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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) 2019/1020

{COM(2020) 798 final} - {SEC(2020) 420 final} - {SWD(2020) 334 final}

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Glossary

Term or acronym	Meaning or definition
'alkaline batteries'	Batteries that contain Zinc, Zinc oxide, Manganese dioxide and potassium hydroxide, as the main components.
'automotive battery'	Any battery used for automotive starter lighting or ignition power.
'batteries placed on the market'	Batteries made available, whether in return for payment or free of charge, to a third party within the European Union market.
'battery' or 'accumulator'	Any source of electrical energy generated by direct conversion of chemical energy. They may be non-rechargeable (primary) or rechargeable (secondary). The terms 'batteries' and 'accumulators' are considered synonyms and used indiscriminately in this report.
'battery collection point/ battery return point'	A designated collection place where consumers can bring their waste batteries for recycling. Return points usually include a container or box where consumers can drop their spent batteries. The Batteries Directive requires that return points for portable batteries be free of charge.
'battery pack'	Any set of batteries or accumulators that are connected together and/or encapsulated within an outer casing so as to form a complete unit that the end user is not intended to split up or open.
'button cell'	Any small round portable battery or accumulator whose diameter is greater than its height and which is used for special purposes such as hearing aids, watches, small portable equipment and back-up power.
'collection rate'	For a given Member State in a given calendar year, it is defined as the percentage obtained by dividing the weight of waste portable batteries and accumulators collected in that year by the average weight of portable batteries and accumulators placed on the market during that year and the preceding 2 years.
'end-of-life' batteries	Batteries that are unable to deliver electricity any longer or that are unable to be recharged.

‘durability’	The ability of a product to perform its function at the anticipated performance level over a given period (number of cycles-uses-hours in use), under the expected conditions of use and under foreseeable actions.
‘industrial battery’	Battery (primary or secondary) designed for exclusively industrial or professional use or used in any type of electric vehicle.
‘Joint Research Centre’	The European Commission's science and knowledge service.
‘lead-acid batteries’	Any battery where the generation of electricity is due to chemicals reaction involving lead, lead ions, lead salts or other lead compounds, having an acid solution as electrolyte.
‘lithium batteries’	Any battery where the generation of electricity is due to chemical reactions involving lithium, lithium ions or lithium compounds.
‘material recovery’	Any operation the principal result of which is waste serving a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.
‘portable battery’	Any battery, button cell, battery pack or accumulator that: (a) is sealed; and (b) can be hand-carried; and (c) is neither an industrial battery or accumulator nor an automotive battery or accumulator.
‘recyclates’	Raw material sent to, and processed in, a waste recycling plant or materials recovery facility.
‘recycling’	Any operation, which reprocesses waste materials into useful products, materials or substances.
‘recycling efficiency’	A measurement of the volume of material recovered in a recycling process. The Batteries Directive sets minimum material return levels (in % weight) resulting from the recycling of lead and nickel-cadmium batteries. The rules for calculating recycling efficiencies of processes are set by

	Commission Regulation (EU) No 493/2012 of 11 June 2012.
‘second life’	Status of batteries that are used in a context different to the one for which they were designed and placed on the market.
‘state of health’	Reflects the battery performance. It is measured in % and it is related to three main indicators: Capacity - the ability to store energy; Internal resistance - the capability to deliver current; and Self-discharge - reflecting the mechanical integrity and stress-related conditions.
‘treatment’	Any activity carried out on waste batteries after they have been handed over to a facility for sorting, preparation for recycling or preparation for disposal.
'waste batteries available for collection'	In broad terms, calculated weight of generated waste batteries, taking into account the differing life cycles of products in the Member States, of non-saturated markets and of batteries with a long life cycle.

List of acronyms

Term or acronym	Meaning or definition
3C industry	Computer, communications and consumer electronics
Ah	Ampere-hour, a unit of electric charge, used in measure of battery capacity
BAU	Business as usual
BEV	Battery Electric Vehicle
BMS	Battery Management System
CAGR	Compound Annual Growth Rate
EPR	Extended Producer Responsibility
ESS	Energy-Storage Solution
EV	Electric Vehicle
FTE	Full Time Equivalent
GHG	Greenhouse gas
GPP	Green Public Procurement
GWh	Giga watt hour, a unit of energy representing one billion watt hours
IEC	International Electro technical Committee
ISO	International Organisation for Standardisation
LCA	Life Cycle Analysis
LIBs	Lithium-ion batteries
LME	London Metal Exchange
NACE	Statistical classification of economic activities in the European Community
OEM	Original Equipment Manufacturer
PEFCR	Product Environmental Footprint Category Rules
PHEV	Plug-in hybrid electric vehicle

POM	Placed on the Market
SME	Small and medium enterprise
SoH	State of Health
WEEE	Waste Electric and Electronic Equipment

1. Introduction and Policy Context

Batteries development and production is a strategic imperative for Europe in the context of the clean energy transition and is a key component of the competitiveness of its automotive sector. In the EU, transport causes roughly a quarter of greenhouse gas (GHG) emissions and is the main cause of air pollution in cities.

A broader uptake of electric vehicles will help reduce GHG and noxious emissions from road transport. In the EU, a strong increase in the electrification of passenger cars, vans, buses and, to a lesser extent, trucks is expected to take place between 2020 and 2030, mainly driven by EU legislation setting CO_2 emission standards for carmakers. The electrification of some housing services, like energy storage or heating, will follow and will contribute to further reducing GHG emissions.

According to estimates by the World Economic Forum**,** to accelerate the transition to a low-carbon economy, **there is a need to scale up global battery production by a factor of 19** for every step of the value chain (see **Figure 1**).

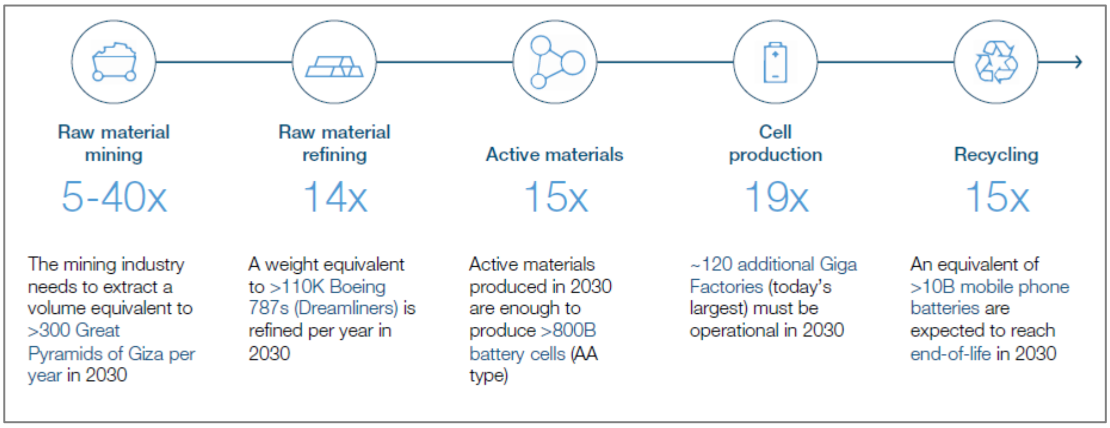

Figure 1: Factor increase needed worldwide in every segment of the batteries value chain[1]

In the EU, from 2025 onwards, **there is an opportunity to capture the market for batteries** valued at up to **€250 billion a year**. They would be produced in at least 10 to 20 Gigafactories (battery cell mass production facilities) and help meet EU demand.[2]

The aim of this initiative is to update the EU's legislative framework for batteries. It is an integral part of the **Green Deal**, the EU's new growth strategy that aims to transform the EU into a modern, resource-efficient and competitive economy where there are **no net emissions**

1 World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

2 Figures from COM(2018) 293.

of greenhouse gases by 2050, where economic growth is decoupled from resource use, and where no person and no place is left behind.

1.1. Policy context

This initiative builds on several reports adopted by the European Commission and commitments made.

In May 2018, the Commission adopted the **strategic action plan on batteries** as part of the third 'Europe on the Move' mobility package.[3] The action plan sets out measures to support efforts to build a battery value chain in Europe, from raw material extraction, sourcing and processing, battery materials, cell production, battery systems, reuse to recycling.

The Commission subsequently published in April 2019 a **report on the implementation** and on the impact on the environment and the functioning of the internal market of the **Batteries Directive** (2006/66/EC). It also published a report **evaluating** the Batteries Directive.[4]

In the **European Green Deal**[5], the Commission announced that it would "continue to implement the strategic action plan on batteries and support the European Battery Alliance. It will propose legislation in 2020 to ensure a safe, circular and sustainable battery value chain for all batteries, including to supply the growing market of electric vehicles." It also calls for the decarbonisation of transport and industrial sectors, stating that "the Commission would consider legal requirements to boost the market of secondary raw materials with mandatory recycled content and continue to support research and innovation on batteries".

The new **circular economy action plan, "For a cleaner and more competitive Europe"**[6] adopted in March 2020, requires the proposal for a new regulatory framework for batteries to include assessing the rules on recycled content, measures to improve the collection and recycling rates of all batteries to ensure the materials recovery. It should also examine non-rechargeable batteries with a view to progressively phasing out their use where alternatives exist. Furthermore, sustainability and transparency requirements (taking into account e.g. the carbon footprint of battery manufacturing, ethical sourcing of raw materials and security of supply) should be set to provide guidance to consumers and facilitate reuse, repurposing and recycling.

In its **new industrial strategy for Europe**[7], the Commission highlights its intention to uphold Europe's industrial leadership in areas where it has a global competitive advantage, where it meets the highest social, labour and environmental standards and allows Europe to project its values. It clearly includes the emerging EU manufacturing industry of advanced batteries.

Furthermore, in the document '**Europe's moment: Repair and Prepare for the Next Generation'**[8], the Commission states that the new Strategic Investment Facility will invest in technologies key for the clean energy transition, such as batteries, and that the work of the European Battery Alliance will be fast-tracked.

In December 2019, the European Commission approved under EU State aid rules an **important project of common European interest** for a pan-European research and innovation project in all segments of the battery value chain supported by seven Member

[3] Annex to COM(2018)293 final.
[4] COM(2019)166 and SWD(2019)1300.
[5] COM(2019)640 final.
[6] COM(2020)98 final.
[7] COM(2020)102 final.
[8] COM(2020)456 final.

States. In the coming years, Belgium, Finland, France, Germany, Italy, Poland and Sweden will together provide up to approximately **€3.2 billion** in funding for this project, which is expected to unlock an additional €5 billion in private investment.[9] A second important project of common European interest on batteries is expected to be approved by the end of 2020.

In September 2020, the Commission presented an action plan on critical raw materials including the 2020 list of critical raw materials[10] and a foresight study on critical raw materials for strategic technologies and sectors with an outlook to 2030 and 2050[11]. The list of critical raw materials has been updated and now includes lithium in addition to cobalt and natural graphite as it is essential for a shift to e-mobility.

Lastly, the Commission's **sustainable and smart mobility strategy** aims to achieve a 90% reduction in transport-related greenhouse gas emissions by 2050.

In addition to the Commission's work, both **the Council and Parliament** have called for action on policies that support the transition to electro-mobility, carbon neutral energy storage and a sustainable batteries value chain.

The **Council conclusions on 'more circularity – transition to a sustainable society'** from **4 October 2019** call for action on batteries on several fronts, including for the "transition to electro-mobility to be accompanied by coherent policies supporting the development of technologies that improve the sustainability and circularity of batteries …". Furthermore, they call for an urgent revision of the Batteries Directive, noting that it should "include all relevant batteries and materials and consider, in particular, specific requirements for lithium and cobalt as well as a mechanism allowing adaptation of the Directive to future changes in battery technologies".[12] The Council conclusions of **2 October 2020** stated that "the EU must pursue an ambitious European industrial policy to make its industry more sustainable, more green, more competitive globally and more resilient", and confirmed the importance of "stepping up the assistance to the existing Important Projects of Common European Interest on Batteries […] so as to overcome market failures and enable breakthrough innovation".[13]

In July 2020, **Parliament's Committee on Industry, Research and Energy** adopted a motion for a resolution on a comprehensive approach to energy storage. The motion includes several points on batteries, such as:

- the concern that the EU has a very low lithium-ion battery manufacturing capacity and relies on production sourced outside Europe,
- concern about the EU's high dependence on imports of raw materials for battery production, including from sources where their extraction involves environmental degradation, breaches to labour standards and local conflicts over natural resources;
- a call for design for recycling;
- a call on the Commission to develop guidelines and/or standards for repurposing batteries from electric vehicles, including testing and grading processes, as well as safety guidelines; and

9 https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6705.
10 COM/2020/474 final.
11 https://ec.europa.eu/docsroom/documents/42881 and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474
12 https://www.consilium.europa.eu/media/40928/st12791-en19.pdf
13 https://www.consilium.europa.eu/media/45910/021020-euco-final-conclusions.pdf

- a call to the Commission to propose ambitious collection and recycling targets for batteries based on critical metal fractions etc.[14]

In May 2020, the **European Investment Bank** announced that it expects to increase its support for battery-related projects to over **€1 billion of financing in 2020**. This matches the level of support the EIB has provided over the last decade. Since 2010, battery projects financed by the EIB totalled €950 million, funding €4.7 billion of overall project costs. EIB support was provided under a successful partnership with the European Commission, which has created new financing instruments such as the InnovFin Energy Demonstration Programme, a tool to facilitate the demonstration phase of innovative energy projects, including battery pilot lines.[15]

1.2. Legal context

1.2.1. The Batteries Directive

The Batteries Directive is the **only piece** of EU legislation that focuses specifically on batteries.

The objective of the Directive is to minimise the negative impact of batteries and waste batteries on the **environment**, to help protect, preserve and improve the quality of the environment and to ensure the smooth functioning of the **internal market**. It also seeks to improve the environmental performance of businesses involved in the life cycle of these products and related processes, e.g. producers, distributors, end users and operators involved in processing and recycling waste batteries.

The Directive addresses the environmental impacts of batteries related to the **hazardous components** they contain. If spent batteries are landfilled, incinerated or improperly disposed of at the end of their life, there is a risk that the substances they contain leach out into the environment, compromising environmental quality and human health. To address these risks, the Directive promotes the reduction of hazardous components in batteries and sets out measures to ensure the proper management of waste batteries.

The Directive requires Member States to **maximise the separate collection** of waste batteries and sets **targets** for waste battery **collection** and for **recycling efficiencies**. Member States must ensure that, by 2016, up to 45% of the waste portable batteries placed on the market are collected. All batteries collected must be recycled through **processes** that reach the **minimum efficiencies** set under the Directive, in order to attain a high level of material recovery. It sets targets for three groups of batteries: lead-acid, nickel-cadmium and all other batteries.

Producers of batteries and of products incorporating batteries are responsible for managing the waste generated by the batteries they place on the market **(‘extended producer responsibility’**).

Further details about the Batteries Directive can be found in **Annex 5**.

Article 23 of the Batteries Directive: Implementation review and scope for revision if necessary

Article 23 of the Directive tasks the Commission with reviewing the implementation of the

14 European Parliament Committee on Committee on Industry, Research and Energy (2020) 'Report on a comprehensive European approach to energy storage', (2019/2189(INI)), https://www.europarl.europa.eu/doceo/document/A-9-2020-0130_EN.html.

15 https://www.eib.org/en/press/all/2020-121-eib-reaffirms-commitment-to-a-european-battery-industry-to-boost-green-recovery.

Directive and its impact on the environment and on the functioning of the internal market. In April 2019, the Commission published an evaluation of the Batteries Directive[16], in line with the Commission's Better Regulation guidelines and taking into account the specifications of Article 23. **Annex 6** provides a summary of the **Batteries' Directive Evaluation report**.

Article 23 also states that, if necessary, proposals should be made to revise the applicable provisions of the Directive.[17]

1.2.2. EU environmental law

Although the **Batteries Directive** covers some of the environmental impacts related to the **end-of-life stage** of batteries, there are also environmental risks related to the other stages in the life cycle. Examples include adverse impact related to the extraction of raw materials, emissions resulting from the production or recycling of batteries, the impact on health and the environmental of the hazardous substances used in batteries etc. In the EU, most of the environmental impacts related to battery production are also **covered by EU environmental law**.

One key example is the **Industrial Emissions Directive**[18] (IED), which regulates emissions of pollutants from industrial activities, including the production of chemicals and the processing of non-ferrous metals. During battery production, several stages of the value chain (e.g. production of the required chemical compounds, recycling) may generate significant sources of emissions that pollute the air, soil, and water. As part of the revision process of the IED, the Commission is currently assessing whether there are gaps in the scope of the IED with regard to industrial activities that are part of the battery value chain.

1.2.3. Internal market regulation

There is currently no legislation at EU level that specifically covers battery performance and sustainability aspects. A number of international standards exist to test the performance of rechargeable batteries, but they are not considered fit for the purpose of providing presumption of conformity with minimum performance requirements. Therefore, a related standardisation request is being formulated in parallel with the regulatory proposal.

