MARKET INTELLIGENCE REPORT

COBRA

KEY TECHNICAL, POLICY AND MARKET DEVELOPMENTS INFLUENCING THE ELECTRIC VEHICLE BATTERY LANDSCAPE

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NEW BATTERY REGULATION

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INTRODUCTION

The European Commission (EC) has been actively supporting the development of the EU Li-ion battery value chain during the last couple of years, with many investments put in place to ensure that the supply of sustainable cells meets the expected demand from the automotive and renewable energy storage industries in the European market.

Together with these investments, in 2017 the EC started working on the major update of the Battery Directive – a document from 2006 which aimed to minimise the negative impact of (End-of-Life) batteries and accumulators on the environment. As a result, in 2020, a New Battery Regulation was proposed, focusing on three interlinked objectives: 1. strengthening the functioning of the internal market by ensuring a level playing field through a common set of rules; 2. promoting a circular economy; and 3. reducing environmental and social impacts throughout all stages of the battery lifecycle. One of the key trade-offs to be balanced in this regulation: do not hamper innovation and market position of the European battery and automotive industry, whilst achieving ambitious environmental targets.

Although the final shape of the Regulation is still under negotiation, its core measures are not expected to undergo major alterations and the document is on its way to being launched in 2023. Considering the ambitiousness of these measures, it is important to anticipate their influence on the EU market, to support businesses, research, and national decision-makers in preparing for the upcoming changes. This market intelligence report discusses the potential impacts of the proposed New Battery Regulation on the industry dynamics, research priorities, and governmental actions, focusing on the measures related to EV batteries.

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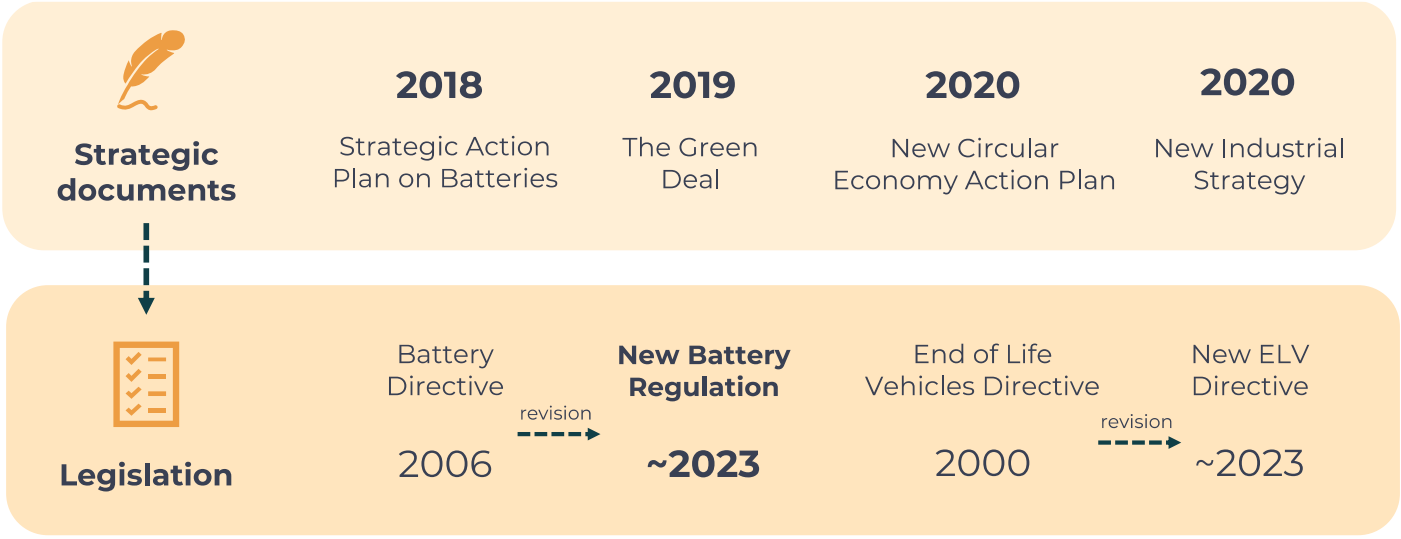
OVERVIEW

ONGOING EU LEGISLATION AND STRATEGIC INITIATIVES

The top 3 priorities of the 2019-2024 European Commission that relate to batteries are: implementing the European Green Deal, a Europe fit for the digital age, and a stronger Europe in the world [1]. Amongst these priorities, the proposal for a new battery regulation is part of the following set of EU strategic documents and initiatives [2]: Strategic Action Plan on Batteries, European Green Deal, New Circular Economy Action Plan and the New Industrial Strategy.

Figure 1: Strategic documents and legislation relevant to EV batteries in Europe



The **Strategic Action Plan on Batteries** was published by the EC in 2018, before the Green Deal [3]. With this document, the Commission aims to put Europe on a firm path towards leadership in the battery sector as the key industry for the future, supporting jobs and growth in a circular economy, whilst ensuring clean mobility and an improved environment and quality of life for EU citizens.

The **Green Deal** was presented in December 2019: this set of policy initiatives sets the 2050 goal of climate neutrality and how the EU wants to get there with its 8 policy areas. It provides certainty for decision-makers, public planners, businesses, and investors [4].

