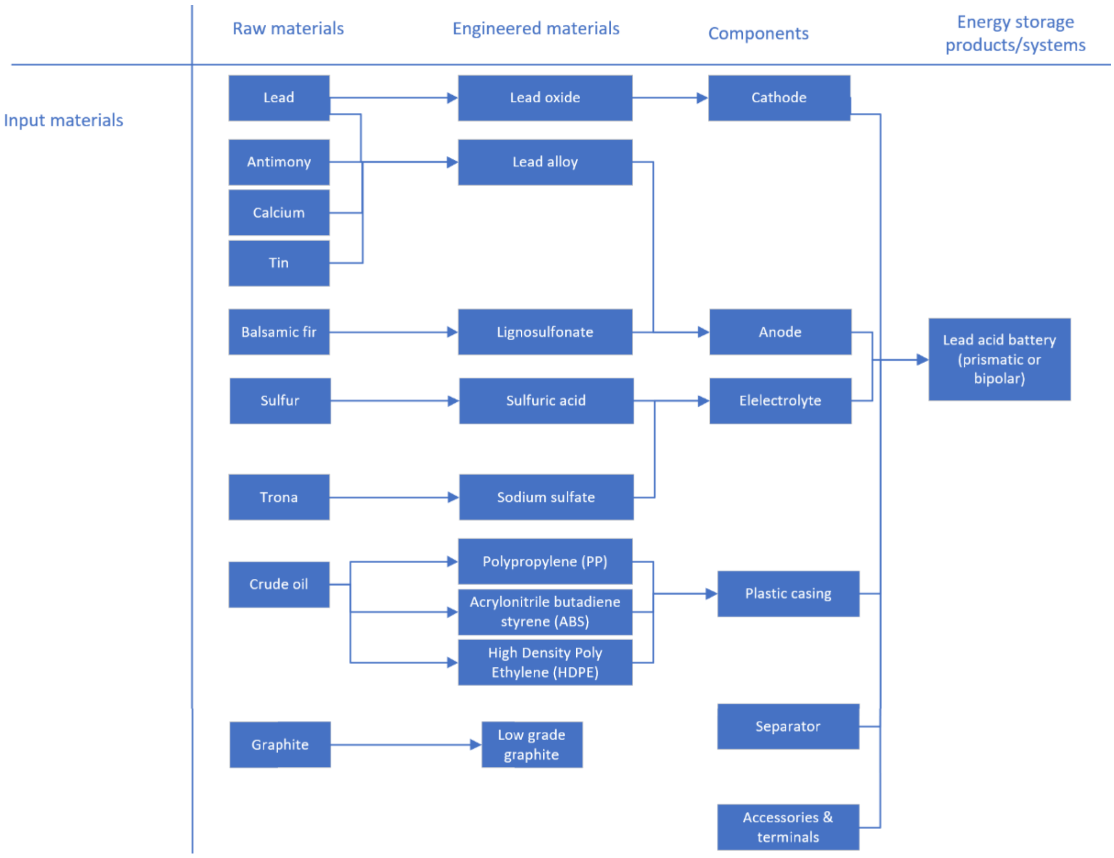
- Active material as described above must be adhered to something – Lead because it is recyclable, cheap, and provides good adhesion.
- Generally, the active material, lead grid, COS, and terminal Pb provide 62-67% of the weight. The remaining third is separator (~1-2%), electrolyte (16-20%), plastic (10-15%)



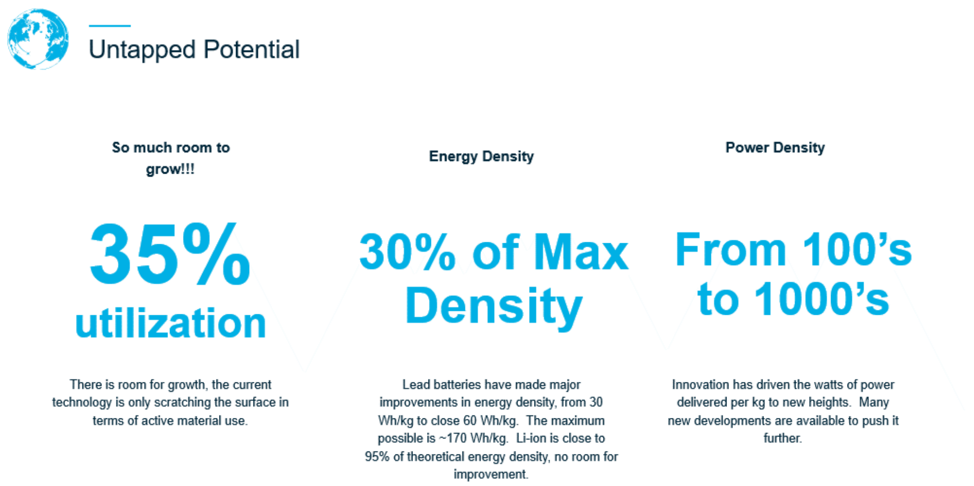
The vast majority of the Lead battery is recyclable, except for the separator, reaching efficiencies of 98%.