Creating a regulatory framework to gradually bring in performance and sustainability requirements for batteries will therefore help avoid potential regulatory differences between Member States.

1.3. Environmental and social context

In the EU, transport generates roughly a quarter of GHG emissions and is the main cause of air pollution in cities. Road transport in particular is the main contributor to transport-related GHG emissions. Ensuring a swift transition to electric transport is one of the biggest levers to reduce GHG emissions and pollution from transport. This is why the EU's commitments made in the Green Deal, including the **sustainable and smart mobility strategy**, will have the key objective to deliver a 90% reduction in transport-related greenhouse gas emissions by 2050.

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16 SWD(2019)1300.

17 The Directive has been amended several times: in March 2008 (Directive 2008/12/EC, L 76, 19.3.2008), November 2008 (Directive 2008/103/EC, L 327, 5.12.2008), November 2013 (Directive 2013/56/EU L 329, 10.12.2013) and June 2018, (Directive 2018/849/EU, OJ L 150, 14.6.2018).

18 Directive 2010/75 on industrial emissions.

Batteries are the major driver in the short term to decarbonize road transportation and support the transition to a renewable power system. For road transport for example, automotive original equipment manufacturers are launching more than 300 electric vehicle (EV) models in the next five years[19]. A recent study carried out for the Commission using a life cycle assessment approach found that **electric vehicles have a better environmental performance compared to conventional vehicles**[20,21] across all assessed indicators. The study also concluded that environmental benefits from the use of battery electric vehicles would increase in the future, particularly in view of the steadily decarbonised electricity mix.

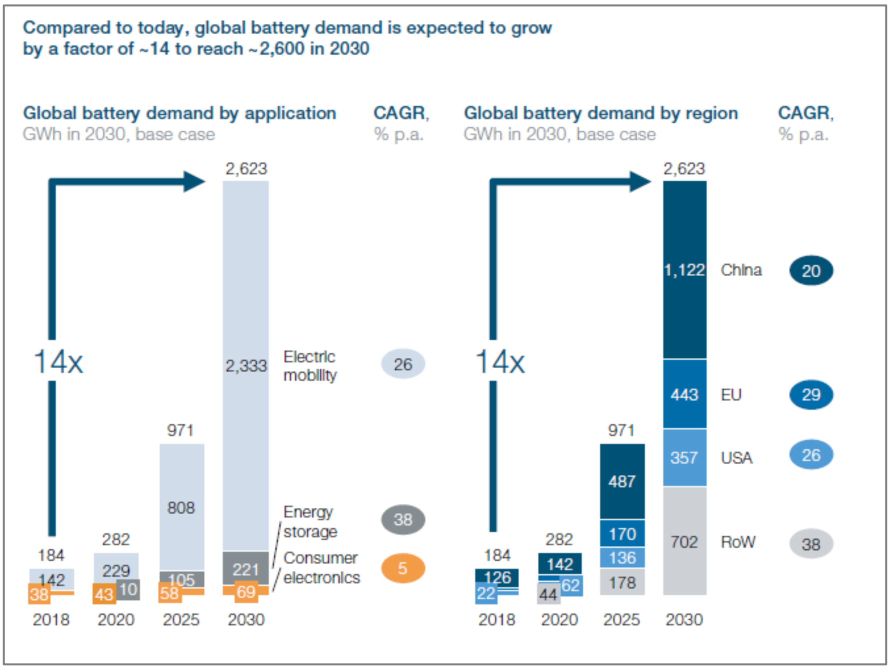
Nevertheless, to ensure sustainability and avoid the substitution of negative environmental and social effects, attention will need to be paid to lowering the emissions during the production phase, eliminating human rights violations across the value chain and improving repurposing and recycling.

1.4. Economic context: increasing demand for and production of batteries

1.4.1. Demand

In 2018, global demand for batteries was 184 GWh, a high share of which was provided by lead-acid batteries.[22,23] On average, the worldwide battery market increased by 9% per year between 2010 and 2017.

The transition to a low-carbon economy will lead to **an exponential increase in the demand for batteries** (see **Figure 2**). According to estimates by the World Economic Forum and the Global Batteries Alliance, global demand for batteries is set to **increase 14 fold** by 2030 (compared to 2018 levels), mostly driven by electric transport.



[19] World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

[20] Comparing different powertrains running on different fuels.

[21] E4Tech, *Determining the environmental impacts of conventional and alternatively fuelled vehicles through LCA*, 2020, study commission by the European Commission

[22] Avicenne, *The Rechargeable Battery Market and Main Trends 2017–2025*, 2018.

[23] In 2018, over 70% of world rechargeable energy charging capacity was provided by lead-acid batteries.

Figure 2: Compound annual growth rate for batteries[24,25]

For the EU, estimates made by the World Economic Forum and the Global Batteries Alliance indicate that **demand could be the second highest worldwide**, worth 170 GWh by 2025 and 443 GWh or 17% of the total global demand by 2030[26].

- In the **short term**, the expected demand for battery capacity will be **driven primarily by passenger electric vehicles**. Currently, electric vehicles only account for a relatively small market share of the EU fleet, but the numbers of registered electric vehicles have been increasing steadily over the last few years (see also Annex 7).[27]
- **Further growth is expected in the coming years**, driven by stricter CO_2 targets for manufacturers that came into force at the beginning of 2020, more targets that will come in force in 2025 and 2030 and the Green Deal commitment to deliver a 90% reduction in transport-related greenhouse gas emissions by 2050.

Batteries: a quick introduction

The batteries value chain

- The batteries value chain consists of several stages, starting from raw material extraction, manufacturing, use and end-of-life (see **Figure 3**)

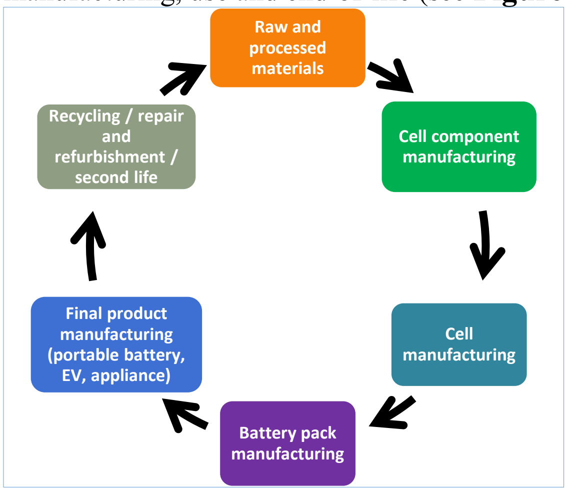


Figure 3: Battery life cycle

How batteries are typically categorised

- Batteries can be either primary (non-rechargeable) or secondary (rechargeable) types.
- Batteries can also be categorised according to use, technology or size. The most common market segmentation, used by the Batteries Directive, is to distinguish between portable batteries (mostly used in the 3C sector: consumer electronics, communication and

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24 World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

25 Compound annual growth rate (CAGR) is a business and investing specific term for the geometric progression ratio that provides a constant rate of return over the time period.

26 These forecasts are in line with the conclusions of a recent JRC report, see Tsiropoulos, I., Tarvydas, D., Lebedeva, N., Li-ion batteries for mobility and stationary storage applications – Scenarios for costs and market growth, doi:10.2760/87175, JRC113360.

27 European Environment Agency (2019), *Electric vehicles as a proportion of the total fleet*, at https://www.eea.europa.eu/data-and-maps/indicators/proportion-of-vehicle-fleet-meeting-4/assessment-4 (accessed on the 11 March 2020).

computing), automotive batteries (used for automotive starter, lighting or ignition power and traction batteries used in electric and plug-in-hybrids) and industrial batteries.

Production in the EU

- In 2015, the total volume of batteries placed on the EU market was about 1.8 million tonnes. Automotive batteries represented by far the largest share in weight with 61%, amounting to 1.10 million tonnes (see figure 4 in Annex 7). The second largest share, 27% or about 0.49 million tonnes, were industrial batteries. The remaining 12%, 212 000 tonnes, were portable batteries.
- In 2018, the EU produced €8.4 billion of batteries. Around €3.9 billion worth were exported and €7.5 billion worth were imported, so in total €12 billion worth of batteries were placed on the EU market.

- In the **medium term**, there will be **a significant increase in the volume of lithium-ion batteries placed on the market** (see **Figure 4**).

  For other chemical compositions, estimates indicate that EU demand for **lead-acid batteries** will fall from around 100 GWh in 2018 to about 80 GWh in 2030. Global demand for lead-acid batteries is likely to remain stable or slightly increase from 450 GWh in 2018 to 490 in 2030.[28]

  As regards **alkaline batteries**, which are mostly used in the 3C sector, total EU demand in 2030 is expected to remain relatively stable in absolute terms.[29] The 3C sector, which is the main destination for this type of batteries, is expected to continue growing over the medium term, but at a much lower rate than the other sectors.

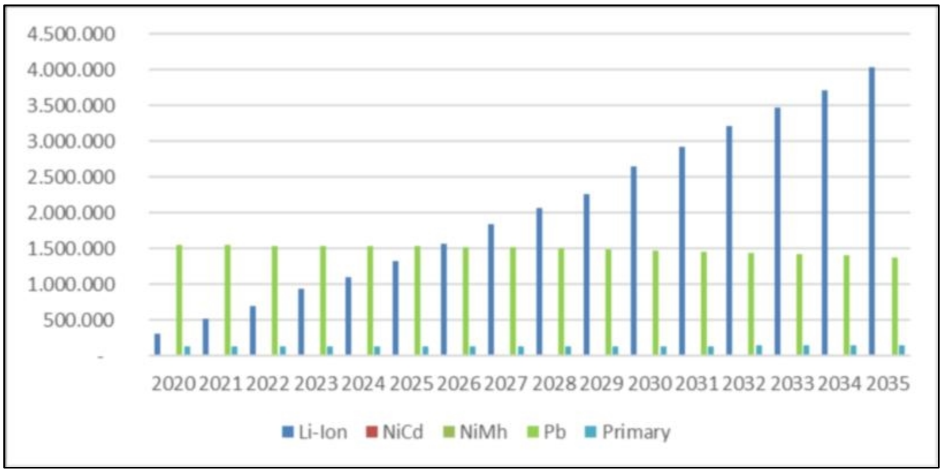

Figure 4: Batteries projected to be placed on the EU market (2020-2035, in tonnes)[30]

- Whereas forecasts about demand for batteries by 2025 is consistent among studies, **uncertainty** about the expected demand rises in the **medium to long term**. **Figure 5** shows a minimum and a maximum scenario for battery capacity demand generated by electric vehicles and energy storage solutions applications until 2049. It shows that the expected EU demand for battery capacity will amount to 180-230 GWh in 2025

28 Global Battery Alliance & World Economic Forum, *A Vision for a Sustainable Battery Value Chain in 2030*, 2019.

29 ENV Study 2020.

30 Study report to support the impact assessment.

and to 450-730 GWh in 2030. According to this study, in 2049 the minimum scenario points to a demand of approximately 1500 GWh and the maximum scenario to 2400 GWh.

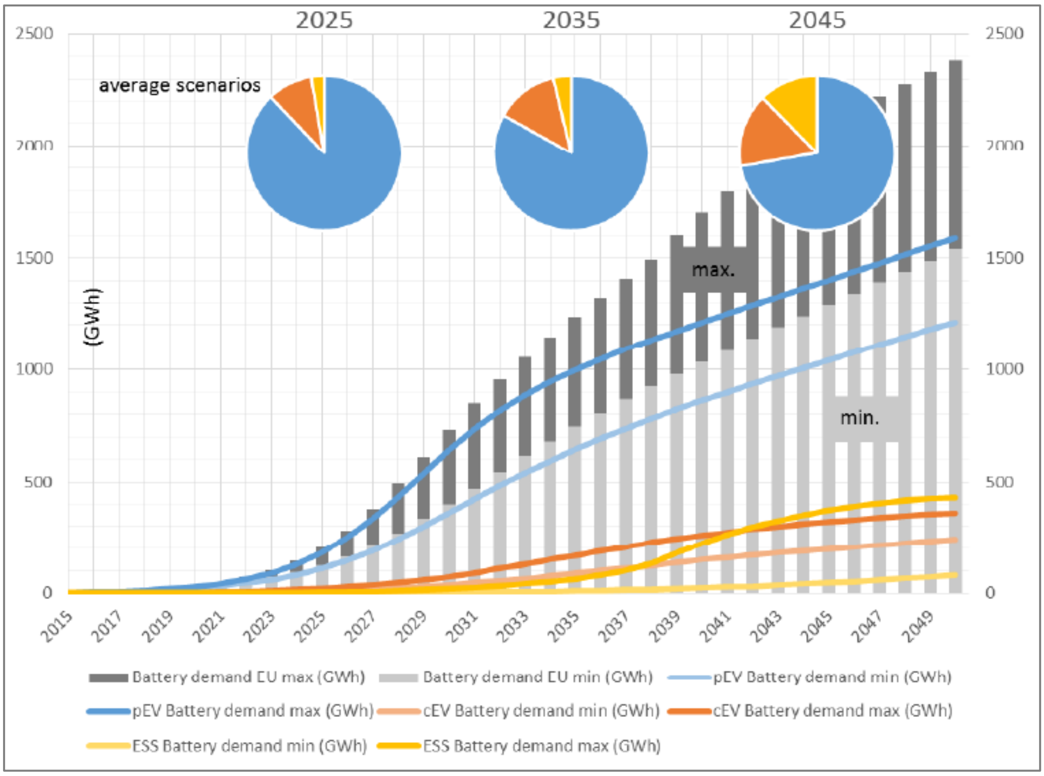

Figure 5: Battery capacity demand derived from new installations in electric vehicles (passenger EV, commercial EV) or energy storage systems and replacements in existing systems in EU-28

Annex 7 provides more facts and figures about the increasing demand for batteries.

1.4.2. Future production

If the demand forecast overleaf materialises, annual **global battery production** revenues in **2030** could reach up to **$300 billion**, of which over $30 billion could be in the EU, according to the Global Battery Alliance.[31]

The global manufacturing capacity of lithium-ion cells for electric cars and energy storage is about 150 GWh per year. **The EU does not have yet a large-scale lithium-ion cell production capacity but this is rapidly changing.** In 2019, certain EV producers were struggling to ramp up production of some of their models due to delays in the production capacity of the tier-one battery cells they need.[32]

For the EU automotive sector, consolidating an EU battery value chain is particularly important. In electric vehicles, traction batteries and the electric powertrain can represent up to 40% of their value. This was one of the reasons that prompted the European Commission and EU Members States to launch, back in 2017, the European Battery Alliance.

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31 Global Battery Alliance & World Economic Forum, *A Vision for a Sustainable Battery Value Chain in 2030*, 2019.

32 Mathieu, Carole, *The European Battery Alliance is moving up a gear*, https://energypost.eu/the-european-battery-alliance-is-moving-up-a-gear/, 2019.

According to the information provided by members of the European Batteries Alliance on the industrial plans of its members and the information of publically announced investments in the EU, the **production of lithium-based cells within the EU (by EU and non-European manufacturers) could reach up to around 370 GWh per year in 2025**. **If these levels of production materialise**, this could serve the demand in Europe.[33] This would also make the EU the second highest region of production worldwide (see **Figure 6**).[34]

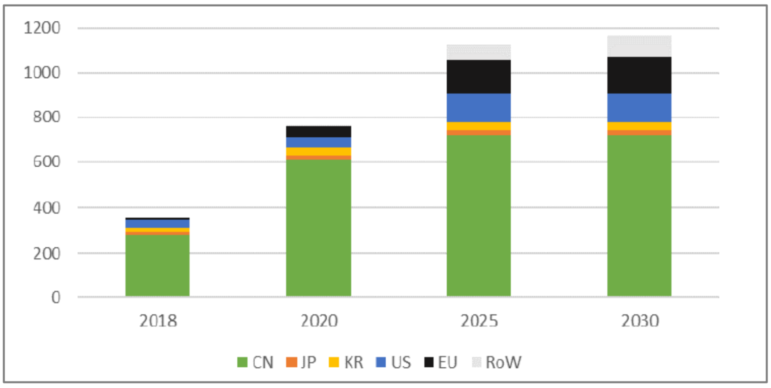

Figure 6: Lithium-ion cell production capacities for industrial batteries within the EU in GWh per year by location of plants

Mass manufacturing, through economies of scale and experience in production, **could halve the costs of lithium-ion batteries by 2030**, and an additional 50% reduction may be achievable after that, i.e. a lithium-ion battery that today costs about €200/kWh may ultimately cost €50/kWh. This is attainable based on advanced battery chemistries, but does not take into account potential disruption in raw material prices (e.g. cobalt).[35]

Efforts to build manufacturing capacity in Europe will primarily target lithium-ion cells with cathodes employing nickel, manganese and cobalt (NMC) in different proportions, and anode mainly graphite.[36,37] An increasing number of car makers are choosing full NMC chemistry to achieve higher energy density and thus extend vehicle battery autonomy.[38]

Annex 7 provides more facts and figures on battery production.