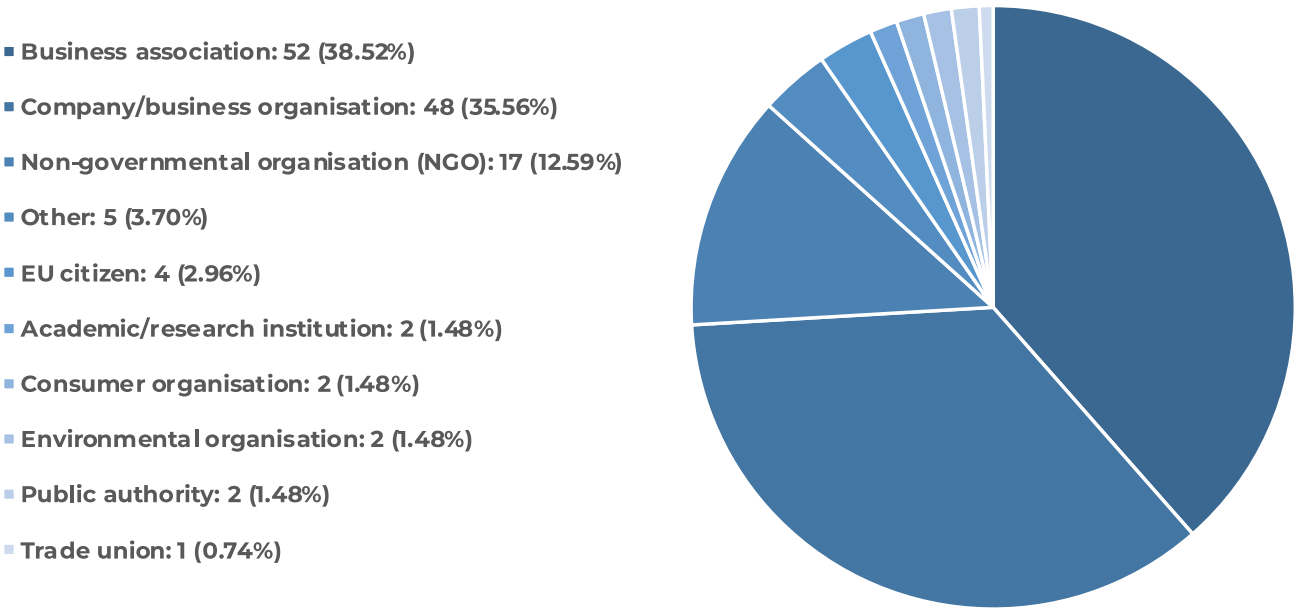
The **New Circular Economy Action Plan**, adopted by the EC in March 2020 [5] as a part of the Green Deal, addresses both batteries and vehicles. The new Battery Regulation and the upcoming proposal for an End-of-Life vehicle directive [6] have adopted circular actions, and the Waste Shipment proposal also adopts parts of the circular plan [7].

The **New Industrial Strategy**, adopted by the EC in March 2020 [8] is independent of the other initiatives mentioned here. 'Europe is embarking on a transition towards climate neutrality and digital leadership. The European industrial strategy aims to ensure that European industry can lead the way as we enter this new age'. It delineates Europe's dependencies in industry, which includes battery components and relevant (processed) materials.

LEGISLATIVE PROCESS AND ITS STATUS AS OF JULY 2022

The upcoming legislation is a regulation seeking to replace an old (2006) directive. Colloquially speaking, a **directive** leaves legislative room for Member States, whereas a **regulation** is a binding legislative act to be applied in its entirety across the EU [9]. The New Battery Regulation builds on the ex-post evaluation of the previous document, extensive public consultations, political commitments delineated above and a three-part **impact assessment** that proposed a broad range of policy options [10]. The first proposal was published in December 2020 and was followed by another public consultation which lasted until March 2021. A total of **135 stakeholders submitted their position papers** (Figure 2), most of which were business associations (52), companies (48), and NGOs (17). After that, the EU **Environment Council** debated and published their views in two progress reports in June 2021 and December 2021, finally reaching a general approach in March 2022. In the EU Parliament, the Committee on the Environment, Public Health and Food Safety (**ENVI**) adopted its report on the proposal in February 2022 [11]. This document, proposing amendments that increase the ambition of the proposed regulation, became the basis of the European Parliament's position. **As of July 2022**, the EC, the Council, and the Parliament are in trilogue negotiations with the goal of developing the final text of the New Battery Regulation in the first reading.

Figure 2: Breakdown of organisations that submitted feedback to the proposal



THE GLOBAL PERSPECTIVE

For years, Chinese and other Asian countries have dominated battery raw material processing and cell manufacturing. Here, the West is seeking to gain more control over the battery value chain, securing market power and self-reliance in the electromobility surge. With this upcoming regulation, the EU aims to secure industrial stability, whilst achieving ambitious environmental goals.

On the **United States federal** level, little attention is paid to battery circularity outside national labs and strategic planning efforts. Rather, priority is given to securing raw material supply and processing capacity and restoring global competitiveness in battery value chains. In the absence of federal action on end-of-life management for batteries commonly used in EVs and grid storage, policymaking has been largely left to state governments. California, for example, inaugurated a Lithium-ion Car Battery Recycling Advisory Group to deliver recommendations to the state legislature, while other jurisdictions—most notably Washington, DC—have passed or are considering comprehensive Extended Producer Responsibility laws for rechargeable batteries **[12]**.

China, on the other hand, has put much legislative effort into battery circularity. In 2020, a New Electric Vehicle battery recycling regulation came into effect, which added to the 2018 EPR regulation **[13]**. It includes a comprehensive set of laws and regulations to achieve better traceability management, encourage shared recycling pipelines and establish centralised recycling service stations [14]. However, Chinese academic circles have expressed a need for further clarification in the regulation regarding rights and responsibilities, standards, and battery assessment technologies **[15]**

INDUSTRY VERSUS REGULATION: DIFFERENCES ACROSS THE ATLANTIC

In the US, we see a lot of pushback from members of industry toward what they view as overregulation on design or manufacturing processes. This differs from the approach of EU industry, which generally has a higher threshold for these types of requirements. Such tolerance is clear from the robust stakeholder engagement around the EU Batteries Regulation and relative acceptance of minimum recycled content mandates for new batteries, despite some reservations. Nevertheless, in absence of federal incentives or regulations, US industry has taken initiative to pursue more sustainable battery life cycles, as is evident from new partnerships between automakers and recycling companies (such as General Motors and Li-Cycle or Ford and Redwood Materials).