Raw materials used include the following, based on a similar simple structure providing the advantage of high recyclability:

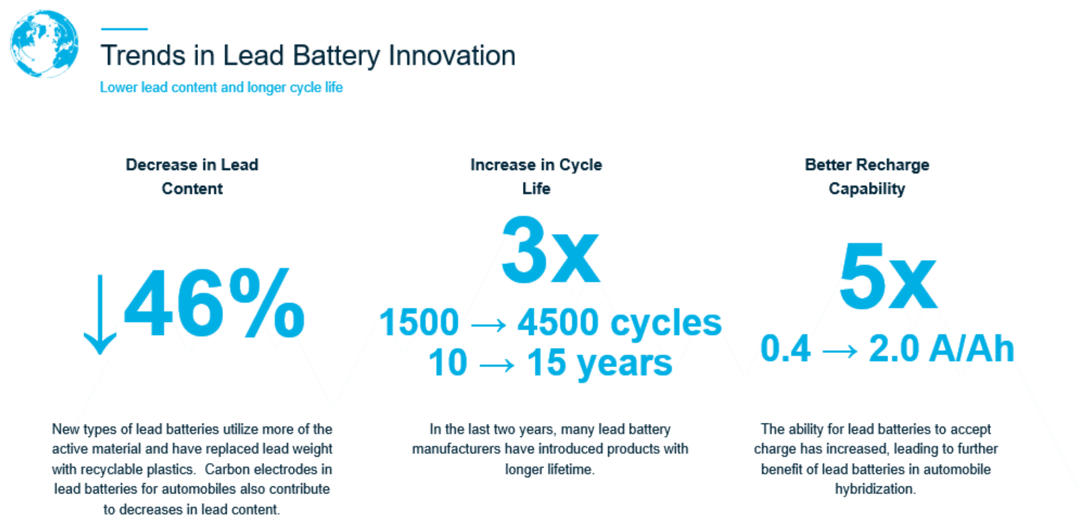
(Some lead batteries also use small amounts of additives: Barium or calcium sulfate, Silver, Carbon Black, Aluminum, Copper)



Lead batteries are used in over 100 applications and are key to dozens of industries. Enormous impact on motive, automotive, telecom, warehousing, and renewable energy markets. This is an industry that is still growing. Lead-based batteries are used in multiple applications further than just EVs. This is illustrated by the battery market overview: In SLI/Auxiliary (Starting, Light, and Ignition), UPS and telecom there is still a big market dominance (90-70% compared to Li) and still predicted to be the lead for some applications due to the beneficial attributes of Lead. For motive, this figure stands at 43% for Lead and 57% for Lithium.



Some of those more advanced batteries have significantly reduced Lead content, into the increased cycle time and recharge capacity, which are some of the weaknesses of Lead-based batteries. Research has shown that these can be significantly increased with the use of different additives.



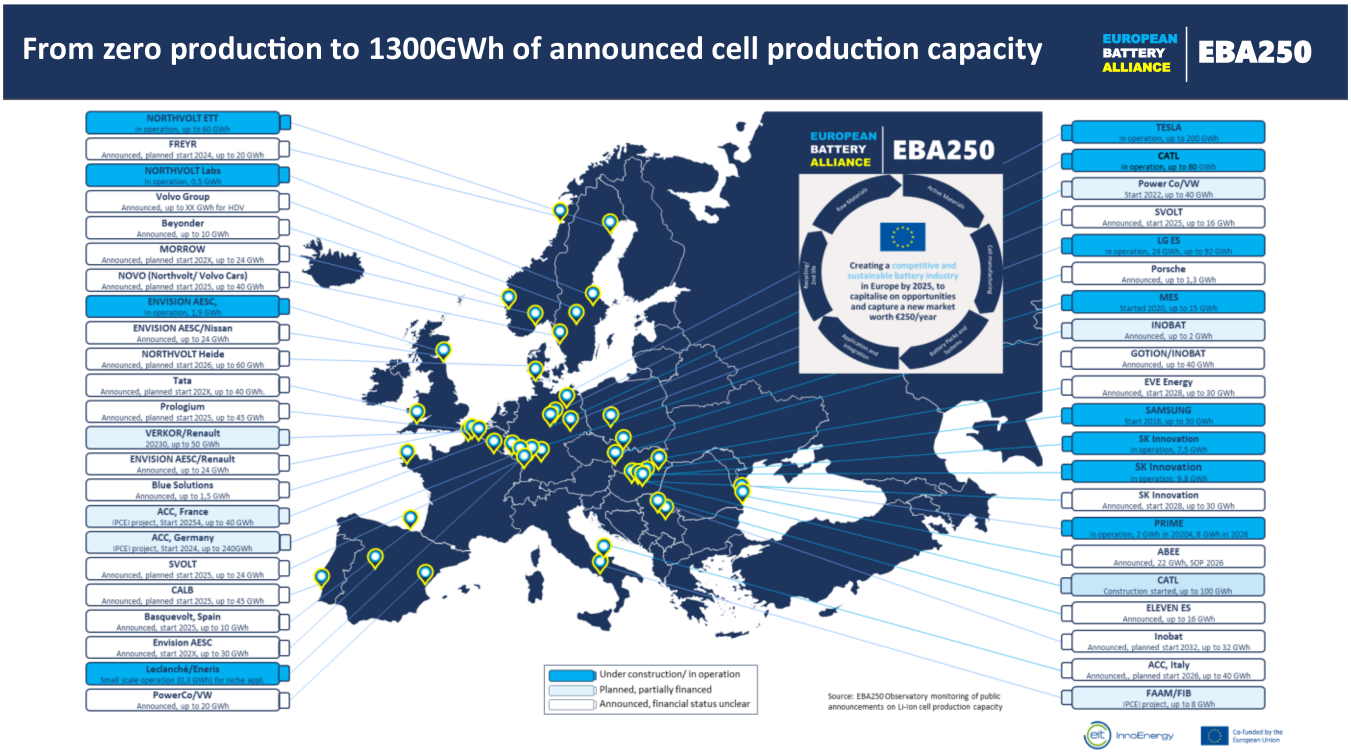
Presentation 5: EBA250 Market Outlook, Future of cell manufacturing in the EU

Ilka von Dalwigk (European Battery Alliance) presented the future of cell manufacturing in the EU. EBA was launched by the European Commission in 2017 with the mission to enable and build the resilient, competitive and sustainable EU battery value chain worth €250bn/a by 2025. Back in 2017 there was no battery supply chain, no cell production capacity in Europe. Nowadays we stand at