1.5. Public context

There is a **general acknowledgement** among the public that there is a need for a regulatory initiative that covers the entire battery value chain in an integrated manner. Stakeholders who responded to the public consultations generally acknowledged that **technological, economic and social changes** justify the need for a new regulatory framework for batteries. They also called for a **better harmonisation** of existing rules and an EU framework covering the **entire life cycle**, comprising common and stronger rules for batteries, components, waste batteries and recyclates, for the purpose of ensuring the function of the **EU's internal market**.

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33 Based on announced investments at the time of writing.

34 VITO, Fraunhofer and Viegand Maagøe, *Study on eco-design and energy labelling of batteries*, 2019.

35 Steen, M et al., *EU Competitiveness in Advanced Li-ion Batteries for E-Mobility and Stationary Storage Applications – Opportunities and Actions,* JRC Science for Policy Report, doi:10.2760/75757, 2017.

36 Steen et al., *EU Competitiveness in Advanced Li-ion Batteries for E-Mobility and Stationary Storage Applications – Opportunities and Actions,* JRC Science for Policy report, 2017.

37 D. T. Blagoeva et al., *Assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU*, 2017.

38 EC Report on Raw Materials for Battery Applications, CSWD(2018)245/2 final.

The main needs expressed by representatives from **industry** are for a stable regulatory framework that provides investment certainty, a level playing field that enables the sustainable production of batteries and the efficient functioning of recycling markets. The main concerns expressed by representatives of **civil society** include sustainable sourcing and implementing the principles of the circular economy to the batteries value chain.

A detailed analysis of the stakeholder consultations is provided in **Annex 2** and (per topic) in **Annex 9**.

2. PROBLEM DEFINITION

The aim of this initiative is to tackle **three groups of highly interlinked problems** related to batteries (Figure 7).

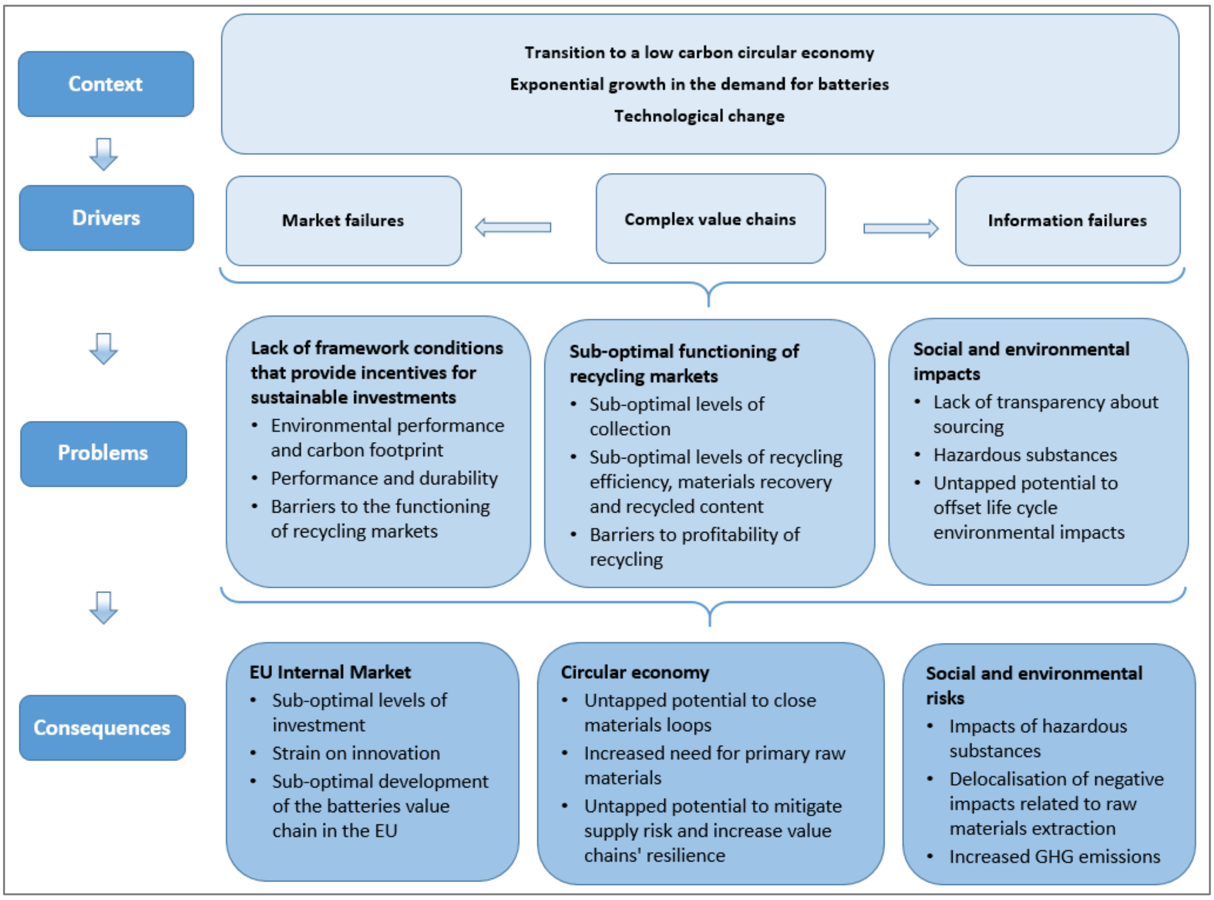

Figure 7: Problem tree

The **first group** relates to **the lack of framework conditions providing incentives to invest** in production capacity for sustainable batteries. These problems are linked to potentially diverging regulatory frameworks within the **internal market.** Another underlying cause is the lack of reliable and comparable information.

The **second group of problems** relates to **sub-optimal functioning of recycling markets** and **insufficiently closed materials loops**, which limits the EU's potential to mitigate the supply risk for raw materials. A number of shortcomings in the current regulatory framework are a drag on the profitability of recycling activities and put a strain on investment in technologies and the capacity to recycle batteries in the future. These shortcomings include a lack of clear and sufficiently harmonised rules, and provisions in the Batteries Directive that take into account recent technological and market developments.

The **third group of problems** relates to **social and environmental risks** that are currently not covered by EU environmental law. It includes a lack of transparency on sourcing raw materials, hazardous substances and the untapped potential to offset the environmental impacts of battery life cycles.

2.1. What are the problems?

2.1.1. Lack of framework conditions providing incentives for sustainable investment

To enable the transition to a low-carbon economy, **an exponential increase in the production of batteries is needed** (see Section 1), which requires considerable investments. In view of achieving **carbon neutrality and environmental protection**, stimulating **a race to the top and avoiding lock-in**, it is important to channel these investments to batteries with minimised environmental impacts over their life cycle. Currently, however, there a number of **barriers** that prevent this, such as lack of reliable information to make informed decisions and diverging regulatory frameworks across the Member States.

2.1.1.1. Environmental impact and carbon footprint

The **carbon footprint** of batteries critically depends on the energy source used in the manufacturing phase, and **can differ significantly across producers**. Compared to regular combustion engines, the potential for reducing GHG emissions savings ranges between 48-60% for the better performing ones and 19-26% for some others.[39]

Currently, however, **the data needed to calculate carbon impact is not always readily available and often not comparable**. This hampers sustainable choices and investment in the transitions underway in the mobility and energy-storage sectors.

The carbon footprint of products is likely to become more prominent in trade and climate policy discussions over the coming years.

2.1.1.2. Battery performance and durability

The lack of requirements or information on performance and durability of rechargeable batteries leads to potential regulatory differences for batteries placed on the EU market. Even though consumer awareness of sustainable consumption is rising, insufficiently detailed or harmonised labelling requirements mean that it is currently not possible to make informed purchasing decisions. As a result, **market competition is currently largely price driven with insufficient incentives or rewards** for businesses that produce batteries with a lower environmental impact.

2.1.1.3. Second life market for industrial batteries

The emerging market for second life batteries is an example of a market that is **hampered by a lack of a harmonised regulatory framework** in the EU.

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[39] World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

When the functionality of EV batteries falls to 75-80 % of its original value after a certain usage, the battery is unable to perform as required for automotive use. These batteries can be **repaired or repurposed** and then reused (for the same use), or be adapted to have a **'second life'** (different to the original use). The global second-life battery market is forecast to reach 26 GWh by 2025.[40]

The Batteries Directive does not explicitly cover 'second life' batteries. Moreover, applying the general waste policy principles to this particular case is far from straightforward. As a result there are currently **different approaches arising across the Member States**: some Member States treat end-of-life batteries as waste while others treat them as products, which results in different legal requirements. This gives rise to **market fragmentation**, leads to **uncertainty** for business and could **hinder the development of related economic activities**.

2.1.1.4. Barriers to the functioning of recycling markets

Finally, **with regards to the recycling of batteries**, the evaluation of the Batteries Directive found that one of the shortcomings of the Directive is that **its provisions are insufficiently detailed** on certain aspects, leading to uneven implementation and creating **significant barriers to the functioning of recycling markets**. Examples include the classification of batteries, the definition of recycling, the requirement on battery removability, labelling provisions, and requirements for extended producer responsibility.

As a result, implementation of the Directive is **uneven** and **the levels of batteries collected and recycled are sub-optimal**. One specific example is the lack of detailed provisions for **producer responsibility organisations** (PROs), on which the evaluation of the Batteries Directive identified several examples of unfair competition. For example, there are PROs that compete for the collection of profitable battery types only (known as "cherry picking"), even collecting batteries from non-private end users, while ignoring other types of batteries.

These sub-optimal levels of collection are **problematic**, given that recycling technologies are rather **capital-intensive** and require significant **economies of scale,** in some cases beyond what EU national markets can provide. In this context, metal refiners have stated that they are willing to invest in building up capacity, provided there is sufficient security of feed later on.[41]

2.1.2. Barriers to the functioning of recycling markets

The global exponential growth in demand for batteries will lead to an equivalent **increase in demand for raw materials**. The Global Batteries Alliance forecasts that four battery metals will see the highest impact from this growth. By 2030, demand for cobalt, lithium, class 1 nickel and manganese is set to rise by a factor of 2.1, 6.4, 24, and 1.2 respectively compared to 2018 levels (see **Figure 8**).

This trend is expected to increase the supply risk for EU producers for two reasons.

Firstly, the supply of raw materials is rather inelastic due to long planning cycles: the time between exploring a mineral deposit and building a mine can be 10 years or more[42].

[40] 'Battery second life: Hype, hope or reality? A critical review of the state of the art', *Renewable and Sustainable Energy Reviews 93*, 2018, p.701-718.

[41] Hagelüken, "The recycling of (critical) metals", in *The Critical Metals Handbook*, John Wiley & Sons, 2014.

[42] European Innovation Partnership on Raw Materials, *Raw Materials Scoreboard*, 2016.

Secondly, the reserves of some minerals needed for batteries are **geographically concentrated** in a few countries, some of which are characterised by weak governance and use different policy tools (such as export restrictions on raw materials) to support their domestic industry. This may pose an additional supply threat to downstream battery producers in the EU. For example, in September 2010, China (which, at the time, was producing 93% of the world's rare earth minerals and was the dominant world supplier of rare earth metals) introduced significant **export restrictions**. These severely affected car manufacturers and high-technology-producing companies.

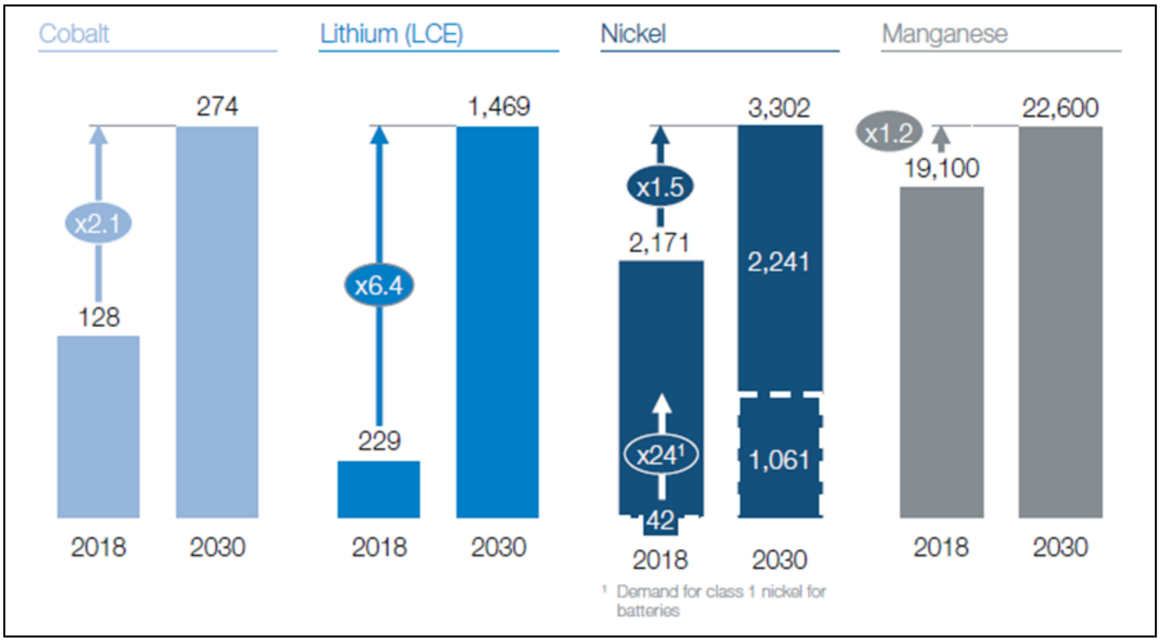

Figure 8: Expected growth in the global demand of materials for batteries[43]

This supply risk could at least partially be reduced by **closing the materials loop** as much as possible, i.e. by promoting the durability extension, removability and replaceability, and where feasible the repair and reuse of batteries, and the use of secondary materials coming from recycling instead of virgin materials.[44] For example, secondary production of one ton of lithium could be achieved by recycling 28 tonnes of used batteries (from around 256 electric vehicles). However, within the EU, **the volume of metals recovered that are used in battery production is low**. Only 12% of aluminium, 22% of cobalt, 8% of manganese, and 16% of nickel used within the EU are recycled[45]. Only for lead-acid batteries is the volume of recovered materials used in manufacturing higher than the volume of primary materials[46].

In the current situation of market development, mostly as result of market failures, **the potential for recycling within the EU remains largely untapped.** This has resulted in 1) sub-optimal collection of waste batteries, 2) sub-optimal levels of recycling efficiencies, material recovery and uptake of recycled content and 3) factors that drag down the profitability of recycling industries. These problems are further discussed below.

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[43] World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

[44] See e.g. Mathieux, F., et al. (2017). Critical raw materials and the circular economy - Background report (Issue December). https://doi.org/10.2760/378123; Matos C.T, et al "Material System Analysis of five battery-related raw materials: Cobalt, Lithium, Manganese, Natural Graphite, Nickel," doi: 10.2760/519827, JRC119950. In Press.

[45] European Innovation Partnership on Raw Materials, *Raw Materials Scoreboard*, 2018.

[46] European Innovation Partnership on Raw Materials, *Raw Materials Scoreboard*, 2018.

2.1.2.1. Sub-optimal collection of waste batteries

The collection and proper treatment of waste batteries are essential to **material recovery** to make secondary materials available and avoid the risk of **pollution** from the hazardous substances found in batteries. For example, in 2015, about 37 000 tonnes of portable Li-ion batteries were placed on the EU market. If all these batteries had been collected and recycled[47], about 1,500 tonnes of secondary cobalt could have been recovered, a sufficient volume to manufacture approximately 200,000 Li-ion batteries for battery electric vehicles (BEV), enough to cover all BEV placed on the market in Europe in 2015.[48]

In practice however, in 2014, **60% of waste portable batteries** (128,000 tonnes) were **not collected**, falling to 52% in 2018. Of these, an estimated 35,000 tonnes of waste portable batteries were disposed of as part of municipal waste. The rest may inadvertently remain with the last end user (a phenomenon called 'hoarding') or erroneously enter the WEEE stream if the battery is not removed from its discarded appliance.

The evaluation of the Batteries Directive notes that it is **difficult to identify a single reason to explain the failure of some Member States to meet the collection rate target** for waste portable batteries. One possible explanation is the difficulty in implementing certain provisions such as **awareness raising** or the accessibility of **collection points** for waste portable batteries, due to the Directive's **lack of detail in the provisions for extended producer responsibility** and producer responsibility organisations.