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IMPACTS OF PROPOSED CHANGES

Nine measures proposed by the European Commission have been selected for this assessment and presented in Figure 3 under three clusters and with respective years of implementation. Although the proposal of new regulation concerns all types of batteries, **the scope of this analysis is limited to the EV battery value chain**. The analysis of impact interprets how the new measures influence industry dynamics, research priorities, and governmental actions, following the structure below.

IN BRIEF: section explaining the details of the measure, implementation timeline, and possible alterations due to feedback from stakeholders and EU agencies.

INDUSTRY DYNAMICS: an explanation of the impacts of the measure on companies, investments, battery prices, and EU economy.

RESEARCH PRIORITIES: analysis of opportunities for the research and development of new solutions.

GOVERNMENTAL ACTIONS: identification of the actions required from the national governments to implement the proposed measure.

STAKEHOLDERS AFFECTED BY THE REGULATION

INDUSTRY: battery (component and pack) manufacturers, EV manufacturers, recyclers, collectors, 2nd life solution providers, data start-ups, aggregators, certification centres.

RESEARCH: universities, research institutes, innovation transfer centres.

GOVERNMENT: national ministries, agencies, or other government bodies.

METHODOLOGY OF THE ASSESSMENT

Each of the stakeholders have been assigned one of four relevance levels:

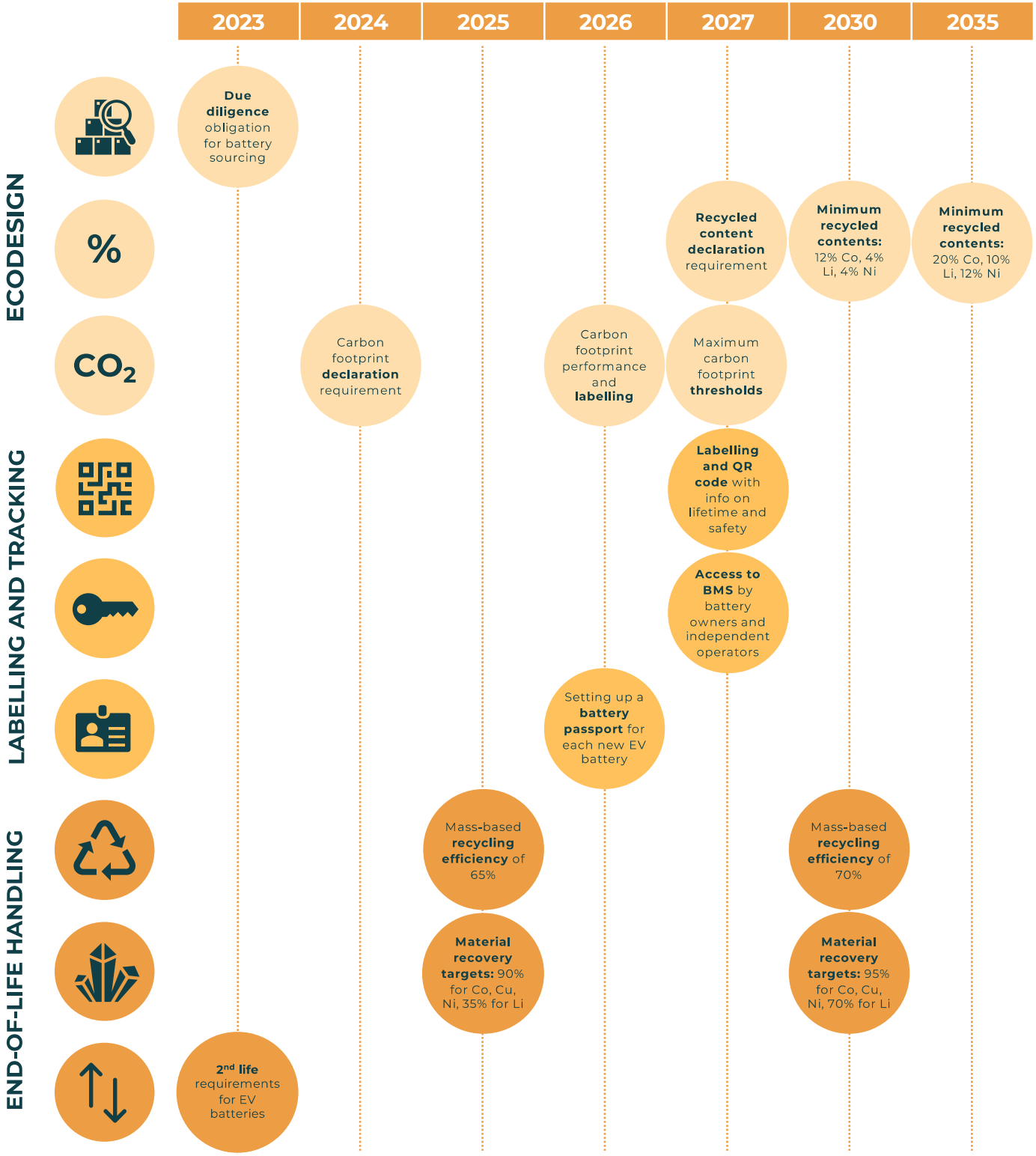
NO RELEVANCE: the measure does not directly influence the stakeholder's business, strategic priorities, or actions that need to be undertaken.

LOW RELEVANCE: the measure does not affect the core activities of the stakeholder, however it creates some new opportunities and obligations.

MEDIUM RELEVANCE: some core activities of the stakeholders are affected by the measure, allowing to develop new lines of business, inflicting costs of adaptation, and creating new responsibilities.

HIGH RELEVANCE: the measure has a major influence on the stakeholder, creating opportunities not to be missed, high risks of inaction, and generating new significant costs or administrative burden.