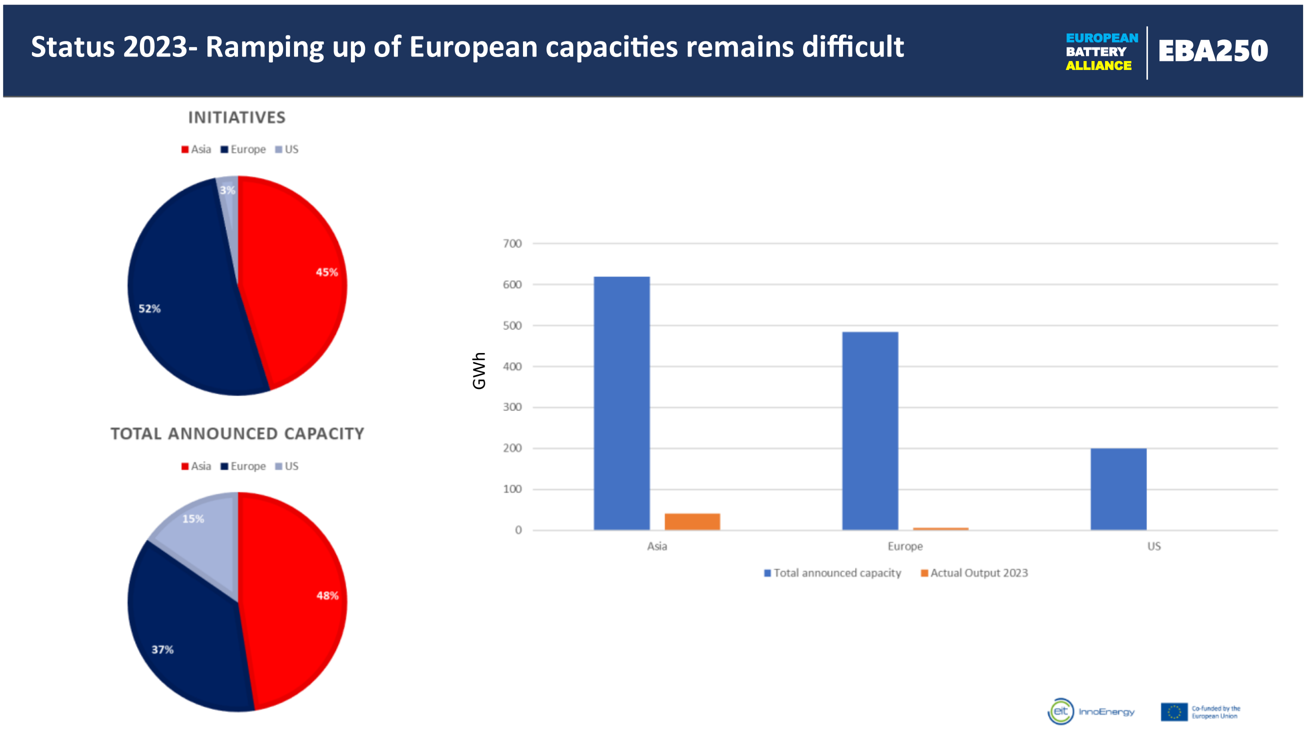
1300GWh of announced cell production capacity – but ramping up of European capacities remains difficult.

The total production capacity in 2016 amounted up to 28 GW hours, today when we see the announcement of one single GW factory it's around the same range, in many times even double its size. Production of Li-ion batteries, thanks to the EV drive, is an expanding market. Nevertheless, it is looking quite bleak in the upstream sector (1% of Li is not even going to the battery industry since it is not fit for purpose), so we are still trying to develop this value chain in the EU.

When it comes to cell manufacturing currently open or announced in the EU, we have around 30 projects, but looking into the detail, the overwhelming part are **focusing on Nickel-based batteries, and very few look at producing LFP** (some have been announced by NO and Asian companies). **Europe's focus has been to jump into an existing technology.**



Ramping up battery production is a difficult game. **Half of the announced initiatives are EU-based, and the rest are in Asia or the US** (predominantly Tesla). There is already an overweight of Asia and Tesla factories in terms of size (bigger factories than European startups that are still growing), that is even more apparent when looking at what has been produced over the last years. Asian companies come with their knowledge and entire supply-chains, which show the **challenges for EU newcomers to ramp up.**



When it comes to mastering mass production of cells, **EU champions are still in a steep learning curve.** Asian utilisation rates (actual quality batteries) are around 90-100% whereas Europeans are below 30% and are still in commissioning phase.

In terms of challenges, the US Inflation Reduction Act stimulated US domestic production and there is increased competition from China (entity of foreign concern for the EU so they have had to increase their market share in the EU). The war in Ukraine has shown that our supply chains are vulnerable, and we need to work internationally to get our feedstocks. Short reminder: quite clear when looking at short-term forecast that projects in the EU are delayed or stopped as money is available in the US. There are more balanced longer-term forecasts for the US growth in the market since it has proven challenging even for them to ramp up production. On Chinese competition, it is a very important factor to keep in mind because new Chinese cars on the market(s) are EVs, so the market share of the EU in China is also shrinking.

EV penetration rates are stalling, but a lot of Chinese affordable cars with LFP batteries will reach the EU market soon (30-40% in China, while 96% of EU announced production is NMC), with a real competition coming our way. Share of EVs made in China and sold in Europe has risen to 8% and could reach 25% in 2025, with prices typically 20% below EU-made models.

There is also competition when it comes to **innovation**, with China in the driving seat.

Looking more broadly into batteries, we should keep an eye on the increasing import of batteries into the EU market due to the slow ramp-up (while the automotive sector needs batteries now) and on the enormous overcapacity in China, and the pressure that it will put on EU players.