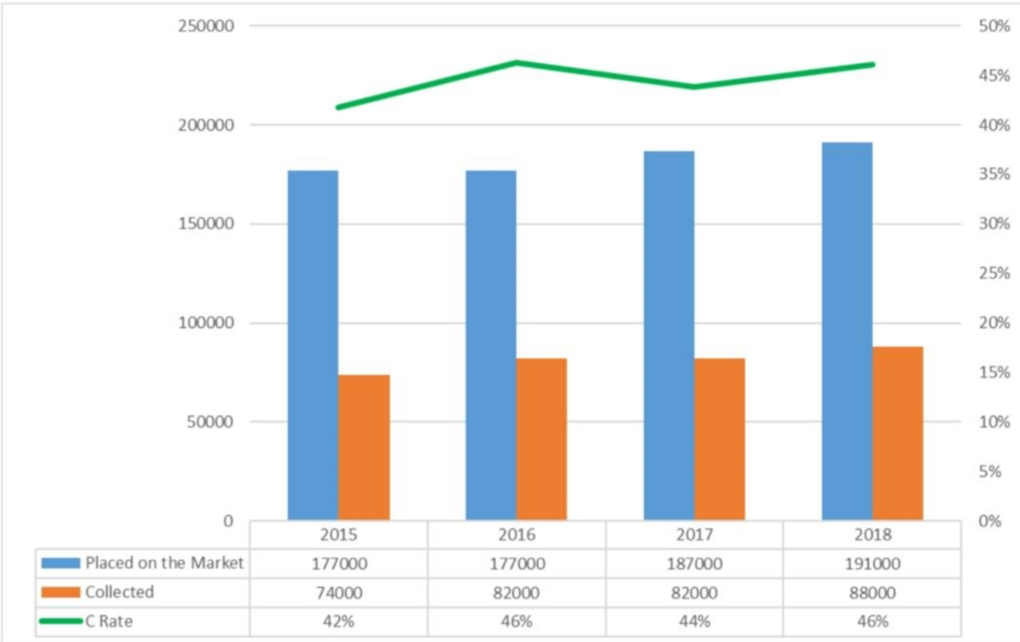

Figure 9: Waste portable batteries generated and collected in the EU[49]

The Batteries Directive does not set explicit targets for the collection of industrial or automotive batteries, but it includes an implicit "no loss" policy by requiring that all industrial and automotive batteries must undergo proper treatment and recycling. When the Batteries Directive was adopted, it did not set an explicit target, based on the assumption that the recycling of industrial batteries is profitable and that business would ensure that these

47 Assuming a 95% rate of recycled co-content.
48 Study underpinning the evaluation of the Batteries Directive.
49 Data from Eurostat.

batteries are properly collected and recycled. However, data show that **11% of industrial batteries** placed on the market are **not collected** at the end of their life and could be lost.

In the future, the share of uncollected industrial batteries is **expected to increase**, mostly due to industrial batteries used and owned outside professional or industrial contexts, such as batteries in EV vehicles, e-bikes, e-scooters and private energy-storage systems. This is partly a result of the lack of **collection, monitoring and reporting systems** and the lack of an explicit target. This analysis is **confirmed by the evaluation of the Batteries Directive**, which found that the fact that there are only collection rate targets for spent portable batteries could cause confusion and prevent the achievement of the Directive's objectives.

2.1.2.2. Sub-optimal levels of recycling efficiency, material recovery and uptake of recycled content

In addition to collection rate targets for waste batteries, the Batteries Directive also includes a provision setting **a minimum level of recycling efficiency**[50] for lead-acid batteries (65%), nickel-cadmium batteries (55%) and "other" batteries (including lithium-ion) (50%). It also sets the obligation to **recover lead and cadmium** content to the highest degree that is technically feasible while avoiding excessive costs (but does not set a quantified target).

When the Directive was adopted, the **approach** taken to include both the input to the recycling process (i.e. the collection rate) and the efficiency of the recycling process was **innovative**. It has stimulated the development and roll-out of state-of-the art metallurgical processes and increased material recovery rates in the EU. Research[51] suggests that this has resulted in **the Batteries Directive indirectly contributing to making the EU a global leader in recycling capacity for spent batteries**.

This approach to set recycling efficiency and material recovery targets has been successful to a very large extent:

- For **nickel-cadmium batteries**, nearly all EU Member States achieved 75% recycling efficiency or higher in 2018 (with some exceptions), as shown in **Figure 10** below.
- For **lead-acid batteries**, nearly all EU Member States achieved 65% recycling efficiency or higher in all reference years from 2012 to 2018. To date, the recycled input to lead-acid battery production in the EU is above 80%, making it an almost fully circular business.

Despite the relative success of the approach, to date **the provisions in the Batteries Directive are no longer fit-for-purpose**, as pointed out in the evaluation. Although the recycling efficiency targets are broadly met, the Directive's current provisions have not resulted in a high level of material recovery. The Directive no longer provides an incentive to roll out state-of-the art recycling facilities for lead-acid and nickel-cadmium batteries.

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[50] According to Commission Regulation 493/2012, 'recycling efficiency' of a recycling process means the ratio obtained by dividing the mass of output fractions accounting for recycling by the mass of the waste batteries and accumulators input fraction expressed as a percentage.

[51] Mayyas A., Steward D. and Mann M., 'The case for recycling: Overview and challenges in the material supply chain for automotive li-ion batteries', *Sustainable Materials and Technologies 17,* e00087, 2018.

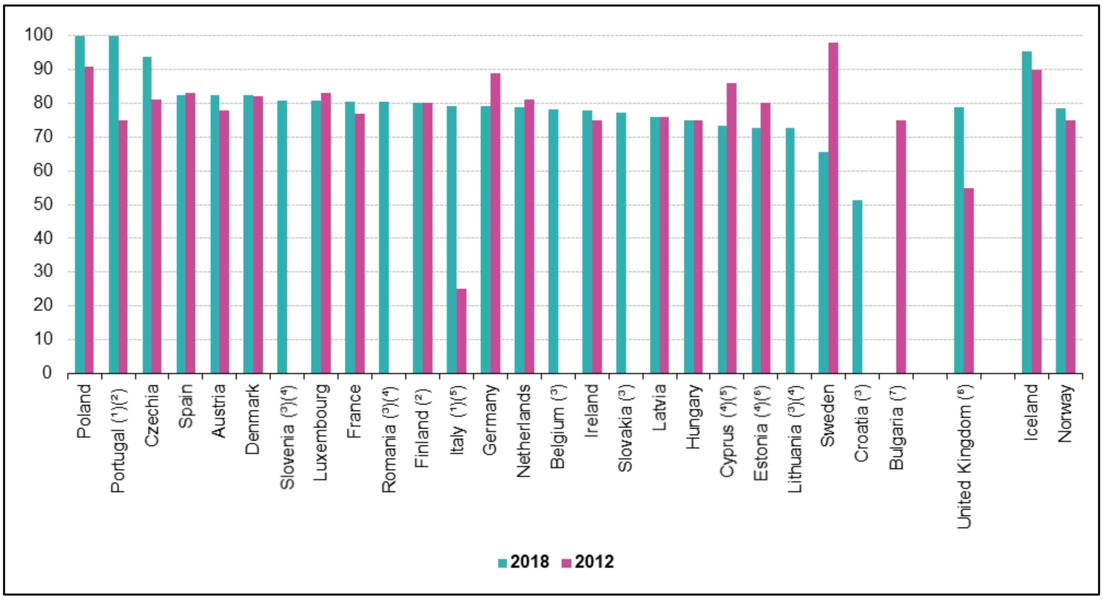

Figure 10: Recycling efficiencies for nickel-cadmium batteries, 2012 and 2018, data from Eurostat.

For lithium-ion batteries, the problem is even more pronounced. There are no specific provisions for lithium batteries, despite their growing market and economic importance or the valuable materials they contain such as nickel, cobalt and copper. This discourages recycling of these batteries and is a barrier to the development of high-quality recycling processes.

The recycling of lithium-ion batteries is a complex and costly process hindered by the wide variety of chemistries and battery formats. It has long been insignificant because of dissipative end-uses (e.g. lubricating greases, metallurgy), non-functional recycling (e.g. glass and ceramics)), or reusable end-uses (such as catalysts). The only waste flow with lithium recycling potential is spent lithium batteries[52].

Today, **almost no lithium is recovered in the EU because it is** considered not cost-effective in comparison with primary supplies, leading lithium-ion battery recycling plants to focus on recovering cobalt, nickel, and copper, which have a higher economic value than lithium, although there are some examples of industrial-scale lithium recovery. The recycling technologies for lithium-ion batteries in use at industrial scale in Europe are lithium recovery from the slag fraction through a pyro-metallurgical process, hydrometallurgical recycling process and a combination of mechanical processing and subsequent hydrometallurgical processing[53].

Where lithium is recovered, its **quality is mostly insufficient** to be used in batteries. Instead, it is **used in other sectors** such as ceramics, glass and alloys. Demand for lithium from these sectors is however set to grow at a much lower rate than demand for EV batteries. Therefore, as soon as EV batteries become available for recycling, scientific research indicates that, as soon as 2021, **the supply of recovered (low-grade) lithium would exceed demand**.[54] This will also be a barrier to the substitution of primary lithium by secondary lithium, thus leaving the potential to lower environmental impact untapped.

52 Study on the EU's list of Critical Raw Materials (2020) Critical Raw Materials Factsheets

53 Study on the EU's list of Critical Raw Materials (2020) Critical Raw Materials Factsheets.

54 Ziemanna S., Müllerb D.B., Schebekc L. and Weila M., 'Modeling the potential impact of lithium recycling from EV batteries on lithium demand: A dynamic MFA approach' *Resources, Conservation & Recycling 133,* 2018, p.76–85.

2.1.2.3. *Factors that are a drag on the profitability of recycling*

Currently, recycling activities in the EU are not operating at an optimal level because there are a number of factors that negatively affect these operations' profitability.

The **viability and economics of battery recycling** depend first on the costs of collecting, sorting, handling and disassembling the batteries that enter the recycling process, and second on the material value of batteries recycled.[55]

For batteries that are a component of a device (e.g. mobile phones, power tools, e-bikes), **ease of removal** is a factor influencing the efficiency of the recycling process. Although the Batteries Directive includes an obligation of removability, data from the ProSUM project[56] estimates that on average only **1-20% of batteries are removed** from electric and electronic equipment at the end-of-life. According to recyclers[57], there are **several reasons why battery removal is becoming more complicated**, such as the decreasing size of batteries and the trend to use soft pouch cells and to glue batteries into devices.

Once batteries have been removed, they are usually **sorted according to their chemistries**, which is currently mostly carried out manually. Here the problem is that **there is currently no mandatory or harmonised labelling system** to provide information on the chemical (and other component) composition of the batteries. This can result in batteries being **sent to landfills** or being wrongly classified, which is reported to have increased the number of **fires and safety incidents.** This in turn increases operational costs and insurance costs. However, even for batteries that do have labelling codes, the lack of specific labels for the different **chemistries within the Li-ion battery category** (e.g. lithium-cobalt oxide, nickel-manganese-copper etc.) leads to a **less-pure recyclable fraction** and thus a missed opportunity to extract valuable materials.[58]

2.1.3. Problems related to environmental and social impacts

2.1.3.1. *Transparency on the sourcing of raw materials*

Extracting some of the raw materials used to produce batteries can sometimes pose **substantial social and environmental risks** or challenges. There is the issue of extractive waste: producing one tonne of lithium for example requires, depending on the ore content, around 250 tonnes of the mineral ore hard rock mineral ('spodumene') or 750 tonnes of mineral-rich brine.[59,60,61,62]

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55 World Economic Forum and Global Batteries Alliance, *A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation*, 2019.

56 http://www.prosumproject.eu, a Horizon 2020 project financed by the EU.

57 EuRIC quoted in the consultant's report.

58 Tecchio, P., Ardente, F., Marwede, M., Christian, C., Dimitrova, G. and Mathieux, F., 'Analysis of material efficiency aspects of personal computers product group' – *JRC Technical Report*, 2019.

59 Meshram, P., Pandey, B. D. & Mankhand, T. R. (2013) 'Extraction of lithium from primary and secondary sources by pre-treatment, leaching and separation: a comprehensive review', *Hydrometallurgy 150*, 2014, p.192–208.

60 Tedjar, F. (2018) in *Challenge for Recycling Advanced EV Batteries*.

61 H. Stahl et al., 'Study in Support of Evaluation of the Directive 2006/66/EC on Batteries and Accumulators and Waste Batteries and Accumulators', 2018.

62 Huisman, J., Ciuta, T., Mathieux, F., Bobba, S., Georgitzikis, K. and Pennington, D., RMIS, *Raw materials in the battery value chain*, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-13854-9, doi:10.2760/239710, JRC118410, 2020.

In addition, the deposits of some of these minerals are partially located in conflict-affected and high-risk areas, where their extraction may give rise to, either directly or indirectly, to unacceptable social and environmental impacts. **Battery manufacturers**, regardless of their position or leverage over suppliers, are **not insulated** from the risk of contributing to such adverse impacts on the local communities and workers involved in the mineral supply chain. Risks include indirect contribution to armed conflict and associated human rights abuses, dangerous working conditions, or harm to the surrounding environment in the form of leakage of hazardous substances to the air, water and soil.

International organisations and NGOs have regularly documented their concerns about the responsible sourcing of raw materials used in batteries[63]. **Cobalt** mined in the Democratic Republic of Congo (DRC) is a particular concern, but a recent JRC report also identified **other materials**, such as lithium from Bolivia, graphite from Tanzania or Mozambique, and nickel from the Philippines or Indonesia.[64] The expected rise in demand for batteries may exacerbate these risks and jeopardise the sustainability of the energy transition.

None of these materials are covered by the EU Conflict Minerals Regulation[65]. When it enters into force in 2021, the Regulation will lay down supply chain due diligence obligations for importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas. However, these provisions apply to imports of the raw materials and not to materials present in imported intermediate or finished products (e.g. batteries) placed on the EU market. The Conflict Minerals Regulation will be reviewed by 2023 and a potential extension of the scope will be evaluated as part of the review process. The Commission has also announced **a horizontal initiative on due diligence** for 2021[66] and it is currently in the process of **reviewing the Non-Financial Reporting Directive**, which includes due diligence requirements for EU companies.

Although the metals industry is making efforts to improve due diligence and supply chain transparency and increase compliance with ILO core labour conventions, **it is still difficult** for EU downstream operators to identify the smelters/refiners in their own supply chains.

In an effort to address these challenges, operators across the supply chain run **several initiatives** that aim to promote sustainable sourcing practices[67]. **These initiatives are voluntary** and thus remain open to **free-riding**. In addition, **the effectiveness of the initiatives is unclear**. A recent report, based on research from a number of Harvard University academics, found that "multi-stakeholder initiatives can be powerful forums for building trust, experimentation, and learning. However, multi-stakeholder initiatives are **not designed or equipped to be effective tools for protecting rights holders against human**

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63 See e.g. 'Amnesty challenges industry leaders to clean up their batteries', *Interconnected supply chains: a comprehensive look at due diligence challenges and opportunities sourcing cobalt and copper from the Democratic Republic of the Congo*, OECD, 2019. (https://www.amnesty.org/en/latest/news/2019/03/amnesty-challenges-industry-leaders-to-clean-up-their-batteries/).

64 Mancini, L., Eslava, N. A., Traverso, M., Mathieux, F., 'Responsible and sustainable sourcing of battery raw materials', *JRC Technical Report, 2020*.

65 Regulation (EU) 2017/821.

66 A study on due diligence requirements through the supply chain funded by the Commission (Directorate General for Justice and Consumers), *Study on due diligence requirements through the supply chain*, https://op.europa.eu/en/publication-detail/-/publication/8ba0a8fd-4c83-11ea-b8b7-01aa75ed71a1/language-en, January 2020.

67 Examples include the Initiative for Responsible Mining Assurance (IRMA), Certification of Raw Materials (CERA), the Responsible Minerals Initiative (RMI), the Cobalt Industry Responsible Assessment Framework (CIRAF) etc. For more detailed information, see Annex 9.

rights violations, holding corporations accountable for abuse, or providing survivors and victims with access to remedy."[68]

Furthermore, although it is true that battery raw materials are also used by other industries, it is important to note that for **some raw materials, over half of global production is for use in battery applications**. For example, over 50% of the global demand for cobalt (64% originating from the DRC) is used for battery production and over 60% of the world's lithium is used for electric vehicle production. Taking **vertical policy action in the batteries value chain specifically can thus be justified based on the potential to create a leverage effect.** On this point, the stakeholder consultation that accompanied this impact assessment revealed that **a broad range of stakeholders support** the view that mandatory supply chain due diligence obligations are necessary to ensure responsible sourcing of raw materials and to create a level playing field for business by creating a set of common rules.

2.1.3.2. Hazardous substances

One of the environmental concerns related to batteries is linked to the hazardous materials they contain. These substances pose no particular environmental or health concerns when they are inside the battery in use or even when the battery is spent. However, **when batteries are not properly collected and treated**, these substances can leach into the environment and create significant risks to public health and to the environment. Organic compounds, electrolyte salts, metals and metallic compounds from batteries disposed of under non-controlled conditions may pollute **water**, vaporise into the **air** when incinerated, or leach into groundwater after landfilling and expose the **environment** to highly corrosive substances. **Recycling operations** may also be significant sources of **emissions** of such pollutants to the air, the soil, and water.