Figure 3: Main innovations for EV batteries envisaged by the New Battery Regulation



(ECO)DESIGN OF BATTERIES

DUE DILIGENCE OBLIGATION FOR BATTERY SOURCING

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

Due diligence obligations apply to a set of **economic operators who place batteries on the EU market**, verified through third-party notified bodies. It's still under debate which battery types (e.g., industrial, EV) will require due diligence, covering either the whole or only the raw material part of the value chain.

INDUSTRY DYNAMICS

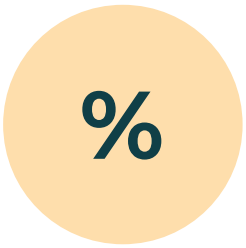
Performing a proper due diligence analysis will be especially hard for economic operators that are not as vertically integrated. Depending on the information that must be shared along the supply chain, the **competitiveness of players** could be impacted who currently benefit from being less transparent. In turn, this could cause further vertical integration which is an already ongoing trend **[16]**. The ease of due diligence efforts will also **depend on Chinese refiners and cell manufacturers**. However, it has been shown **[17]** that Chinese industries tied to Western supply chains are very aware of EU regulations and public outcry for higher transparency.

RESEARCH PRIORITIES

A **cross-value chain data platform** could be tailored to the battery value chains. Such a tool could create a necessary feeling of **security and trust** and expand the possibilities of data sharing. Examples of supply chain data-sharing can be found in the semiconductor industry **[18]**, or the European automotive Catena-X **[19]** data-sharing portal. Such a platform should also include data sharing on the **social and environmental costs** of batteries **[20]**.

GOVERNMENTAL ACTIONS

The EC will need to define the environmental and social indicators to be reported under the due diligence process. This issue has been raised by industry **[21]** and Member states **[22]**, to reduce the **significant administrative burden imposed on companies**. It has been proposed to have the EC provide lists of 'non-sustainable' companies, for the consideration of battery manufacturers **[21]**. Moreover, as stated in the regulation proposal *'the Commission proposal envisages mandatory third-party verification through notified bodies'*. This means **each Member State will** have to notify assessment bodies **[23]** according to principles laid down in Decision 768/2008/EC **[24]**.



RECYCLED CONTENT REQUIREMENTS

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

The EC envisions a mandatory minimum level of recycled content for lithium (4%), cobalt (12%), nickel (4%), and lead (85%) by 2030 and increasing these minimum levels by 2035. The EC's intention with this regulation is to **encourage investments in recycling technology** that otherwise would not be cost-competitive with virgin raw materials. It's still unclear whether the measure will also apply to portable batteries, in addition to the currently included EV/industrial/automotive batteries.

INDUSTRY DYNAMICS

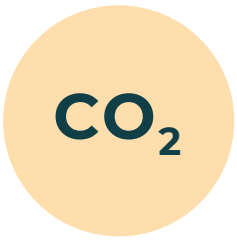
Direct impacts are the **upcoming business opportunities** and the need for upscaling productivity, in both the waste management and recycling sectors. The respective industry associations have welcomed the recycled content measures in their position papers [25], [26]. Furthermore, the **collaboration between OEMs and recyclers** is expected to strengthen [27]. However, there is another side to this coin. The increased demand for secondary raw materials and corresponding investments in recycling over other End-of-Life battery treatment routes – e.g. reuse in stationary applications – could **adversely affect the second-life usage** of EoL batteries [28].

RESEARCH PRIORITIES

A research priority in retrieving **high-quality and cost-effective secondary raw materials** could lie in direct recycling, which is more low-cost and environmentally friendly than current methods. Direct recycling entails a long pre-treatment process, thereby effectively sorting the materials. However, an important improvement to be made [29] in the field is the reconditioning of degraded active materials for cell development. Moreover, active materials synthesised ten years ago do not meet current market demands. It could prove to be a challenge to identify and **validate positive business cases**.

GOVERNMENTAL ACTIONS

The regulation measures require reporting and traceability systems which are currently not in place [30]. A **pressing issue** in enforcing this measure is the **metal differentiation** between battery-grade recycled and virgin materials, since they won't be uniquely identifiable [31]. Like the due diligence reporting, the EC envisions third-party verification to be applied. Part of that system will have to be a **legal and procedural way of calculating the content of the battery**, which also applies to batteries imported from outside the EU.



CARBON FOOTPRINT DECLARATION AND THRESHOLDS

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

This proposed measure is aimed at rechargeable, industrial, and EV batteries and gets **incrementally stricter**. It starts with a carbon footprint declaration (2024), up to a maximum lifecycle carbon footprint threshold (2027). Big discussion points put forward by the battery **[28]** and car **[32]** manufacturing industries are the timeline of the subsequent measures and the calculation procedures and methodologies of the CO2 footprint.

INDUSTRY DYNAMICS

OEMs and their value chain will be required to cooperate with notified bodies to certify their carbon footprint calculations. This will create an administrative burden and **need for verifiable data and transparency in the globally dispersed battery value chain**, a strenuous endeavour. Subsequently, OEMs will have to develop strategies for CO2 reduction in their batteries. Depending on the ability of manufacturers to adapt, a reduced carbon footprint **could be used as a competition differentiator**. As delineated previously **[33]**, the energy-intensive processing of nickel and cobalt, combined with the local energy mix, is the most impactful on a battery's environmental footprint. This could incentivise the relocation of processing and manufacturing facilities to areas with a "cleaner" energy mix. In addition, 2nd life, cobalt-free and LFP batteries could become increasingly popular due to this measure, a trend already observed in research **[34]** and industry **[35]**.

RESEARCH PRIORITIES

Researchers and the EC could work together to **finetune existing LCA approaches and standards** (e.g., ISO), into harmonised calculation rules, appropriate for the battery industry. Here, the proposed regulation mentions the Joint Research Centre (JRC) as a key technical partner in developing this work.