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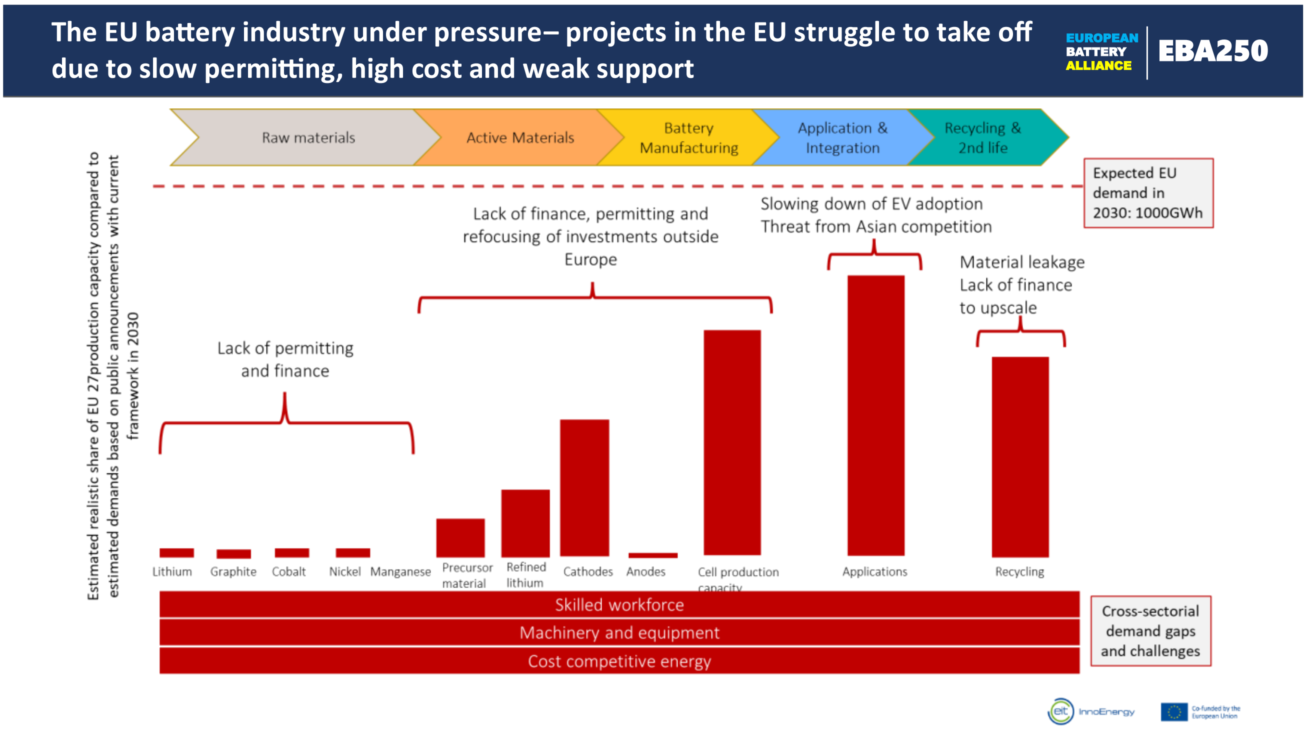
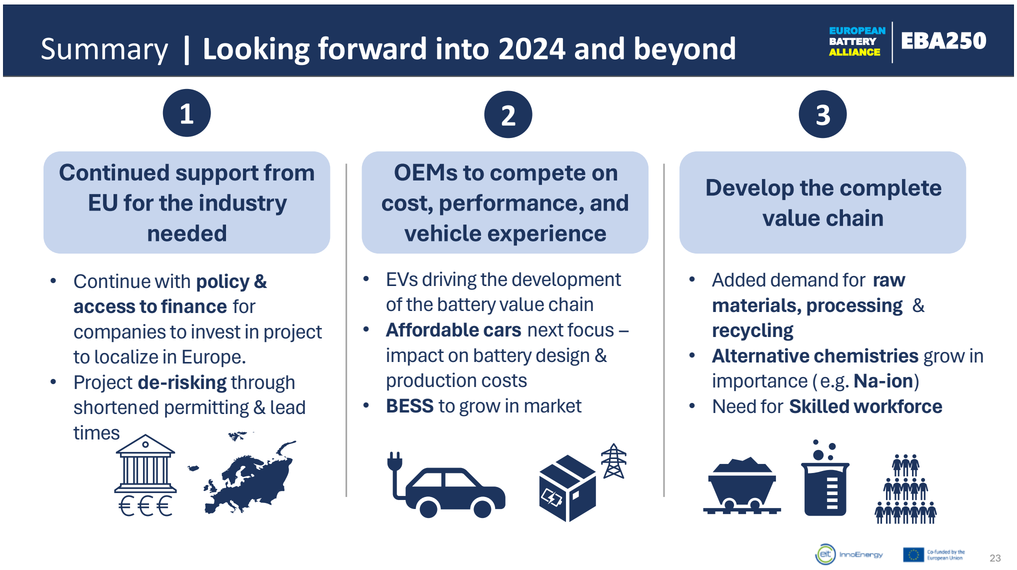


On upcoming trends, **affordable cars** will be coming from Asia and hopefully EU with new cell chemistries. There will be a strong growth of EVs in heavy-weight vehicles that will focus on nickel-based technologies. EVs will be the main driver to move forward but **stationary storage will grow much more strongly** and affect the chemicals mix, opening the door to many battery chemistries such as Sodium-ion or Zinc (but smaller market segment than EVs).