In response to these risks, the Batteries Directive provides for a **ban on batteries containing mercury and cadmium**, lays down obligations for the collection of waste batteries and encourages the **reduction** of hazardous substances used.

However, other than for mercury and cadmium, the Directive has **not led to a reduction in the other hazardous substances.** Even ‘new’ batteries contain harmful substances such as cobalt and some organic electrolytes, which are highly volatile and toxic (see Annex 7).

2.1.3.3. Untapped potential to offset life cycle environmental impacts

Longer lasting and better performing batteries have a lower overall environmental impact as they provide more energy for longer periods. This applies to both rechargeable and non-rechargeable batteries, although durability considerations and degradation patterns may be quite different, and, in both cases, application-specific.

The volume of portable batteries placed on the market is increasing. The highest share (around 70%) is for primary (i.e. non-rechargeable) batteries. In some cases, consumers choose to use primary batteries because they are cheaper (e.g. AA, AAA); in others because secondary batteries are not be available in all formats (e.g. button cells).

For **non-rechargeable batteries**, the potential to offset the environmental impacts related to their production and end-of-life phases is much **more limited compared to secondary batteries** because they can only be used until the battery is spent. The Batteries Directive sets

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68 MSI Integrity (2020) "Not Fit-for-Purpose: The Grand Experiment of Multi-Stakeholder Initiatives in Corporate Accountability, Human Rights and Global Governance" - http://www.msi-integrity.org/not-fit-for-purpose/.

no threshold for the durability of primary batteries, which allows operators to place low-scoring batteries on the EU market. It doesn't set any other restrictions on primary batteries.

For **rechargeable batteries**, **high performance** battery life is one of the features that end users appreciate the most.[69] In **smartphones** and similar handheld devices, poor battery life contributes to customer dissatisfaction more than any other feature.[70] Premature obsolescence and discontinued battery lines exacerbates not only customer disappointment, but also the waste of resources. For **EVs**, the driving range is already a competitive factor amongst vehicle manufacturers, but for the moment, measuring battery performance or degree of degradation represents several complexities, and there is not yet a universally used standard.

Current provisions are insufficient to enable end-users to make informed choices and do not set rules governing battery lifetime and durability. This does not encourage the placing on the market of batteries with adequate levels of performance and durability.

Another way to lower the environmental impact of batteries is to extend their lifetime, in particular for industrial batteries. Life-cycle assessments[71] indicate that, under certain conditions, **second-life batteries used for energy storage could help offset the environmental impact** of their manufacturing processes by providing a longer and more efficient use of resources. It is widely acknowledged that the viability and the environmental impact of this approach depends on many factors, in particular the legal framework, which is currently non-existent or uneven across the Member States. On the other hand, extending EV battery lifetime will delay their availability for recycling.

2.2. What are the problem drivers?

At the root of the issues described above are two main problem drivers: **market and information failures**, which are both **related to the functioning of the internal** m**arket**. In addition, they are exacerbated by a third driver, **the complexity of battery value chains**. Value chains comprise many different stages, from mining, refining and active materials production to cell and pack production, device manufacturing and finally collection and recycling. Most stages take place in different geographical locations and are carried out by different market players.

The **first problem driver** is **market failure**, i.e. situations where the market outcome is sub-optimal from a societal point of view. In such situations, the **costs** to public health, social conditions and the environment are not factored into the market price and are thus **borne by society as a whole**. One example is **the misalignment of incentives across the value chain,** e.g. the profitability of recycling operations depends on factors that are outside recyclers' control, such as ease of removability and the cost of collection.

The **second problem driver** is **information failure,** i.e. situations where not all market players have the same information available, preventing them to make informed choices. This can lead to **unfair competition** or to **sub-optimal levels of material recovery** (e.g. battery removal is difficult because it is unclear where the battery is located).

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69 https://www.prnewswire.com/news-releases/camera-and-battery-features-continue-to-drive-consumer-satisfaction-of-smartphones-in-us-300466220.html.

70 https://www.digitaltrends.com/mobile/j-d-power-consumers-most-dissatisfied-with-smartphone-battery-life/.

71 Bobba, S. et al., 'Life Cycle Assessment of repurposed electric vehicle batteries: an adapted method based on modelling energy flows', *Journal of Energy Storage 19*, 2018, pp. 213–225. https://doi.org/10.1016/j.est.2018.07.008

These problem drivers lead to **three main groups of consequences**, as set out in the problem tree (Figure 7, p. 17):

- The problems identified have negative impacts on the functioning of the **internal market**. This can, for example, result in under-investment in capacity and innovation and act as a drag on productivity growth in the market and higher costs for consumers.
- In addition, the problems identified lead to an inefficient use of resources, which hampers the development of a proper **circular economy**, increases the need for primary raw materials and leaves the potential to mitigate supply risk and increase value chains' resilience untapped.
- Lastly, they lead to a number of **environmental and social risks** along the supply chain. As well as generating impact in Europe, there are resulting risks outside Europe given that the upstream part of the value chain is predominantly located outside the EU. The environmental impacts include increased greenhouse gas emissions. Social impacts include child labour, severe health and safety risks, and hazards to workers.

2.3. The current regulatory framework

The current regulatory framework comprises (specifically) the **Batteries Directive and (more generally) the Waste Framework Directive, the Industrial Emissions Directive and chemicals legislation.**

Reports on implementation and evaluation of the Batteries Directive found **that the Directive has yielded positive results** in terms of a better environment, the promotion of recycling and better functioning of the internal market for batteries and recycled materials. However, **limitations in some legal provisions or their implementation prevent the Directive from fully meeting its objectives**, particularly as regards waste battery collection or efficient recovery of materials. In response, the reports propose setting new targets for collection and recycling.

One such shortcoming is that the Batteries Directive mostly **focuses on the end-of-life phase** of batteries and does not sufficiently cover **other sustainability aspects** related to the **production and use phases of batteries** such as durability, GHG emissions or responsible sourcing, for which there are currently no legal provisions in the EU. This is out of step with current EU approaches on sustainable management of materials and waste, which focus on optimising products and production processes.[72]

Another shortcoming is the **lack of sufficient detail on certain provisions**, which leads to a lack of harmonised rules across the EU and hampers the functioning of recycling markets. Examples include labelling, removability requirements and requirements for producer responsibility organisations.

The Batteries Directive is also not well equipped to keep pace with new technological developments. An example is **lithium-ion batteries**, which are becoming the most important battery chemistry in the market, but are not specifically covered by the Directive. Another example is the development of the second-life market for industrial batteries, where the lack of a regulatory framework leads to diverging national approaches and thus market fragmentation. Another example are **new products or appliances** such as **e-bikes**, which are currently classified as "industrial batteries" even though they are used by consumers. As a consequence, these batteries may not be properly collected or recycled.

[72] ‘Paving the way for a circular economy: insights on status and potentials’, EEA, 2019.

In sum, **the current regulatory framework for batteries is not sufficiently powerful** to drive the EU battery market towards higher levels of sustainability, neither in terms of production processes (manufacturing, use and end-of-life battery processing) nor in terms of products (reliability, durability, etc.).

2.4. How will the problem evolve?

Driven by the transition to a low-carbon economy and by consumer demand, **the use of batteries in the EU is set to continue to increase significantly**.

Although it is expected that there will be **changes to the products and batteries placed on the market** (e.g. more efficient and durable batteries), **these changes will not fundamentally affect the sustainability and market-related problems** across the batteries life cycle as described above. On the contrary, some problems are expected to **become more pronounced due to the expected exponential growth in demand**. This applies in particular to new technologies and applications that are not yet specifically regulated such as second-life for industrial batteries or the collection of small industrial batteries (i.e. batteries used in light transport or energy small storage applications).

2.5. Who is affected and how?

Society as a whole (general public). If the environmental burden inherent in battery production is not factored into the market price, they represent a hidden cost to society, either now or in the future (e.g. public health, environmental remediation etc.).

EU consumers. EU consumers currently lack sufficient, reliable and comparable information to be able to make informed purchasing choices about batteries, e.g. regarding their carbon footprint, expected lifetime, etc.

Non-EU citizens. The environmental and social risks inherent in extracting the raw materials needed to produce some types of batteries significantly affect citizens in non-EU countries where these materials are extracted in an unsustainable manner. This includes **workers in supply chains**, who may experience labour rights violations, in particular in conflict-affected regions.

Public authorities. Public authorities are currently in charge of monitoring, reporting and enforcing the Batteries Directive. Some uncertainties about batteries classification may result in higher administrative costs and uneven approaches taken in the different Member States.

Battery producers. Battery producers that apply high environmental standards face unfair competition from producers that are not subject to the same rules. The lack of a stable and predictable regulatory framework is also a barrier to making the investment needed in sustainable battery production in Europe.

Downstream industries. Notwithstanding the importance of global value chains, clustering or integrating certain production stages is common. The COVID-19 crisis has demonstrated that disruptions in upstream segments of the value chain can have significant negative implications on downstream producers. In addition, for downstream producers proximity to the supply of battery cells and modules contributes to lower transport costs, closer collaboration on the design and quality of the cells, innovation and the development of know-how.

Brands. Producers of appliances that include battery production with links to human rights abuses, dangerous working conditions or harm to the surrounding environment and which are called into question by NGO campaigns carry the risk of significant reputational damage.

Battery recyclers. Batteries are typically recycled in three steps:

- **Waste battery collection.** This usually takes place at local or regional level and commonly involves small and medium enterprises. Logistics and funding are usually organised by producer responsibility organisations. Collection is currently covered by the provisions in the Batteries Directive, which are insufficiently precise to be effective.
- **Dismantling and pre-processing.** This usually takes place at local, regional or inter-regional level, involving small and medium enterprises, but also some large waste companies. Businesses operating at this stage are affected by the lack of alignment of incentives across the value chain (e.g. irremovable batteries), which affects profitability.
- **Material recovery.** Key players at this stage of recycling are mostly large companies who source their feed at international level. These companies are affected by the sub-optimal levels of collection as their operations are very capital-intensive and thus require economies of scale.

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

It is the intention to adopt the proposal on the basis of **Article 114 of the Treaty on the Functioning of the European Union** (TFEU), which is to be used for measures that aim to establish or ensure the functioning of the **internal market**.

The **current Batteries Directive 2006/66/EC** is based on Article 175 TEC (now Article 191 TFEU) and on Article 95 TEC (now Article 114 TFEU) for the identified product-related provisions, namely restrictions of certain hazardous substances and labelling. For the current Directive, the Commission in its proposal had identified the situation of **diverging national measures** on, for example, marketing restrictions or marking obligations, which constituted barriers to trade and, if not addressed, potentially compromised the functioning of the internal market.

Section 2 of this impact assessment demonstrated that there are **a number of key problems related to the internal market.** These include barriers to the functioning of recycling markets, uneven implementation of the Batteries Directive, the imperative need for large-scale investment to respond to the changing market, the need for economies of scale, and the need for a stable fully harmonised regulatory framework.

Section 2 also set out a number of **environmental problems** related to the production, use and end-of-life management of batteries. It is important to note that the environmental problems that are not directly covered by EU environmental law and that thus require regulatory action **can all be linked to the functioning of the internal market**. One example is the **adverse impacts of hazardous substances** contained in batteries when they are not properly disposed of, a problem that can be solved by proper battery collection and recycling. One of the reasons why collection levels are so low is that setting up collection systems has a cost, and the internal market is not providing an adequate and harmonised implementation of the polluter pays principle. Sub-optimal levels of collection are also **problematic** from a business profitability perspective, given that recycling technologies are rather **capital-intensive** and thus require significant **economies of scale,** in some cases beyond what EU national markets can provide. Another example is the **untapped potential of lowering the total environmental impact of batteries** by increasing the circularity of the battery value chain. Here the main driver is again market failure, i.e. the lack of alignment of incentives (and information) between different operators across the value chain, or, in the case of the market for second life EV batteries, a lack of legal certainty.

The **objective** of this proposal is thus to ensure **the functioning of the internal market** for economic actors operating in the market. The measures lead to further harmonisation of **product requirements** for batteries placed on the EU market and the level of waste management services provided by economic operators. The proposal will also set requirements to create **a well-functioning market for secondary raw materials.** In addition it will create a regulatory framework that will prevent and reduce the **environmental impact** from the production and use of batteries as well as their processing, including recycling, at their end-of-life. This will promote a circular battery industry and **avoid market fragmentation** due to diverging national approaches.

The manufacture and use of batteries, the underlying value chain, and the processing of end-of-life batteries are **cross-cutting issues**, relevant to many policy areas of policy. Therefore, in addition to pursuing internal market objectives, **the proposal will also contribute to objectives related to environment, transport, climate action, energy and international trade**. The analysis of the impact of the proposed measures (see Section 7) demonstrates that **in most cases, the internal market objectives are predominant** and the environmental benefits are complementary. Therefore, it is appropriate to use Article 114 TFEU as the sole legal basis.

3.2. Subsidiarity: need for EU action

The necessity test is the question of whether the objectives can be sufficiently achieved by action taken by the Member States alone. In this case, they cannot. It is essential to ensure a **level playing field** for manufacturers, recyclers, importers and economic operators more broadly in terms of the requirements to be met when placing a battery on the EU market by putting in place a common set of rules within the EU internal market and by providing reliable information to end-users. For these reasons, EU-wide legislation is necessary.

In the absence of EU level action to set harmonised rules, action at national level would lead to a divergence in the requirements for economic operators.

In addition, the evaluation of the Batteries Directive showed that the legislation did not meet its objectives. In light of the exponential increase in demand for batteries and fundamental changes to the batteries market, the evaluation identified the need to **modernise the legislative framework** to adequately support the circular economy and low-carbon policies and to adapt to technological and economic developments in the battery market.

3.3. Subsidiarity: Added value of EU action

There is clear added value in setting common requirements at EU level that cover the full lifecycle of batteries.

Harmonisation supports investment as the batteries value chain is **capital-intensive** and thus needs **economies of scale**. Achieving this requires a harmonised and well-functioning internal market across all Member States and, therefore, a **level playing field** for businesses operating in the battery value chain in the EU.

The proposed measures do not go beyond what is necessary to provide the regulatory certainty required to **stimulate large-scale investment** in the circular economy while ensuring a high level of protection of health and the environment.

The **transition to a circular economy**, including fostering innovative and sustainable business models, products and materials, requires setting common binding provisions. The aims cannot be sufficiently achieved by the Member States but can be better achieved at EU level given the **scale and effects** of the action. **EU action is therefore justified and necessary**.

As demonstrated above, and thereby fulfilling the requirement of **Article 114(3) TFEU**, the Commission's proposal related to the functioning of the internal market is based on **a high level of protection** in terms of health, safety, environmental protection and consumer protection**.**

3.4. Nature of the instrument

The evaluation of the Batteries Directive and the analysis preceding the impact assessment revealed that **harmonisation is necessary in the form of a regulation**, rather than a directive, as used in the previous and more limited approach.

A regulation would **set direct requirements applicable to all operators**, thus providing the necessary legal certainty and scope for enforcement of a fully integrated market across the EU. A regulation would also **ensure that the obligations are implemented at the same time and in the same way in all 27 Member States**.

In line with the one-in-one-out principle[73], the proposed regulation should **replace the current Batteries Directive**.

Differing national measures on waste collection and recovery have led to an **uneven regulatory framework**. The existing barriers in the form of differing national regulatory frameworks can only be removed by more detailed, harmonised rules on the organisation of collection and recovery processes and related responsibilities, including rules that should apply directly to economic operators.

The instrument will also **mandate the Commission to develop implementing measures** to flesh out the Regulation further, where necessary, allowing for common rules to be set swiftly. This will **reduce uncertainty over the timescale** during the transposition process in an area where time and legal certainty are of the essence due to investment-related issues and expected increases in market size.

4. OBJECTIVES

The aim of the regulatory action is to foster the production and placing on the EU market of high performing, sustainable and durable batteries and components, produced with the lowest environmental, social and human health impacts possible along the entire battery lifecycle and in a way that is cost-effective.

The objectives are broken down into three levels of action:

1. **Areas of action** under the Treaty, namely on internal market and, to a lower extent, on the environment;

[73] The working methods of the von der Leyen Commission aim to cut red tape as much as possible. The Commission therefore strives to implement the "one in, one out" principle, whereby each legislative proposal creating new legislative burden should relieve people and business of an equivalent burden at EU level in the same policy area. See: https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6657

2. General objectives

1. Strengthening the functioning of the internal market (including products, processes, waste batteries and recyclates), by ensuring a level playing field through a common set of rules;
2. Promoting a circular economy;
3. Reducing environmental and social impact throughout all stages of the battery life cycle.

3. Specific objectives

1. Strengthening the functioning of the internal market:
   - Fostering the production and placing on the EU market of high-quality batteries;
   - Ensuring functioning markets for secondary raw materials and related industrial processes;
   - Promoting innovation and the development and take-up of EU technological expertise.
2. Promoting a circular economy:
   - Increasing resilience and closing the materials loop
   - Reducing the EU's dependence on imports of materials of strategic importance;
   - Ensuring appropriate collection and recycling of all of waste batteries.
3. Reducing environmental and social impact:
   - Contributing to responsible sourcing;
   - Using and source resources, including raw and recycled materials, efficiently and responsibly;
   - Reducing GHG emissions across the entire battery life cycle;
   - Reducing risks to public health and to environmental quality and improve the social conditions of local communities.