GOVERNMENTAL ACTIONS

The EC has set out to **establish a method of carbon assessment before 2023**. One aspect will be the required detailed level of analysis, which impacts the administrative burden for manufacturers. Life Cycle Assessment on a single batch level would be unfeasible **[32]**, and even though factory-level requirements would be more feasible, the different carbon footprints across factories could confuse the end customer. Besides the calculation methods, like the due diligence requirements, the EC envisages third-party verification of carbon footprint through notified bodies. This lays an administrative burden on national governments.

LABELLING AND TRACKING

SETTING UP A BATTERY PASSPORT FOR EACH NEW EV BATTERY

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

By 1 January 2026, each EV battery with a capacity higher than 2 kWh placed on the market will have a unique electronic record (or in other words, a "battery passport"). This record should include the basic characteristics of the battery and be accessible online through an **electronic exchange system**. The architecture of the system, data formats, and rules of information exchange will be established by the EC by 2024. Whenever the battery changes its status, the economic operator will have to update the information about its performance.

INDUSTRY DYNAMICS

This measure will have the highest impact on the economic operators, e.g., EV OEMs or repurposers. They will have to 'connect' to the system, which may require **investments in battery connectivity**, as well as **hiring data experts** capable of exercising this new obligation. Moreover, new data-driven businesses are expected to arise, such as **digital twinning** and **predictive maintenance**. The development of an exchange system and its operator is another opportunity to be picked up by software companies. This measure, combined with the CO2 and recycled content requirements, will also greatly impact **the transparency and competition dynamics** of the EU market, pushing out non-compliant or low-performing products.

RESEARCH PRIORITIES

The research areas connected with this measure can be divided into two types: advancements supporting the implementation of the system, and opportunities enabled by the introduction of the battery passport. The first area includes: **data adaptors** converting input from various sources into the same format, **blockchain solutions** ensuring the integrity and traceability of the data, and **governance standards** defining stakeholders' rights to read and upload information. In the second area, researchers should explore utilising the field data gathered through passports: faster **battery state diagnosis**, **machine learning approaches,** and EV **fleet management systems**.

GOVERNMENTAL ACTIONS

The unanswered question is who will create and manage the battery electronic exchange system, and who will **verify the reliability of information** uploaded by stakeholders? Another important aspect is how the system will be integrated with other projects following the same principles (e.g., the German Catena-X platform **[19]** and Battery Passport by Global Battery Alliance **[36]**). National governments may need to support stakeholders entering the new system with **training**.

ACCESS TO BMS BY BATTERY OWNERS AND INDEPENDENT OPERATORS

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

According to this measure, all industrial and EV batteries above 2 kWh should include a BMS containing data on the parameters for determining the state of health (SoH) and expected lifetime (RUL) of batteries. Access to this data, specified in the annex to the regulation, shall be provided to **any organisation or person who has legally purchased the battery**, or any third party acting on their behalf for the purpose of: evaluating the residual value; facilitating reuse, repurposing, or remanufacturing; making the battery available to independent aggregators.

INDUSTRY DYNAMICS

Granting access to BMS by the OEMs to third parties is one of the most game-changing measures enabling 2nd life battery businesses. Currently, only a handful of repurposers receive the matrices allowing them to decipher communication with BMS, through bilateral agreements with the EV makers. With this measure in place, access to BMS will become non-discriminatory. This is expected to **increase competitiveness in the emerging 2nd life industry**, boost the development of start-ups creating value from data and of aggregators using the vehicle-to-grid approach. On the other hand, OEMs will have to implement solutions ensuring that the BMS access is granted in a safe manner, reducing the **risk of cyberattacks** and **compromises to IPR**. The EV makers will also **lose competitive edge** of battery data ownership.

RESEARCH PRIORITIES

By 2030, this measure would give the right to access BMS data to almost 30 million EV owners across the EU. Granting access case-by-case is not a feasible option for the OEMs, therefore an **automated process** should be developed, otherwise, EV owners should be given access by default. Such solutions require piloting for the specific case of EV data. Similarly to the introduction of battery passports, widespread BMS access will enable the higher adoption of **data-driven methods for battery characterisation**, therefore, research in this field should be prioritised in the next years.

GOVERNMENTAL ACTIONS

Currently, it remains unclear how an individual or a legal entity can prove they are the owner of the battery. Governments will have to set the legal rules of authorising BMS access, together with respective documents that the owner has to present and consequences for OEMs for not fulfilling the obligation. This may particularly require the **involvement of agencies protecting consumer rights and competition commissions**.

QR CODE + LABELLING WITH PRODUCT INFORMATION

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

In the current proposal, battery manufacturers are expected to **print or engrave** a CE label by 2022, and a QR code and label on **both the battery and accompanying document** by 2023. In the period until 2027, an increasing amount of information should be linked to the QR code. The attached (non-CE) label should provide information on lifetime, charging capacity, separate collection requirements, hazardous contents, and safety risks. The QR code is envisioned to contain comparably more information by 2027, ranging from the carbon footprint declaration and performance class, to the percentage of recycled content used. Here, several industry position papers have addressed the duplication of information asked for the QR code and labelling, and the battery passport **[37]**, **[28]**, **[38]**.

INDUSTRY DYNAMICS

In the short term, industry will need to **design and implement** the CE and other labels, as well as QR code placement. Before doing so, compliance with the CE standards must be obtained with the nationally-appointed notified body. In the medium term, it is likely that industry associations are to **work with governments** to specify and standardise metrics which are required for the labels. In the long term, it can be expected that this measure will create more transparency in the battery value chain. This should make for more market entrance possibilities for independent battery handlers (car workshops, repurposers, remanufacturers, recyclers).