As a summary, the future of the EU batteries industry is not assured, what is important for the EU battery industry is:



Presentation 6: Overview of battery recycling processes for Li-ion batteries

Jan Tytgat (Umicore) presented an overview of battery recycling processes for Li-ion batteries and tried to answer some of the questions raised during the previous sessions.

One key message is that **battery recycling does not start with battery recycling.** The main volume of waste generated in the battery field today is production waste, and it's not because we are not that good in producing, but because every new plant and every segment of the battery manufacturing has to be qualified and that needs production of tests. For the coming decade, we expect that the volume of battery waste will be higher than the volumes coming from the end of life of batteries. The second effect is that the batteries of the future are already being produced now. That means that battery recycling has to be ready to absorb battery waste of the batteries that will be end of life in 10 years, because already they are being produced. All in all, **battery recycling must be flexible, especially given the diversity of the chemistries and technologies coming. Sorting will never be 100% correct.**

Recyling is not the only answer: recycling is essential to complement primary supply and reduce the need for Critical Raw Materials, but primary supply of Ni, Co and Li will remain very important - the recycling of batteries will only bring more than 50% of the input of the recyclers beyond 2030.

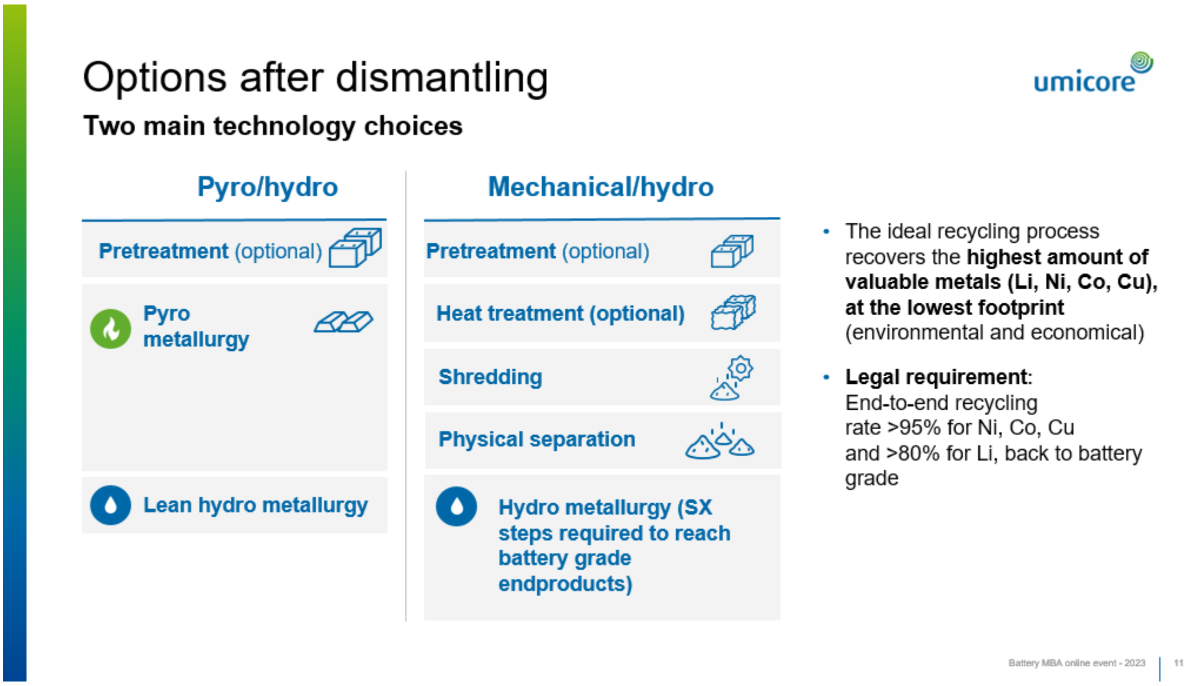
Regarding what drives recycling, you can look at price and the regulatory framework on top of that. If it were only the price, the fluctuation and volatility of the prices would not enable us to build a really strong recycling industry. In a certain quarter of 2022, the price of Li was so high that it was about 60% of the metal price contained in the battery. At low Li prices, economics of recycling become much more challenging for chemistries with lower metal value (as basically only Li bringing value): LFP, HLM. This volatility shows that you need a robust framework to ensure the development of a real recycling industry and not a stop and go industry.