5. BASELINE

This scenario involves taking **no action at EU level**. The situation would evolve as described in Section 2.4, which outlines several ways in which the problems inherent in the life cycle of batteries are likely to worsen in the absence of EU action.

Driven by the transition to a low-carbon, circular economy, **demand for batteries is set to grow rapidly**. This trend will be exacerbated by the recent COVID-19 crisis, which has given a strong boost to sales of EVs (see text box below). Unless the problems and their drivers identified above are addressed, the **negative consequences** they create will only **worsen**.

The impact of the COVID-19 crisis on EV sales

The COVID-19 crisis has had an impact on the uptake of e-transport, both for cars and light means of transport as e-bikes. As carmakers must meet the EU's CO_2 targets, sales of electric cars are booming in Europe.[74]

While European sales of passenger cars fell by about 50%, sales of electric vehicles increased and in March 2020, they reached an all-time high market share of 10% of all passenger car sales.[75]

The upward trend in sales of EVs is likely to continue in the future as all but one Member States have put in place some form of incentive for EV purchases, including purchase tax or VAT exemptions, car ownership tax reductions, company car deductibility and purchase incentives.[76] Additional public measures include increasing availability charging facilities, access to restricted traffic and free parking.[77]

Similarly, after an initial stall due to the lockdown and retail store closures, sales of e-bikes and other light means of transport are now booming. Many brands have reported increased sales that have already compensated for the losses incurred during the lockdown weeks.

Currently, there have been **announcements for investments in several battery factories**, and four companies have announced investments in the production of cathode materials.

In the absence of a regulatory framework and common rules for all batteries that are placed on the EU market however, a lack of a **level playing field** may result, especially for producers or recyclers who are subject to stricter environmental rules. This may prevent the **investments** needed to boost **battery production capacity**. More importantly, it would also have negative environmental consequences, because it would create lock-in and fail to steer the market towards adopting the best environmentally performing batteries.

Furthermore, to reach a market optimum, **all actors across the value chain need to have sufficient, comparable and reliable information** to make efficient choices. Most participants in the public consultation on the evaluation of the Batteries Directive agree that, although there have been advances in labelling and information, this is still insufficient, especially given the changes expected in the market.

In terms of **social and environmental risks** (including waste management), due to complex global value chains, it is unlikely that unguided market forces will lead to sustainable outcomes. On the contrary, investment in **sustainable sourcing** or investment to reduce the **environmental impact of production** (including the carbon footprint) may not be made at all.

In terms of the **inefficiencies across the supply chain,** it is very likely that the problem will lead to many **missed opportunities to increase resource efficiency, namely as regards material recovery.** An increasing volume of batteries will fall outside the scope of the collection targets under the Batteries Directive. In addition, because the Batteries Directive mostly covers the end-of-life stage of the batteries value chain, the problem of misaligned

74 'Can electric cars beat the COVID crunch? The EU electric car market and the impact of the COVID-19 crisis', Transport & Environment, 2020.

75 *Market Monitor*, International Council on Clean Transportation, 2020.

76 *Market Monitor*, International Council on Clean Transportation, 2020.

77 *Electric vehicles: tax benefits & purchase incentives*, ACEA, 2020.

incentives across the value chain (e.g. changes in design than can facilitate reuse or recycling) is unlikely to be resolved.

With regard to **research and innovation**, the EU is mobilising all its channels of support covering the entire innovation cycle, from fundamental and applied research to demonstration, first deployment and commercialisation. It is expected that this will facilitate breakthroughs in terms of battery materials and components, battery performance and durability, new chemical systems and even alternatives to currently used batteries. More details about the EU's research and innovation support for batteries can be found in **Annex 8**.

6. Policy options

6.1. Measures and sub-measures

This impact assessment includes 13 measures to address the problems and their negative consequences identified in Section 2 and to reach the objectives set out in Section 4. They are based on the analysis carried out as part of the evaluation of the Batteries Directive, the public consultations on this initiative, multiple support studies and political commitments such as the Green Deal, which are listed in Section 1.1. The measures reflect the fact that a series of responses are needed along a complex value chain.

Table 1 gives an overview of the measures that contribute most strongly to the objectives.

Table 1: Overview of how the measures contribute to the objectives

		Objectives		
		Internal market	Circular economy	Environmental and social impacts
Measures	1. Classification and definition			
	2. Second life of industrial batteries			
	3. Collection rate target for portable batteries			
	4. Collection rate target for industrial batteries			
	5. Recycling efficiencies and material recovery			
	6. Carbon intensity			
	7. Performance and durability for rechargeable batteries			
	8. Non-rechargeable batteries			
	9. Recycled content			
	10. Extended producer responsibility			
	11. Design			
	12. Provision of reliable information			
	13. Due diligence for the origin of raw materials			

Under each of the broad policy measures set out above are several sub-measures, which are presented in **Table 2**.

Table 2: Overview of the sub-options for the different measures (italic = sub-measure discarded in an early stage; (+) = cumulative)

	Baseline	**Sub-measures**				
		a	**b**	**c**	**d**	**e-f**
1. **Classification and definition**	Current classification of batteries based on their use	New category for EV batteries or new sub-category in industrial batteries	*Weight limit of 2 Kg to differentiate portable from industrial batteries*	Weight limit of 5 Kg to differentiate portable from industrial batteries	New calculation methodology for collection rates of portable batteries based on batteries available for collection	
2. **Second-life** of industrial batteries	No provisions at present	At the end of the first life, batteries are considered waste (except for reuse) and therefore the EPR and product compliance requirements restart when they ceased to be waste and a new product is placed on the market	At the end of the first life, batteries are not waste, second life batteries are considered new products, and therefore the EPR and product compliance requirements restart	*At the end of the first use cycle, batteries are not waste but second life batteries would not be considered a new product and the EPR and product compliance requirements would be kept by the producer*	*Mandatory Second life readiness*	
3. **Collection rate** for **portable** batteries	45 % collection rate	55% collection rate in 2025	65% collection rate in 2025	70% collection rate in 2030	75% collection target rate in 2025	*e) Deposit and refund schemes* *f) A new set of collection targets per chemistry of batteries*
4. **Collection rate** for **automotive and industrial batteries**	No losses of automotive and industrial batteries	New reporting system for automotive, EV and industrial batteries	Explicit collection target for industrial, EV and automotive batteries	Collection target for batteries powering light means of transport		

	Baseline	Sub-measures				
		a	b	c	d	e-f
5. **Recycling efficiencies and recovery of materials**	Recycling Efficiencies defined for lead-acid (65%), nickel-cadmium (75%) and other batteries (50%) 'Highest degree of material recovery' obligation for lead and cadmium without quantified targets	Lithium-ion batteries: Recycling efficiency lithium-ion batteries: 65% in 2025 (a-1), 70% in 2030 (a-2) Material recovery rates for Co, Ni, Li, Cu: resp. 90%, 90%, 35% and 90% in 2025 (a-1), 95%, 95%, 70% and 95% in 2030 (a-2) (+)	Lead-acid batteries: Recycling efficiency lead-acid batteries: 75% in 2025 (b-1), 80% in 2030 (b-2) Material recovery for lead: 90% in 2025 (b-1), 95% in 2030 (b-2) (+)	*Recycling conditions*	*Add Co, Ni, Li, Cu and Graphite to the list of substances to be recovered to the highest possible technical degree (without quantified targets)*	*Multi-metal quantified target values for the degree of recovery*
6. **Carbon footprint for industrial and EV batteries**	No provisions at present	Mandatory declaration of carbon intensity	Carbon footprint performance classes and maximum carbon intensity thresholds			
7. **Performance** and **durability of rechargeable industrial and EV batteries**	No provisions at present	Information requirements on performance and durability	Minimum performance and durability requirements			
8. Non-rechargeable portable batteries	No provisions at present	Technical parameters that set out minimum performance and durability requirements:	Phasing out primary portable batteries of general use	Phasing out of all primary batteries		
9. **Recycled content in industrial, EV and automotive batteries**	No provisions at present	Information requirements on levels of recycled content for industrial batteries in 2025	Mandatory levels of recycled content for industrial batteries in 2030 and 2035 (+)	*Adding graphite and / or auxiliary materials to the list*		

	Baseline	Sub-measures				
		a	b	c	d	e-f
10. Extended Producer Responsibility	EPRs and PROs obligations reflect the provisions of the WFD, as amended.	Clear specifications for Extended Producer Responsibility obligations for all batteries that are currently classified as industrial	Minimum standards for Producer Responsibility Organisations (PROs)			
11. **Design requirements for portable batteries**	Obligations on removability	Strengthened obligation on removability	Additional requirement on replaceability (+)	*Requirements on interoperability (+)*		
12. **Reliable information**	Specifications on information and labelling	Provision of basic information (as labels, technical documentation or online)	Provision of more specific information to end-users and economic operators (selective access) (+)	Setting up an electronic information exchange for batteries and a battery passport (for industrial and electric vehicle batteries only) (+)		
13. Supply chain **due diligence** for raw materials in industrial and EV batteries	No provisions at present	Voluntary supply chain due diligence policy	Mandatory supply chain due diligence policy b1) Self-certification of supply chain partners b2) Third-party auditing b3) Third-party verification based on Notified Bodies			

The sub-measures are in many cases **alternatives** to each other (e.g. for Measure 3, the remedy could be to set collection rate targets for portable batteries of either 65% or 75% by 2025, but not both). In other cases, the sub-measures are designed so that they can be **cumulative and/or complementary,** or a different sub-measure is proposed for different categories of batteries (e.g. for Measure 13, a battery passport for industrial batteries works on top of information obligations).

Overall, **over 50 sub-measures are tabled**. All sub-measures are analysed in proportionate detail in **Annex 9**, with an assessment of their impacts compared to the business-as-usual or baseline scenario.

Annex 9 also includes some further details about the issue of **green public procurement** (GPP) as an enabler that is not tabled as a measure in this impact assessment. GPP is a route to ensuring that the best performing batteries are procured and used by public authorities, which often have significant weight to shift the market in terms of demand. GPP criteria and the approach to using them will be assessed in line with current approaches i.e. with the involvement of stakeholders, and with the consideration of making the criteria mandatory and setting targets.

Annex 9 also includes a short synthesis of issues related to **safety**. It also clarifies how the assessment of chemicals in batteries will be carried out within the REACH framework, namely with the involvement of the European Chemicals ECHA agency. That said, for reasons of legal certainty, the new regulatory framework will extend the existing ban on mercury and cadmium-containing batteries.

6.2. Policy options

To facilitate the analysis, the sub-measures listed in **Table 3** are grouped into **three main policy options**, which are compared against a business-as-usual scenario.

- **Option 1**, **business-as-usual**, keeps the Batteries Directive, which mostly covers the end-of-life stage of batteries, **unchanged**. For the **earlier stages** in the value chain, there is currently **no EU legislation** in place and so this will remain unchanged. Further details on this option are given in **Section 5** on the baseline and in **Annex 9**.
- **Option 2**, with a **medium level of ambition**, builds on the Batteries Directive, but gradually strengthens and increases the level of ambition. For the **earlier stages** in the value chain for which there is currently no EU legislation, the proposed change is to bring in **information and basic requirements** as a condition for batteries to be placed on the EU market.
- **Option 3**, with a **high level of ambition**, is an approach that changes some of the current provisions, for example in terms of the calculation method for the collection rate of portable batteries and further increasing some of the current targets such as for recycling efficiencies and recovery of materials. It also sets some new mandatory targets rather than proposing information requirements, for example as regards collection rate for automotive and industrial batteries, carbon footprint, performance and durability, supply-chain due diligence and the use of non-rechargeable portable batteries. This option is clearly **more disruptive** and is more ambitious in its objectives and for many measures indeed it is expected to achieve more significant results.

- **Option 4**¸ with a **very high level of ambition**, is similar to option 3 but proposes a few even more ambitious targets: mandatory second-life readiness, increase the collection rate for portable batteries even further, set an explicit collection target for industrial, EV and automotive batteries and a complete phase-out of portable batteries. These measures are designed to achieve extremely ambitious environmental benefits.

Table 3 presents an overview of the different sub-measures included in the policy options. A number of observations:

- **A cross-reference to the sub-measure** letter (a, b, c, …) used in **Table 2** and Annex 9 is given in brackets;
- To limit the scope of the analysis, **only the most relevant sub-measures are included in Options 2, 3 and 4**. For some measures, additional sub-measures were assessed in the form of a sensitivity analysis (e.g. a 55% collection rate target for Measure 3). **Table 4** provides an overview of the reasons why certain sub-measures are not included in the Options. A further analysis of these measures is included in Annex 9.
- **Option 3 should be seen as a *higher* level of ambition than Option 2**. The level of "disruptiveness" is not the same across all measures.
- Given that the scope of the measures is different, **for some measures no "high" or "very high" level of ambition was identified**.

Table 3: Content of the different policy options

Measures	**Option 2 - medium level of ambition**	**Option 3 - high level of ambition**	**Option 4 – very high level of ambition**
1. Classification and definition	New category for EV batteries (a) Weight limit of 5 kg to differentiate portable from industrial batteries (c)	New calculation methodology for collection rates of portable batteries based on batteries available for collection (d)	/
2. Second-life of industrial batteries	At the end of the first life, used batteries are considered waste (except for reuse). Repurposing is considered a waste treatment operation. Repurposed (second life) batteries are considered as new products which have to comply with the product requirements when they are placed on the market (a)	At the end of the first life, used batteries are not waste. Repurposed (second life) batteries are considered as new products which have to comply with the product requirements when they are placed on the market. (b)	*Mandatory second life readiness (d)*
3. Collection rate for portable batteries	65% collection target in 2025 (b)	70% collection target in 2030 (d)	75% collection target in 2025 (c)
4. Collection rate for automotive and industrial batteries	New reporting system for automotive, EV and industrial batteries (a)	Collection target for batteries powering light transport vehicles (c)	Explicit collection target for industrial, EV and automotive batteries (b)

Measures	Option 2 - medium level of ambition	Option 3 - high level of ambition	Option 4 – very high level of ambition
5. Recycling efficiencies and recovery of materials	Lithium-ion batteries and Co, Ni, Li, Cu: (a-1) Recycling efficiency lithium-ion batteries: 65% by 2025 Material recovery rates for Co, Ni, Li, Cu: resp. 90%, 90%, 35% and 90% in 2025 Lead-acid batteries and lead: (b-1) Recycling efficiency lead-acid batteries: 75% by 2025 Material recovery for lead: 90% in 2025	Lithium-ion batteries and Co, Ni, Li, Cu: (a-2) Recycling efficiency lithium-ion batteries: 70% by 2030 Material recovery rates for Co, Ni, Li, Cu: resp. 95%, 95%, 70% and 95% in 2030 Lead-acid batteries and lead: (b-2) Recycling efficiency lead-acid batteries: 80% by 2030 Material recovery for lead: 95% by 2030	/
6. Carbon footprint for industrial and EV batteries	Mandatory carbon footprint declaration (a)	Carbon footprint performance classes and maximum carbon thresholds for batteries as a condition for placement on the market (b)	/
7. Performance and durability of rechargeable industrial and EV batteries	Information requirements on performance and durability (a)	Minimum performance and durability requirements as a condition for placement on the market (b)	/
8. Non-rechargeable portable batteries	Technical parameters for performance and durability of portable primary batteries (a)	Phase out of primary portable batteries of general use (b)	Total phase out of primary batteries (c)
9. Recycled content in industrial, EV and automotive batteries	Mandatory declaration of levels of recycled content, in 2025 (a)	Mandatory levels of recycled content, in 2030 and 2035 (b)	/
10. Extended producer responsibility	Clear specifications for extended producer responsibility obligations for industrial batteries (a) Minimum standards for PROs (b)	/	/
11. Design requirements for portable batteries	Strengthened obligation on removability (a)	New obligation on replaceability (b)	*Requirement on interoperability (c)*
12. Provision of information	Provision of basic information (as labels, technical documentation or online) (a) Provision of more specific information to end-users and economic operators (with selective access) (b)	Setting up an electronic information exchange system for batteries and a passport scheme (for industrial and electric vehicle batteries only) (c)	/
13. Supply-chain due diligence for raw materials in industrial and EV batteries	Voluntary supply-chain due diligence (a)	Mandatory supply chain due diligence (b)	/

Table 4: Overview of sub-measures that were not included in the Options

Measure	Sub-measure	Reason for being not being included in the Options
1.Classification and definition	1.b) Weight limit of 2 Kg to differentiate portable from industrial batteries (with exceptions)	Carried out as a sensitivity analysis. Analysis shows that a 5 kg weight limit (sub-measure 1.c) would lead to a clearer demarcation.
2. Second life of industrial batteries	2.c) At the end of the first use cycle, batteries are not waste but second life batteries would not be considered a new product and the product compliance requirements would be kept by the producer	Early analysis showed that this sub-measure would lead to some contradictions and possible divergent interpretations, because batteries would be neither waste nor a new product. This would not provide legal certainty to economic operators.
3. Collection rate for portable batteries	3.a) 55% collection target	Carried out as a sensitivity analysis. Not included in the options because environmental benefits are non-linear (i.e. significantly higher when the target is increased to 65%).
	3.d) Deposit and refund schemes	Early analysis showed that this sub-measure would lead to major challenges related to costs, implementation, voluntary collection, tourism and the market of fake batteries.
	3.e) A new set of collection targets per chemistry of batteries	Early analysis showed that this measure would not be very (cost-)effective, as it would lead to a multitude of requirements (different containers, collection points, management measures, …), which would increase costs without significantly contributing to the objective of increasing resource efficiency.
5. Recycling efficiencies and recovery of materials	5.c) Recycling conditions for lithium-batteries	Early analysis showed that this sub-measure would imply a strong market intervention that could have unintended negative impacts. At the same time the objective can also be achieved by Measure 11 and product policy measures.
	5.d) Add Co, Ni, Li, Cu and Graphite to the list of substances to be recovered to the highest possible technical degree (without quantified targets)	Stakeholders pointed out during the consultation period that this sub-measure would not be sufficiently effective to promote recycling activities within the EU.
9. Recycled content in industrial batteries	9.c) Adding graphite and / or auxiliary materials to the list	Early analysis showed that there is no evidence supporting that setting mandatory levels of recycled content for graphite would be environmentally beneficial. For auxiliary materials (steel, copper and aluminium used in the casing and periphery) early analysis showed that setting a target for recycled content would not be effective, as it would just lead to a redistribution of recycled content from non-regulated applications to batteries.