RESEARCH PRIORITIES

As mentioned under the battery passport as well, the researcher's role would mostly include improving current battery lifetime, safety, and performance assessment **methodologies**. Moreover, research organisations could play an important role to support the formation of standards forming.

GOVERNMENTAL ACTIONS

For the EC, it will be key to **streamline the labelling, QR and battery passport measures** to prevent unnecessary administrative burden, thereby stimulating uptake by industry. It will be key to ensure reliability and certification of information provided by the industry. Moreover, like the battery passport, it will be key to **verify and certify** product information provided by the QR code, through established calculation methodologies.

END-OF-LIFE HANDLING

INCREASED TARGETS FOR MASS-BASED RECYCLING EFFICIENCY

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

This measure increases the obligatory minimum percentage of lithium-based battery mass which has to be recycled: from 50% right now to **65%** in 2025 and **70%** in 2030. In the case of EV batteries, this relates to the mass of the modules separated from the pack. Recyclers should ensure that each recycling process achieves these targets, based on the methodology that the EC will implement by the end of 2023. This methodology will replace the 2012 Commission Regulation document **[39]** laying down detailed rules within the same scope.

INDUSTRY DYNAMICS

To achieve such targets, the recyclers will have to improve the efficiency of their processes, which will require new investments. The companies which are already able to recycle at this level or higher will have an **advantage over the laggards**. It is yet to be seen whether the upcoming targets will influence the quality of the resulting recyclate – the precision of the new methodology will be the deciding factor. Since the proposed new targets are a **natural evolution** of the existing regulation, the stakeholders are expected to adapt without any major disruption to the market.

RESEARCH PRIORITIES

New recycling efficiency targets will push for technological advancements. First of all, new automated dismantling and sorting methods will need to be developed. Currently, the EV batteries are only dismantled down to module level and then shredded. **Dismantling to cell level** and sorting before shredding would help increase the mass-based recycling efficiency, but currently this is too expensive and dangerous. Secondly, **new battery cell, module and pack designs** will be sought to allow easier disassembly and recycling.

GOVERNMENTAL ACTIONS

For effective execution of this measure, a sound **certification and verification system** will have to be ensured, possibly auditable by third parties assigned by the national regulators. Since the regulation doesn't forbid battery recycling outside of Europe, the system will also have to be accessible for non-EU recyclers.

INCREASED MATERIAL RECOVERY TARGETS

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

This measure introduces the minimum levels of material recovery from lithium-based batteries. In 2026 recyclers will have to recover at least **90%** of cobalt, nickel, copper, and **35%** of lithium. In 2030, they will increase **95%** for Co, Ni, Cu, and **70%** for Li. The main uncertainties in this measure lie in the final accepted recovery level (some stakeholders still voice strong concerns about the targets) and the methodology of calculation and verification of the material recovery (this methodology will be enacted by 2023).

INDUSTRY DYNAMICS

While the mass-based recycling efficiency leaves recyclers some flexibility in the selection of recycling processes, the recovery measure strictly specifies the percentages for the critical raw materials. This will force many recyclers to change their processes which were optimised for the best economic value. Such an adaptation would come at a **cost for the industry, possibly driving up the prices of batteries**. Secondly, this new type of measure is proposed to ensure a sufficient supply of secondary raw materials, as a balance to the demand-driving measure of minimum recycled content. Due to the **high volatility of the critical raw materials prices and uncertainty in the forecasts of EoL EVs**, this measure may have a significant influence on the battery market.

RESEARCH PRIORITIES

In addition to the advancements in dismantling and sorting, the high material recovery targets will boost developments in recycling and material refinement technologies. The **hydrometallurgical treatment** (and specifically direct recycling) will be the method of choice, since it enables the recovery of a large number of battery components, as well as high purities of metal salts. Several areas are being explored to further increase the efficiency of hydrometallurgical recycling [40]: application of ultrasounds when leaching with mineral or organic acids [40], leachate processing via ion exchange [41], and new methods for **selective recovery of lithium** [42], which is currently the least recovered battery material, despite increasing prices of raw Li in the recent year.

GOVERNMENTAL ACTIONS

Similarly to the mass-based recycling measure, a certification and verification system must be implemented. Additionally, the governments may need to **balance the economic burden** on recyclers through subsidies.

2ND LIFE REQUIREMENTS FOR EV BATTERIES

RELEVANCE FOR:

INDUSTRY

RESEARCH

GOVERNMENT

IN BRIEF

This measure for the first time introduces requirements for the repurposing and remanufacturing of industrial and EV batteries with a capacity of over 2 kWh (of any chemistry). Several **rights** are given to the independent operators: access to the BMS and information about battery handling/testing. The regulation also lists a number of **obligations**. The repurposing/remanufacturing operators have to first prove that the waste battery is no longer waste, by presenting upon request by authorities: evidence of SoH evaluation, documentation of sale or transfer of ownership and evidence of appropriate safety measures taken. The uncertainty of this measure lies in the implementing acts that will establish the methodology for SoH evaluation and requirements for changing the waste status.

INDUSTRY DYNAMICS

Up until now, many repurposing companies and battery trading start-ups have been operating in the grey zone. The new regulation will give them tools to **gain credibility**, possibly creating opportunities for larger contracts. On the other hand, these SMEs will have to professionalise and adopt several new administrative procedures, limiting their agility. More open access to battery data means big changes for many EV OEMs, which will have to **rethink their business models** based on their own repurposing capacity or single partnerships. In a scenario of a large percentage of batteries being repurposed, there may be an insufficient amount of recycled material on the market, which would increase the prices of new batteries.