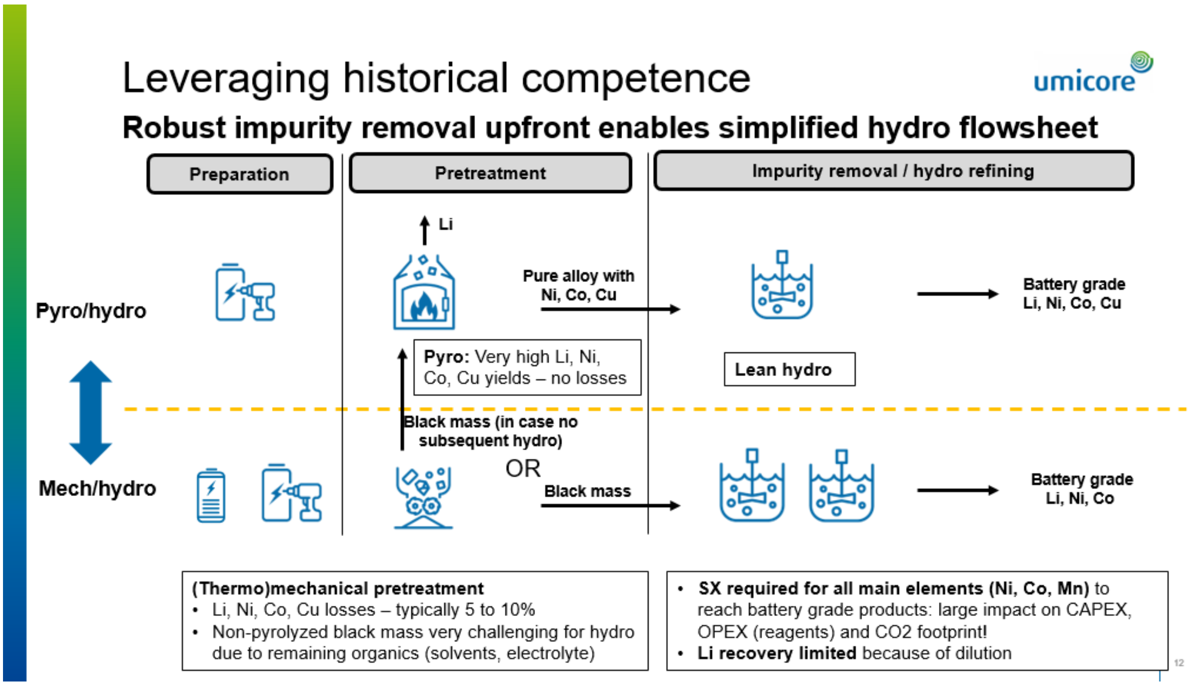
If you compare the composition of a battery pack, compared to concentrates of mines, the situation is much more complex. The recycling processes are thus more complex than production processes of Co or Li from natural resources. Moreover, design for recycling is not always on top of the mind of pack designers, which comes after performance, safety, etc. Dismantling will have to be imaginative, but thankfully the Batteries Regulation now imposes a "reverse Ikea manual" to help with dismantling. For example, there is a more than 10% Al difference in feed composition between a battery pack with Al modules or cell-to-pack without Al modules, which has a huge effect on the recycling process: (mechanical, smelting, leaching …). A battery pack with both NMC and LFP results in Nickel based metallurgy or Iron based metallurgy, where totally different processes are needed.

Battery recyclers need to look at different perspectives:

- Robust processes: Effective volume & mass reduction at massive scale (> 100kt/y), high metal extraction yields, capable to process complex feed mix, and sustainable processes (safe elimination of hazardous compounds, manage occupational health exposure risks, and low environmental impact)
- Comply with product requirements: Output of high-quality battery grade materials (no downcycling), realise effective compatibility with existing primary CAM-flowsheet (is there a market for it?), and products for high-volume addressable markets.
- Services portfolio offered: Capability to collect and treat a wide variety of materials (production scrap, off-spec components, end-of-life batteries, modules, cells, black mass), closed-loop operating system, competence center with integrated offering – "design for circularity".

Dismantling is the first step, but core is what to do with the cells, with two main technology choices (below). The aim for both is to have the highest yield and comply with legal requirements:





The big difference is in fact in the hydro process:

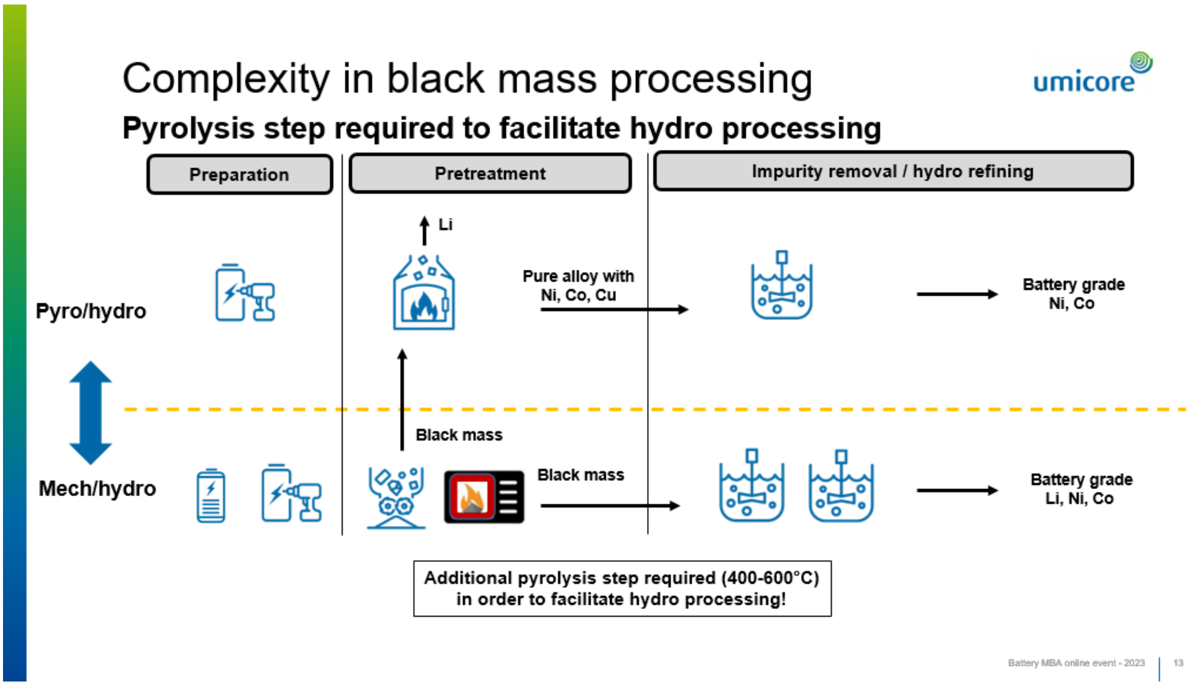
- If you do the **pre-treatment with a pyro process,** you already have a rough separation between Ni, Co, Cu in one fraction, and the lesser valuable elements in another fraction, and that results in a rather lean higher metallurgical process that in fact connects with existing processes.
    - The Co Ni refinery is something that has already existed already for decades, and if you do this pyrometallurgical pre-treatment, then the metal fraction that comes out of

the pyrometallurgy fits immediately in existing hydro flow sheets that can then connect to the rest of the production.