7. IMPACT OF THE POLICY OPTIONS

The **impact** of the two policy options and their constituent sub-measures have been **analysed** based on the main **problems and drivers** identified (see Section 2) and the **general objectives** (see Section 4).

A **detailed analysis** was carried out based on the **following assessment criteria**:

- Effectiveness
- Economic impact
- Administrative burden

- Environmental impact
- Social impact
- Technical feasibility and stakeholders' views

For the measures for which this was relevant, a **mass flow model** was constructed to allow for quantification based on type of batteries, and their treatment. This mass flow model enables a number of impacts to be quantified for different measures. **Annex 4** provides further methodological details.

To put the findings into perspective, four important qualifications need to be made:

1) To ensure the robustness of the findings, **assumptions have been made in a way that they produce conservative estimates**. One example is the measure on recycling efficiency and material recovery: the estimations are based on the assumption of closed loop recycling (i.e. recycled materials are only used in batteries), while in practice open loop processes are legally allowed and used, which yields additional volumes of recovered materials.
2) With regards to the **environmental impact,** it is important to note that this impact assessment **only included direct environmental impact**, such as reduced GHG emissions, human toxicity or resource depletion. However, the **indirect environmental benefits** that these measures will bring about by accelerating the greening of mobility **cannot be accurately quantified** but should also be taken into account. For example, note that in the EU, transport generates roughly a quarter of greenhouse gas emissions and is the main cause of air pollution in cities[78].
3) Similarly, the estimated **direct economic and social impact** from the measures are rather low compared to the **indirect economic benefits** of having a stable regulatory framework to facilitate the development of a new value chain in the EU. For example, the **direct impact on jobs** of the measures assessed in this impact assessment are **never higher than 3,000 additional jobs**. By contrast, according to the JRC, creating a competitive lithium-ion cell manufacturing capability in the EU is expected to create **between 90 and 180 direct jobs per GWh/y production volume**[79] and the additional jobs created both upstream (e.g. cathodes and anode production) and downstream will likely be equally significant. Another report estimates that **15 jobs** are created for the collection, dismantling and recycling **per ton of lithium-ion battery waste.**[80]
4) **All measures** except Measure 11 on design requirements for portable batteries and Measure 13 on due diligence **will be fleshed out in secondary legislation,** which may be accompanied by a specific and proportionate impact assessment.

This section presents **a summary of the assessment of the impact of the measures**, focusing on the economic impact (including administrative costs/burden and social impacts when relevant), environmental impact, feasibility and stakeholder acceptance. It provides an **analysis of Options 2, 3 and 4 compared to Option 1, the business-as-usual scenario**. A more detailed analysis for the different measures is provided in **Annex 9**.

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78 https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1180.pdf.

79 Steen, M et al., 'EU Competitiveness in Advanced Li-ion Batteries for E-Mobility and Stationary Storage Applications – Opportunities and Actions', *JRC Science for Policy Report*, doi:10.2760/75757, 2017.

80 Drabik E. and Rizos V., 'Prospects for electric vehicle batteries in a circular economy', 2018.

7.1. Measure 1: Classification and definition

The purpose of Measure 1 is mostly to **clarify the current provisions** on the categories of batteries and to **update them to the latest technological developments**. This will help identify and apply specific provisions applicable to different types of batteries.

More specifically, for this measure **Option 2**, the medium level of ambition option, proposes to create **a new battery category for EV batteries** and to set **a 5 kg threshold to distinguish portable batteries**. **Option 3**, the high level of ambition option, proposes to introduce **a new calculation methodology** for the collection rate of portable batteries based on "batteries available for collection" (to replace the current methodology, which is based on "batteries placed on the market").

This measure is **not expected to have any significant economic or social costs**, or bring about significant additional administrative burden (given that similar provisions already exist). A new calculation methodology based on "available for collection" would provide a better picture on the mass flows of battery raw materials, but will require collecting some additional information and some further assessment.

Option 2 is not expected to have a direct environmental impact, but it will indirectly **facilitate the increased collection of waste batteries**. Currently some batteries (e.g. e-bikes and e-scooters) may, for example, be placed on the market as belonging to one class and be collected and recycled as another, which distorts producer obligations and the funding of collection and recycling schemes. To set the threshold at **5 kg**, a sensitivity analysis was carried out based on a 2 kg threshold. It found that a 2 kg threshold would classify small industrial batteries as portable and could artificially split product lines, i.e. batteries using the same chemistry and placed on the market by the same producer would be classified differently, making it more difficult to manage the system (batteries of e-scooters and of power tools are examples).

The **stakeholder consultation** showed **clear support** for creating sub-categories or sub-classes in the current industrial batteries class. Producers of batteries and equipment were in favour of using a weight threshold to distinguish between portable and industrial batteries, a practice already in use in some Member States. **Stakeholders also supported the development of the new calculation method** for portable batteries. They argued that, due to the increasing lifespan of batteries and the significant changes in the market, the current "placed on the market" methodology (based on a three-year average) is no longer suitable and does not allow collection schemes to properly plan operations or report on their efficiency.

7.2. Measure 2: Second life of industrial batteries

Measure 2 includes provisions that should provide **legal certainty** to facilitate the **development of a market** for **second-life industrial batteries**. To this end, **Option 2** proposes to follow the provisions in the **Waste Framework Directive** and let batteries go through **waste status,** only allowing the battery to be classed as a "new product" when the waste battery is prepared for reuse or has undergone other transformations to have a second life. **Option 3,** by contrast, only lets batteries become waste when the battery holder decides to discard the battery. Otherwise, **second-life batteries are automatically classed as new products**, and therefore the product compliance requirements restart. This option **requires additional regulatory provisions** to specify the conditions under which it will be implemented, namely to prevent unduly classifying waste batteries as second-life batteries with the aim only to circumvent heavier administrative and technical procedures (e.g. for export).

Options 2 and 3 bring in equivalent costs to place the batteries on the market again (i.e. costs related to the conformity processes). They **differ** however, **in the administrative costs** they would entail. **The administrative costs for Option 2 would be high, because operators would need specific licences to manage hazardous *waste*. The administrative costs for Option 3 would be lower**, because the applicable procedures for hazardous *goods* are less cumbersome than for waste. The lower cost of Option 3 would thus be more likely to facilitate the market penetration of this technology.

Stimulating a market for the second life of industrial batteries could generate a **positive environmental and economic impact**. In particular, the economic impact would depend on the level of market penetration, but if it reaches 25 %, it would generate around **€200 million** in 2030 and create around **2000 FTE jobs**, for both Option 2 and Option 3.

With regard to **environmental impact**, for the same level of market uptake, both options give a significant advantage. Estimates show an overall gain in global warming potential savings (up to 400,000 tonnes of CO_2 per year by 2035), equivalent for Options 2 and 3.

In terms of **feasibility and stakeholder acceptance**, regulating **the second life of industrial batteries** is **a highly complex matter**. Although all stakeholders recognise the business opportunity and the importance of providing legal certainty, opinions are divided on a number of technical issues. Overall, automotive producers are in favour of Option 3 (second-life batteries are not waste but become new products), as it would generate lower administrative costs than Option 2 (batteries become waste). Recyclers, however, expressed concern about the delayed availability of automotive batteries for recycling and the possibility of "losses" through (illegal) exports.

7.3. Measure 3: Collection rate for portable batteries

The **aim** of Measure 3 is to **increase the collection rate** of portable batteries to maximise **resource efficiency** and minimise the **environmental impact** of incorrect battery disposal. To this end, **Option 2** proposes a collection target of 65% by 2025. Option 3 proposes a 70% target by 2030 and **Option 4** a 75% target by 2025.

In terms of **environmental impact,** the mass flow model shows that **the environmental benefits are non-linear**. This is due to the additional types and volumes of batteries that would need to be collected to achieve the target. The higher the target, the lower the loss of lithium batteries, the higher the environmental benefits would be. This is demonstrated by the sensitivity analysis carried out based on a 55% collection target (sub-measure a), for which the model estimates significantly lower environmental benefits.

Figure 11 shows the **greenhouse gas emissions savings** that would be generated by achieving the different targets as calculated during this process. It shows that a 55% target (sub-measure a, not included in the Options) would lead to annual GHG savings of 4% compared to the baseline in 2030. For Options 2, 3 and 4 on the other hand these annual GHG reductions would amount to **51%, 53% and 56%** respectively. Similar results are obtained for the indicators ‘abiotic depletion potential’ and ‘human toxicity potential’ (for example, the incorrect disposal of batteries through WEEE is a non-negligible source of dust and heavy metal emissions).

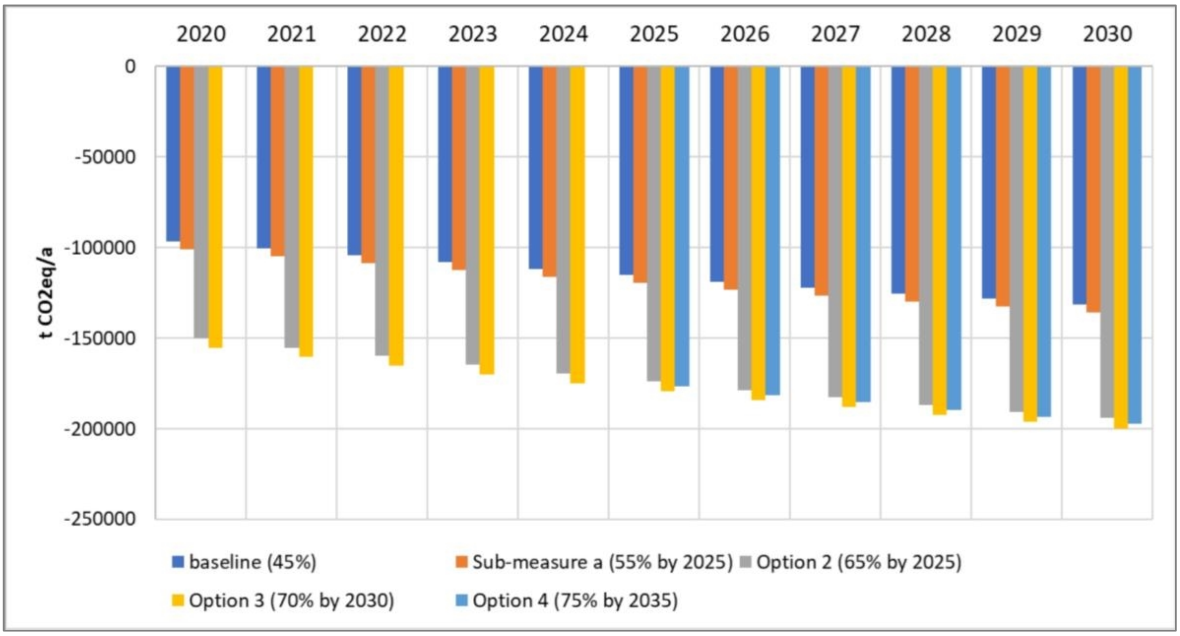

Figure 11: GHG emissions savings generated from battery collection and recycling by achieving different collection rates (in tonnes of CO_2 equivalent per year).

Setting increased collection rate targets would increase the cost of collection. **Estimating the additional cost of meeting these collection targets is not an easy task**, given the limited data available. **Table 5** below presents an overview of estimated annual costs per capita of the different options. It is noted that the cost estimates presented above are subject to **a high degree of uncertainty**, given that they are based on only a few data points.

Table 5: Estimated annual costs to meet the collection rate targets

Collection rate	Estimated annual cost
Baseline (45%)	EUR 0.23-0.51 / capita
Option 2 (65% by 2025)	EUR 1.09 / capita
Option 3 (70% by 2030)	EUR 1.43 / capita
Option 4 (75% by 2025)	EUR 2.07 / capita

Based on the **Polluter Pays Principle**, the Batteries Directive requires that these costs are covered through the **Extended Producer Responsibility** mechanism (see also Measure 10). It is unclear to what extent the cost estimates above, which are expressed in terms of cost per capita, will be passed on from producers to the consumers. Data on the collection of waste portable batteries in **Belgium** indicate that a 65-70% collection rate can be achieved at a cost of around €0.057 per portable battery placed on the market.

There are a number of reasons indicating that the costs estimates for Options 3 and 4 are overestimates.

- A study commissioned by the European Portable Batteries Association[81] indicates that **increases in the collection rate are hindered by the sub-optimal market functioning**, e.g. due to a lack of clarity on the definition of portable batteries, a lack of clear requirements for PROs (e.g. minimum awareness raising campaigns requirements) and distortion of competition between PROs. These issues are **addressed by Measure 1 and Measure 10**, which should facilitate the achievement of higher collection rates.
- Evidence indicates that **systems increase their efficiency**. The PRO that is active in Belgium for example reports that the fee it charges to its members has decreased by 54% since 2013.
- Evidence also indicates **the importance of awareness raising campaigns** to increase collection rates[82]. Compared to the costs of setting up the collection points, the costs of these campaigns are low, thus leading to **decreasing costs to scale**.

On the other hand there are also number of reasons that costs may not go down, and that the estimates can be seen as an **underestimate**:

- Data points used mostly cover **densely populated countries** and with **labour costs** that are higher than the EU average;
- As collection targets increase, the share of **Li-ion batteries** increase, which might have a higher cost.

Costs can be partially **offset by revenue from recycled materials**, but for portable batteries (contrary to automotive and industrial batteries) this revenue is currently not sufficient to cover all the costs. According to the model estimates, Option 2 would lead to an annual increase in the volume of **recovered materials** compared with the baseline of **42%**. For Option 3, this would be **51%** and for Option 4, this would be **61%**. Using current prices, in 2030 this would lead to revenue of **€72.7 million** for Option 2, **€77 million** for Option 3 and **€81.3 million** for Option 4.

The **number of jobs** that would be created by increasing the collection rates is estimated to be **2500** for Option 2 and **5500** for Option 4. These jobs would mainly be created in small and medium-sized enterprises involved in collection and transport.

Achieving a collection rate of 65% and 70% (Options 2 and 3) for portable batteries is feasible in 2025 and 2030 respectively. The average collection rate in 2016 was 48%. Belgium for example, demonstrates that **a 65% and even a 70% target can be achieved** (Options 2 and 3). As a generally accepted principle, **stakeholders welcome higher collection targets as long as they are realistic**, and have enough time to meet them. There are some differences of opinion though, mostly reflecting countries' current divergence in performance.

7.4. Measure 4: Collection rates for automotive, EV and industrial batteries

The **purpose** of Measure 4 is to ensure the highest level of collection for automotive, EV and industrial batteries. To this end, it proposes bringing in a **new reporting system** for automotive and industrial batteries (**Option 2**), and to set a specific **collection target for batteries used in light transport vehicles** (**Option 3**). Option 4, proposes to convert the

[81] Perchards and SagisEPR (2017) 'The collection of waste portable batteries in Europe in view of the achievability of the collection targets set by Batteries Directive 2006/66/EC – 2017 update'
[82] One survey indicates that an average family owns 131 batteries, of which 26 are non-rechargeable and empty

implicit "no loss" policy into an explicit 100% collection target for industrial, automotive and EV batteries.,

Option 2 is expected to give rise to **some minor additional administrative costs**, although the new reporting system can build on existing systems under the End-of-Life Vehicles Directive and the Waste Framework Directive. Putting in place a reporting system will both **improve data availability** and result, according to estimates, in a **3% increase in the collection of lithium industrial batteries**, which will generate additional revenue and environmental benefits.