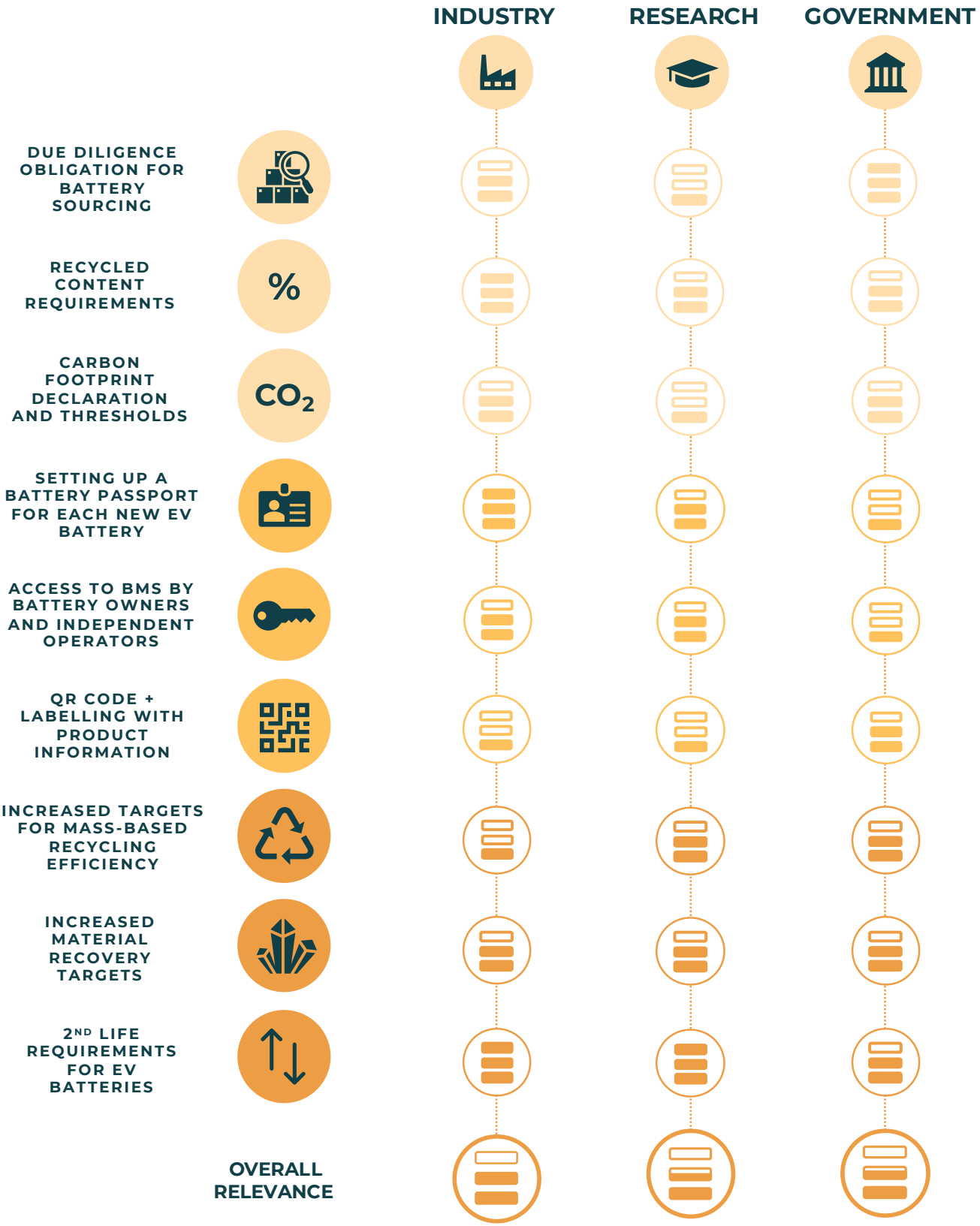
RESEARCH PRIORITIES

Since battery repurposing is a relatively novel concept, there are many fields of research which will require advancements. First of all, new methods of **RUL and SoH evaluation** will be sought, increasing the speed of decision between EoL and 2nd life. Secondly, the technologies for increased **safety of repurposing** and usage of 2nd life products will have to be developed. Last but not least, the economic feasibility of battery repurposing is changing very fast, which is why new tracking tools and market models should be developed to help businesses and policymakers take informed decisions.

GOVERNMENTAL ACTIONS

Member States will have to assign competent bodies that can control whether the waste battery could be repurposed/remanufactured. Moreover, there must be an authority that is able to **enforce the rights of independent operators** to receive all information necessary for the evaluation of the battery from OEMs/collectors/recyclers.

Figure 4: The relevance of New Battery Regulation per stakeholder type



TECHNICAL DEVELOPMENTS

PROSPECTIVE ENVIRONMENTAL ASSESSMENT OF CATHODE ACTIVE MATERIAL FOR COBALT-FREE CELL BATTERY

The COBRA H2020 project has presented its paper at the annual SETAC meeting in Copenhagen, on the environmental assessment of the battery's cathode active materials. High CO2 equivalent emissions were observed in the production of this type of oxide. This was likely due to the production of the active material at lab scale, that needs higher energy consumption.

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RECYCLED CATHODE MATERIALS ENABLED SUPERIOR PERFORMANCE FOR LITHIUM-ION BATTERIES

A team led by Professor Yan Wang of the Worcester Polytechnic has succeeded in recycling a cathode powder with a superior rate and cycle performance compared to its virgin counterpart. The main difference between their recycling method and conventional hydrometallurgical recycling is their end-product, which consists of the cathode material rather than individual metals.

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RECYCLING OF LITHIUM-ION BATTERIES – CURRENT STATE OF THE ART, CIRCULAR ECONOMY, AND NEXT-GENERATION RECYCLING

Researchers participating in the BATTERY 2030+ H2020 project have outlined current practices in material collection, sorting, transportation, handling, and recycling. The paper also includes predictions on the challenges of future battery recycling concerning battery materials and chemical composition, and also discusses future approaches to battery recycling.