- Whereas if you do the **mechanical pretreatment**, then you have in the first phase the “black mass”, a mixture of anode, cathode material and other components with Cu and Al metallic fraction that have to be separated, and can pass to a hydrometallurgical process, but because the complexity of what is going into the hydrometallurgy it is much more complicated and requires more steps.

Answering some previous questions on **what chemicals are used during recycling**, Jan Tytgat explained:

- **Pyro step**: the only chemicals you add there is basic slag forming agents (sand, limestone). This process requires a temperature of over 400 degrees that is sufficient to destroy PFAS components.
- **Hydro step:** you need organic solvents and an extractant (phosphorous-based organic compound making bonds with Ni, Co) resulting in separation. Robust impurity removal upfront enables simplified hydro flowsheet.



Complexity in black mass processing: there is a need for thermal pyrolysis of the black mass, since it contains a lot of organic chemicals, and they may hinder the solvent extraction process in hydro processes. Nowadays, the black mass going into a hydro process will first need to go through a pyro treatment that could remove the PFAS. The practice of today is that most of the black mass goes through a pyro process.

Regarding the main risks associated with processing that recyclers should tackle, these are:

- Exposure to CMRs during shredding operations, with risk of exposure if the right measures are not taken with the powders (incident reported in Hungary, June 2023)
- Fire risk during warehousing of damaged or defective batteries (incident reported in France, Feb. 2024)

Moreover, if you use chemicals (in this case acids) to dissolve metals you need to neutralise them with a base. The result of an acid and a base are salts. As a result, if you use a lot of chemicals, you may have a total waste salt that is quite significant. When you recycle one tonne of modules, you generate almost one tonne of residual waste.

Key takeaways:

- Battery recycling is an enormous opportunity as volumes available for recycling are growing rapidly, but also presents a number of key **challenges** across the value chain (complexity of feed materials, yields, impurity control, economics, sustainability, …)
- Several approaches on battery recycling exist: **Pyro-Hydro, and (Thermo)mechanical-Hydro** are most mature, and currently being industrialised. Direct Recycling is currently at academic stage, and major questions remain on industrial feasibility, especially for EOL batteries.
- The ideal recycling process recovers the highest amount of valuable metals (Li, Ni, Co, Cu), at the lowest footprint (environmental and economical). Umicore has developed and is now upscaling a smart combination of Pyro and Hydro for recycling of NMC EV batteries, with highest yields and lowest end-to-end CO2 footprint.
- **Design for recycling** is too often still an afterthought, as design for cost / performance prevail. As a result, recycling the complex cell2packs will be complex and costly.

Presentation 7: Lead Battery Recycling

Steve Binks (International Lead Association) presented the overview of the Pb battery recycling process, which is very mature in the EU and US. He started his presentation with an illustrative video available here.

Around a million tonnes of Pb go through recycling in the EU per year. The EU is self-sufficient in this regard, 85% of the material in the market is recycled Pb, whereas 15% is imported.

The process flow diagram in slide 184 represents what goes on in the smelter. Larger industry batteries follow the same process as for automative, the only difference is the dismantling before they go through the process. Slags from the foundry contains 3% lead of hazardous waste.

There are new technologies (slide 188) not adopted yet based on a hydro process that remove the need for a pyro process (room temperature electrochemical process reducing the need for smelting operations), resulting in less energy-intensive processes but they are not used by European manufacturers, only trialed in India, Israel, and US.

The recycling efficiency of Pb batteries is extremely high, studies done under ELV regulation confirms values (as a maximum achievable)

- Only lead: 68%
- Lead + PP: 74%
- Lead + PP + Electrolyte: 78%
- Lead + PP + Electrolyte + Sulphates: over 90%
- Collection rates: In the EU between 97.5 and 99% of lead batteries available for collection enter the recycling process.

With regard to **Risk Management Measures:**

- All EU lead battery facilities require operating permits issued by local competent authorities.

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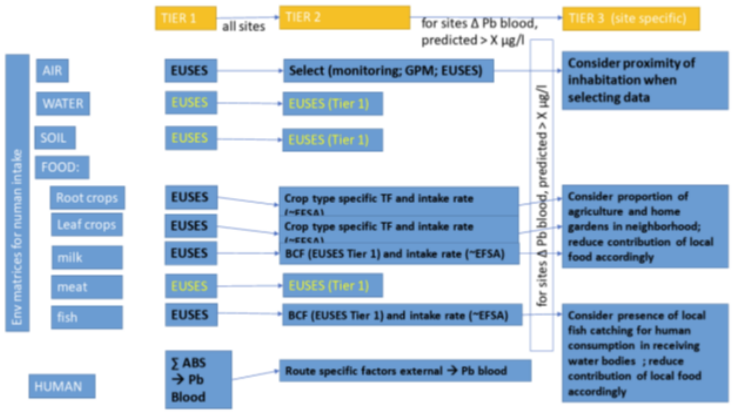
- Lead battery recycling processes are covered by the NFM BREF that describes Best Available Techniques (BATs) and associated emission limits that are included in site permits.
- Fenceline and stack emissions of lead (and other heavy metals), S02 and particulate matter required as condition of site permit.
- Occupational exposures of metals and acid fumes subject to Occupational Exposure Limits (OELs) and regular health surveillance of workers undertaken by health professionals (internal dose < value)
- New EU Binding OEL and Biological Limit Values (BLVs) for lead recently adopted.