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DETERMINING REQUIREMENTS AND CHALLENGES FOR A SUSTAINABLE AND CIRCULAR ELECTRIC VEHICLE BATTERY SUPPLY CHAIN: A MIXED-METHODS APPROACH

According to researchers from Friedrich-Alexander University, a comprehensive and commonly accepted framework to assess the sustainability of this industry is currently missing. They have performed a comprehensive review of EV battery sustainability and circularity requirements and challenges.

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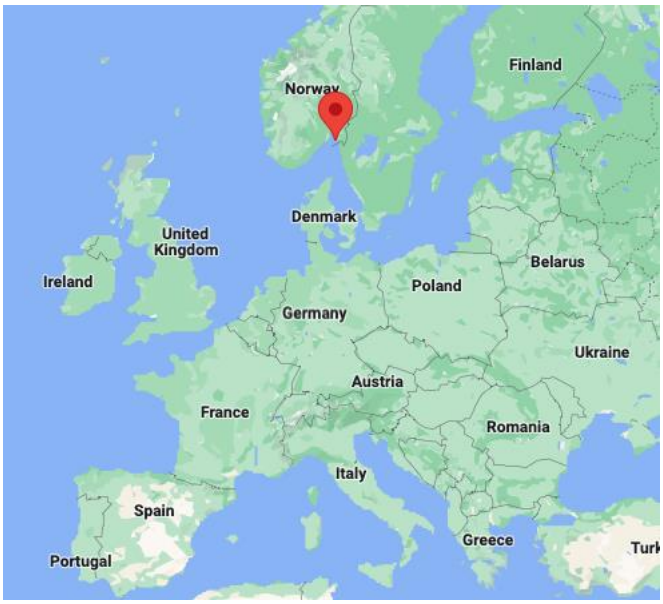
MARKET DEVELOPMENTS

LAUNCH OF EUROPE'S LARGEST EV BATTERY RECYCLING PLANT

Only two years after its official announcement, the biggest EV battery recycling plant in Europe so far began its operation in Fredrikstad, Norway. The facility is operated by Hydrovolt – a joint venture between Swedish battery OEM Northvolt and Norwegian aluminium company Hydro. The current capacity of the plant reaches **12,000 tonnes of battery packs**, but during the next decade, Hydrovolt plans to expand this capacity to 70,000 tons by 2025 and 300,000 tons by 2030. Although the aluminium from battery casing will be recycled on-site and used in new products by Hydro, the active materials will be transported as black mass powder and recycled in Skelleftea, Sweden.



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EV BATTERY COSTS EXPECTED TO RISE DUE TO MATERIAL SCARCITY

According to a new report from a U.S.-based research firm E Source, the battery cell prices will surge 22% from 2023 through 2026, peaking at $138 per kilowatt-hour. This is due to the **spike in demand for key raw materials, like lithium, which in the last 18 months has risen nearly 900%**. Such an increase in price is due to the insufficient number of lithium mining projects, which limits the supply. If this forecast comes true, this would be the first price rise of Li-ion batteries, that may cool down the optimistic scenarios for e-mobility adoption. The analysts believe, however, that after 2026, the prices will resume a steady decline through 2031, possibly dropping to as low as $90 per kilowatt-hour.

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SODIUM-ION BATTERIES A FEASIBLE ALTERNATIVE TO LI-ION?

The raw material uncertainty in the Li-ion industry fuels the search for alternative chemistries for rechargeable batteries. One of the most promising technologies is sodium-ion, which is gaining momentum after recent investments from big industrial players like CATL and Reliance Industries, which recently acquired UK-based sodium-ion specialist Faradion. **Na-ion batteries use fewer critical raw materials** and can be up to 40% cheaper in production but still struggle with **limited energy densities**, which for now reach 190Wh/kg, as demonstrated by Faradion.

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POLICY DEVELOPMENTS

EU BAN ON COMBUSTION VEHICLES BY 2035

To achieve the target of a 100% cut in CO2 emissions from cars by 2035, the European Commission proposes a ban on the sale of new fossil fuel cars from that year. **The ban would not apply to existing cars**, and there would be no restrictions on the sale of used cars. To boost EV sales, the Commission has also proposed legislation that would require countries to install public charging points no more than 60 kilometres apart on major roads by 2025. It estimates that by 2030, there should be 3.5 million charging stations for electric vehicles, while by 2050, this number should rise to 16.3 million. This pace of chargers' deployment will require investments of up to 120 billion euros in the EU by 2040. The proposal has been met with criticism from the automotive industry represented by ACEA, which argues that not only EVs but also hybrids, FCEVs and to some extent combustion vehicles all play a role in the transition.

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THE U.S. PUSHES FOR THE DOMESTICATION OF THE EV SUPPLY CHAIN

The Biden administration has pledged over $3 billion to support the development of electric vehicle battery manufacturing in the U.S., under the Bipartisan Infrastructure Law. The move is part of the administration's plan to boost the domestic EV industry and create jobs in the clean energy sector. The support will be distributed through two funding opportunities: **Battery Materials Processing and Battery Manufacturing** and **Electric Drive Vehicle Battery Recycling and Second Life Applications**. The first opportunity of $3 billion will support research in battery processing and the expansion of domestic manufacturing and recycling capacities, while the second focuses on research, development, and demonstration of EV battery repurposing and recycling solutions. The administration believes that this investment will create thousands of jobs and help the United States compete with China's battery industry.

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NREL LAUNCHES A BATTERY POLICIES & INCENTIVES DATABASE

Following the series of new funding programmes for the U.S. battery industry, the Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) announced that they developed a **Battery Policies and Incentives database**, which is intended to provide information and data that can inform the production of EV batteries and development of a secure domestic battery supply chain. The stakeholders can explore the database searching for policies and financial incentives by jurisdiction, battery chemistry, federal agency, status, and type. NREL points out that apart from the easier navigation across opportunities for the private sector and research institutions, the database will also help to identify what type of support is still missing and needed.

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