International Lead Association

Man Via the Environment Assessment of Lead Battery Manufacturing and Recycling

Figure 9.1: illustration of tiered approach in MvE Pb exposure assessment (yellow marked parts: marginal exposure routes, limited to Tier 1 approach ; red marked parts: potential dominant routes, for which Tier 2 and Tier 3 approach is elaborated)



- Individual EU battery manufacturing and recycling companies (about 50 sites) were surveyed to collect site-specific information:
  - Annual use amount, risk management measures, emissions to air and water and site-specific environmental conditions such as dilution, distance and number of local population around the site were collected .
  - In addition, when available, measured data were collected on air concentrations, deposition rates, effluent concentrations, surrounding soil concentrations etc to compare with modelled estimates and overwrite modelled estimates

International Lead Association

Man Via the Environment Assessment of Lead Battery Manufacturing and Recycling

Table 9.4. Type of risk characterisation required for man via the environment

Route of exposure and type of effects	Risk characterisation type	Hazard conclusion (see section 5.11)
Inhalation + Oral (all routes): Long term, Systemic (children, IQ)	Quantitative	Reference dose = 0.5 µg/kg bw/day or 12 µg/L (B-Pb) for IQ reduction of 1 point
Inhalation + Oral (all routes): Long term, Systemic (adults, SBP)	Quantitative	Reference dose = 1.5µg/kg bw/day or 36µg/L (B-Pb) for BMDL01 SBP
Inhalation + Oral (all routes): Long term, Systemic (adults, kidney)	Quantitative	Reference dose = 0.63µg/kg bw/day or 15µg/L (B-Pb) for BMDL10 renal effects

Battery Recyclers

Table 9.7. Exposure concentrations and risks for the environment and man via the environment

Protection target	Assessment entity	Exposure concentration (µg/kg/d) 10P – 90P		Blood level increase (µg/L) 10P – 90P	Risk quantification 10P – 90P
Man via environment – Combined routes	Pb ion	**Adults**	0.006 – 0.060	0.31 – 3.9	0.004 – 0.04 (SBP) 0.009 – 0.9 (kidney) (All sites RCR<1)
		Children (0-3 yr)	0.017 – 0.17	0.4 – 5.1	0.3 – 0.33 (IQ) (All sites RCR<1)

10P – 90P: 10th percentile – 90th percentile

- Predicted contribution of Pb in human blood arising from emissions from lead battery manufacturing and recycling for the regional scale was 0.15 µg Pb/l for children (1–3 years) . This value is about 1% of total Pb blood levels, according to available recent monitoring data for children <7 years across Europe

De Brouwere., K et al (2022). Assessment of human exposure to environmental sources of lead arising from the lead battery manufacturing and recycling sector in Europe: demonstration of a tiered approach in a case study. Journal of exposure science & environmental epidemiology 32, 418-426

Discussion

- One participant raised that one of the pending questions in the Batteries Regulation regards substances hindering recycling. We heard that organics in the black mass can be a potential challenge, what about pyro?
  - Jan tytgat answered that there is no immediate hindrance. Looking at trends, if you look at sodium instead of lithium silicon doped anode material, he does not see that as threats for pyro processes. Silicon could become a threat for a hydro process as dissolving silicon creates polymerisation, which blocks the installation. The design of a recycling process must cope with that, as batteries manufacturers will not consider this. They have to design a process that makes it work.
- Another question addressed the claim that the pyro process, after burning the black mass does not destroy PFAS.
  - Jan Tytgat replied that he is not familiar enough with the process but suggested that in a pyro process at 450°C, it is not enough to destroy PFAS. He assumes that there are ways to absorb PFAS through activated carbon filters, for example after pyrolysis. Maybe in the hydro process they would need to remove the PFAS before to avoid hindering the process.
- The discussion was concluded by the comment from a participant that a key step is proper sorting before entering any process to avoid problems with substances in the recycling process.
  - Jan Tytgat agreed and complemented the comment by stating that you indeed need several safety or security levels. If the sorting is not 100% effective, you need to check what you get in, and then cope with certain contamination. A good recycling process must be flexible and robust. If there is Cadmium in their flow sheets, they need to make sure there is a way to capture it.

Conclusions and next steps

ECHA provided some concluding reflections and indications of possible next steps for the continuation of the work:

- Any information that will be provided as Confidential Business Information should be marked as such and will remain so, with no disclosure. ECHA has built trust and a robust system to guarantee confidentiality. Participants are free to ask about it and there is a helpdesk at ECHA dedicated to it. There is also an information section on batteries.
- ECHA thanked participants for all the learnings, which were very useful for the type of work they will do.
- The 2-phased process for the substance list provides an opportunity to gather further understanding in a short period of time. **The questionnaire will be improved, looking at the information provided by the JRC** in their report on the amendment of the EU list of waste and making sure the same questions are not asked.
- The questionnaire will also be edited **in parallel according to feedback received.** ECHA invites participants to provide their feedback through the functional mailbox allowed by Eurometaux at: ecabam@eurometaux.be . In order to ensure its quality, a further exchange can take place on the basis of the revised questionnaire for its finalisation.
- This is the beginning of a cooperation for the exchange of information. There will be a follow-up for these activities tentatively in October/November 2024,

to be discussed where and the modalities. More information on ECHA's work on batteries can be found scanning the following QR code:

- The possibility to organise plant visits could be discussed. **Eurometaux asked for volunteers from both battery recycling and battery manufacturing sites in practical places** (e.g., in/or close to Finland, Poland, France, Belgium) to organise plant visits.

The representative from France as SEAC but also leading a project in INERIs on transition (economics, climate mitigation) noted the interest of the ECaBaM project. They are conducting a first exploration on risk index and related scenarios. Work is now focused on selecting technologies, including batteries. They will try to avoid duplication of work with ECHA regarding surveys and data. Exposure profiles could be of interest for INERIs to calculate the risk index through variables, looking at potential exposure (and qualitative factors if it is complex to have exposure scenarios).

Annexes: Slides day 1 and 2.

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