Option 2 is considered to be fully **feasible**. It is also **accepted** by producers, because they are aware of the advantages of reliable information on the status of industrial batteries.

Option 3 proposes bringing in **a collection target for batteries used in light means of transport**. To set the target at the appropriate level however, it would be necessary to develop the "available for collection" methodology (see Measure 1). This methodology – equivalent to the approach used in the WEEE Directive for waste electric and electronic equipment – makes it possible to estimate the volume of waste batteries (and their weight) that have reached their end-of-life at a given moment. The estimates made during the work on this impact assessment indicate that setting a target for batteries powering means of light transport could result in an increase of nearly 30% in the volume of waste batteries collected (as compared to the baseline). Assuming that these batteries are recycled, this would lead to a reduction in GHG emissions of around 22%.

Option 4, an explicit 100% collection target, was not assessed in detail because early analysis showed that it is rather complicated from an administrative point of view and the same results could be achieved by bringing in a reporting system (Option 2).

7.5. Measure 5: Recycling efficiencies and material recovery

The aim of Measure 5 is to ensure sufficient levels of recycling efficiency and material **recovery**. For **lithium-ion batteries** and for cobalt, nickel, lithium and copper, **Option 2** proposes bringing in target levels to provide a regulatory incentive for the roll-out of state-of-the art recycling technologies by 2025. Option 3 increases the level of ambition by 2030, but still based on what should be technically possible in the near future. For **lead-acid batteries and lead**, for which the Batteries Directive already includes a provision, **Option 2** proposes to increase the current target levels on recycling efficiencies and introduces a quantified target for material recovery. Option 3 increases the level of ambition by 2030, but still based on what is currently already technically feasible. No Option 4 was considered for this measure.

Assessing the impacts of the targets has proven to be rather complicated.

In terms of the economic impact, there are too many variables to make reasonable predictions far into the future. First, for lithium recycling, **this is a market still in its infancy**. Compared to the volume of end-of-live EV batteries that will become available for recycling in the coming years, current levels of recyclables are still rather low. Recycling technologies exist (pyrometallurgy, hydrometallurgy or direct recycling), but are not yet rolled out at large scale.

Data on recycling costs are scarce due to confidentiality issues. Costs are **likely to go down** in the future due to economies of scale and further technological developments. Data obtained during the study to support this impact assessment indicate a **cost range of €2290-3730** (in 2020) **per tonne of waste batteries** (including collection, transport, dismantling and recycling), which may fall to **€860-1300** by 2035. **Data on revenue are equally uncertain**. For lithium, for example, prices have more than doubled over the period 2013-2019, from €5,000 to €11,000 per tonne. This would thus suggest that **overall the economic impacts would be positive**. Certainly **from a societal point of view** it would be positive, given that the measure would not only stimulate the **roll-out of state-of-the-art recycling technologies**, but because it would oblige recyclers to not disregard the recycling of lower-value components (e.g. anodes). It could also be argued that the market for **lead** has shown that setting recycling efficiency and material recovery targets can be **a major driver for investment in technological innovation and recycling capacity**.

In terms of administrative costs, this measure is **not expected to create any significant additional administrative burden**, given that the basis for these provisions are already included in the Batteries Directive.

Given the **high degree of uncertainty** about future technological developments, it has proven **difficult to quantify** the exact **environmental impact** of the proposed measure. This is why the study underpinning this impact assessment opted to produce **very conservative estimates**, for example through the assumption of **"closed loop recycling"**, i.e. processes in which only the materials recovered with a grade that would allow its use in battery manufacturing processes are considered as "recycled". In reality, open loop processes yield additional volumes of recovered materials, albeit not all at the same level of quality, and are less energy-intensive, resulting in additional environmental gains. However, **even under the assumption of closed loop recycling, the proposed measure is estimated to yield environmental benefits** in terms of greenhouse gas savings, abiotic depletion and human toxicity. In any case, the overall **environmental impact** of producing secondary raw materials (i.e. recycling) are lower for most environmental indicators (e.g. energy and water intensity, resource use, toxicity). For example, in the production of primary **lithium**, data indicate that **400 litres of water** are needed to produce one kilo of lithium[83].

This measure meets both criteria of **feasibility and stakeholder acceptance**. It is considered **feasible** because the targets set are based on what is technically achievable. The stakeholder consultation has shown that **there is a general recognition that current values of recycling efficiency are not resulting in an increase in material recovery** and that the lack of a specific recycling efficiency value for lithium batteries does not incentivise the deployment of this sector. For many stakeholders, **legal obligations would stimulate the innovation needed**.

7.6. Measure 6: Carbon footprint of rechargeable industrial and EV batteries

Measure 6 proposes provisions to deal with the issue of batteries' **carbon footprint**. **Option 2** proposes to do this by means of a mandatory carbon footprint declaration, while **Option 3** proposes setting carbon footprint performance classes and maximum carbon thresholds for batteries as a condition for batteries to be placed on the EU market. No Option 4 was considered for this measure.

In terms of **environmental impact,** life-cycle analyses suggest that the production phase is a significant contributor to life-cycle GHG emissions of lithium-ion batteries. Setting

83 https://danwatch.dk/en/undersoegelse/how-much-water-is-used-to-make-the-worlds-batteries/

commonly accepted carbon footprint rules and datasets for EV and industrial batteries will provide **an incentive for market differentiation** based on the relative carbon intensity of batteries. This is expected to prompt manufacturers to choose greener electricity providers/contracts, which will contribute to the process of **decarbonising electricity generation**. It is not technically possible to quantify this environmental benefit but it is estimated to be **higher for Option 3 than for Option 2**.

Quantifying the economic impact of Measure 6 on battery prices has not been feasible since no methodology is available to estimate the effect of this regulatory proposal in isolation from other cost drivers. More analysis is needed and any introduction of maximum carbon thresholds via secondary legislation will be subject to a proportionate and dedicated impact assessment. As a proxy indication, **manufacturer feedback** indicates a **willingness to pay premium prices to secure renewable electricity generation** for their factories in order to lower the carbon footprint of battery production and thus attain green credentials.

The administrative costs of Measure 6 would be relatively low, equivalent for Options 2 and 3. One-off costs per "battery type" would be in the range of **€100–5 000**, depending on the availability of the company-specific data needed and consultancy costs. Additional **verification costs** would be **€2 000-7 000** per battery type with small follow-up costs on top. Overall, assuming that on average 50 producers would be subject to this provision, the total cost for industry would be in a range of €500 000-3 000 000, with some costs for support in the Commission.

Stakeholder support for Measure 6 is **significant**. Almost 54% of respondents to the public consultation supported a reporting obligation on all environmental impact categories of batteries' life cycle, including climate change. **Environmental NGOs** view this measure as a lever to push further for the decarbonisation of economic activity. . **Battery manufacturers** support this measure, as long as the carbon declaration rules are clear and widely accepted, and they are already taking steps to be ready for carbon transparency.

Further developing Measure 6 **relies on the availability of a battery database or a battery passport**, or both, to collect market information on the relative carbon content of battery cells/modules placed on the market. This is **even more necessary for Option 3**, which constitutes a market restrictive measure, so the thresholds would need to be set carefully, to avoid creating unintended supply restrictions. **The Commission will facilitate this measure** by providing battery databases and battery passports, to enable data collection and transmission (see Measure 12 for further details).

7.7. Measure 7: Performance and durability of rechargeable industrial and EV batteries

Measure 7 proposes bringing in **information requirements** on battery performance and durability (Option 2) or setting **minimum thresholds** as a condition for placement on the EU market (Option 3). No Option 4 was considered for this measure.

Option 2 would bring in a requirement to provide information on battery characteristics such as capacity, internal resistance, energy round-trip efficiency or estimated lifetime (before significant degradation). This will facilitate the establishment of a **level playing field** and better enable economic operators to take informed decisions. By **removing uncertainty from transactions,** it will help generate economic value.

Supporting harmonised standards or technical specifications would be required to measure and describe the performance parameters. Meeting these standards or specifications would be **unlikely to cause additional economic impact for battery manufacturers/importers** as they already measure these parameters as part of their internal quality controls and their contractual obligations. It may, however, give rise to **some administrative costs for public authorities** related to verification of the information requirements, which may involve testing batteries in laboratories.

Option 3 would be more effective than Option 2 by removing the worst performing batteries from the market in terms of performance and durability. This option would impose some **economic costs** on battery manufacturers, for example if they need to adapt certain manufacturing processes and choice of materials. The **administrative costs** for industry should be similar to those in Option 2, or slightly higher due to the need to calculate minimum characteristics, and more stringently verify compliance. **For battery users,** however, it should generate **economic benefits** (e.g. by providing better value for money).

Similarly to Measure 6 on batteries' carbon footprint, Measure 7 should **lead to a switch in the market towards better performing batteries**, and to a lower environmental impact. Option 3, setting minimum performance thresholds, would have additional environmental benefits over and above Option 2, by reducing the supply of under-performing batteries.

Option 2 for Measure 7 on performance and durability could be **a first step** in defining minimum performance requirements (Option 3) at a later stage. In itself, it is unlikely to make a significant difference in the market in the short term. **Standardisation work** triggered in parallel should **help draw up minimum requirements in the medium term** (3-5 years), once proper measurement methods for performance are in place. Over the same timeframe, it will be possible to build a publicly accessible data bank of real-life performance data, to enable fit-for-purpose measurement methods and accurate minimum requirements.

Most **environmental NGOs support** setting minimum performance requirements. **Battery manufacturers** on the other hand generally **prefer information requirements** over minimum performance requirements, as they claim this gives them greater freedom in the design of batteries for different applications.

7.8. Measure 8: Non-rechargeable portable batteries

The **purpose** of Measure 8 on non-rechargeable batteries is to address the problem of their **environmental impact**. To this end, **Option 2** proposes to bring in performance and durability requirements with the aim of ensuring minimum quality levels. **Option 3** and **Option 4** go a step further and propose a partial (general purpose batteries only) or a total phase out of non-rechargeable batteries.

The **economic impact** of **Option 2** would be **limited**. For **consumers,** it may bring some **economic benefits** by enabling consumers to identify the best value for money battery (by providing information on performance and durability (in low-drain appliances)) or by making the long-term economic benefit of rechargeable batteries more obvious (in high-drain appliances). For producers and public authorities, Option 2 would generate some **administrative costs** – for the development of standards and a market surveillance system – which are considered to be relatively low. As a **benefit,** this option would also **level the playing field** for producers of batteries with better performance and durability.

The **environmental impacts** of **Option 2** would depend on the performance categories and criteria set. Similar experiences with, for example, eco-design requirements show that this can be a very effective measure to steer the market towards products that have a better environmental performance.

For stakeholders**,** Option 2 is the preferred option over Options 3 and 4. A stakeholder group representing **producers of portable batteries** has expressed **positive views** on minimum quality standards and identified the existing IEC standard 60068-2 as a good starting point.

The impacts of **Options 3 and 4** would be much **more far-reaching**, because they would lead to the total or partial phasing out of primary batteries. Depending on the device in which they are used, this would result in a shift to removable rechargeable batteries or a need to replace the device. This will have significant implications for the **producers and recyclers of primary batteries** (loss of business) and for the **producers of the devices** that would need to be redesigned. In the long term, the economic impacts for **consumers** may be positive, though in the short term they may need to buy new rechargeable batteries, chargers and/or new devices.

The assessment of the **environmental impacts** of phasing out primary batteries is a complex matter, because it depends on a multitude of factors, such as the appliances they are used in (high drain vs low drain), the batteries' chemistries, the number of recharge cycles. For this reason, the **evidence and data on this topic is relatively scarce**. There are indications that rechargeable batteries may be preferable from an environmental point of view **for high consumption devices** such as cameras, torches, and electronic toys, because these devices should allow for a number of charge cycles that is required as a minimum (50-150) to lead to a significant reduction of the environmental impact indicators across the batteries' life cycle.

Given the far-reaching negative impacts of Options 3 and Option 4, they are **opposed by EU producers and recyclers** of primary batteries.

7.9. Measure 9: Recycled content

Measure 9 on recycled content proposes a number of provisions that aim to **stimulate the development of cost-efficient technologies that can deliver battery-grade recycled material**, with a view to ensuring their use for the manufacturing of lithium and lead-acid batteries.

As explained in Section 2, **lithium recovery is not yet cost-efficient**, and in the absence of technologies that can produce battery-grade lithium and other substances, there is a risk that the **supply** of (low-grade) secondary lithium would significantly **exceed demand**. Based on experience with recycling and recovering other materials, it has been shown that **legislative requirements can be a means to overcome the "valley of death".** It gives the market legal certainty to invest in technologies that would otherwise remain undeveloped because they cannot become cost-competitive due to market failures. This is the rationale for proposing under Measure 9 to bring in **a mandatory declaration of recycled content** for industrial batteries by 2025 (**Option 2**) and to bring in **mandatory levels** for key materials in industrial batteries by 2030 and 2035 (**Option 3**). No Option 4 was considered for this measure.

Table 6 sets out the current level (baseline) and proposed targets for recycled content for lithium, cobalt, nickel and lead in 2030 and 2035 (Option 3).

In terms of the **economic impact** of **Option 2,** there are no precedents to draw on to estimate the cost of bringing in a declaration of recycled content in a regulatory context. Since this presents a similar level of complexity as Measure 6 (carbon footprint declaration), the expected calculation costs per battery type would be in the range of €100-5,000, plus verification costs estimated to be in the range of €2000-7000 per battery type, **an approximate total of €2100-12000 per battery type**. Assuming that by 2025 the declaration of recycled content would apply to approximately 250 lithium-ion battery types (domestically produced plus imported) and approximately 340 lead-acid battery types (idem), **the total (one-off) cost of this obligation for industry would be in a range of €1 180 000 and €7 080 000** (see Annex 9 for more details). For public authorities, this would also require some additional resources for market surveillance authorities to enforce this new obligation.

Table 6: Proposed minimum levels of recycled content in lithium batteries

	Baseline	**Target**	**Target**
	Recycled content 2020	**Recycled content 2030**	**Recycled content 2035**
Lithium	0%	4%	10%
Cobalt	0%	12%	20%
Nickel	0%	4%	12%
Lead	67%	85%	-

Option 2 is an intermediate step towards Option 3, setting mandatory targets for recycled content for lithium, cobalt, nickel and lead in 2030 and 2035. The **main benefit** is that they would provide long-term investment certainty to recyclers, which is a necessary **incentive to invest** in recycling technologies that will contribute to promoting the circular economy and mitigating the supply risk for certain materials.

Setting mandatory recycled content targets will also generate **environmental benefits**. Adopting this measure could save a cumulated total of about **2.3 million tonnes of CO_2-eq** by 2035, compared to the baseline situation, with similar results for resource depletion and human toxicity.

Stakeholder views on this measure are mixed. Some manufacturers of large EV batteries are against it because they consider that there will not be enough secondary raw materials to meet the criteria due to the expected exponential demand for battery materials over the coming years. Other manufacturers in the same sector not only accept the positive benefit of these measures but also commit to delivering products that go beyond the levels discussed here.

7.10. Measure 10: Extended producer responsibility

Measure 10 on extended producer responsibility (EPR) builds on the already set out in the Batteries Directive, but proposes setting better-defined and more specific EPR obligations and to set minimum standards for producer responsibility organisations (PROs). This measure does not give a **high ambition** option since it mostly involves fine-tuning existing provisions in the Batteries Directive.

On **extended producer responsibility**, this measure proposes clearer EPR requirements for dismantling, collecting, transporting and recycling traction batteries of electric vehicles (EV) and for private energy-storage systems, and to specify obligations on a subset of industrial batteries such as "batteries sold to private costumers and / or used in non-industrial contexts". The **aim** is to ensure that, in line with the EPR principles, **producers cover the costs of dismantling, safe storage, logistics and recycling waste industrial batteries and facilitate higher collection rates** of, for example, batteries used in light transport or energy small storage applications. In this way, it would not be up to the end user to cover these costs.

For producers of traction batteries, the **cost or reporting obligations would not change significantly** compared to the current situation. The **benefit** of the measure would be in **levelling the playing field** by allocating clear responsibilities for the cost of end-of-life battery management and ensuring that producers that exit the market before batteries have reached their end-of-life will have contributed their due share.

For PROs that currently do not collect privately owned industrial waste batteries, the **costs will increase** as a result of the additional volume of batteries they need to accept (potentially from new collection points, i.e. e-bike shops), although these costs will of course in part be compensated by **increased revenue** from recycled materials. Some extra administrative costs may arise for data collection, reporting and auditing, but they are expected to be negligible.

The **environmental impact** of the redefined EPR requirements for **EV batteries** and private energy-storage systems could not be quantified, because the Batteries Directive includes an implicit 100% collection target. The improved allocation of responsibilities would, however, facilitate improved enforcement and may be an additional trigger to opt for second-life use of traction batteries. By contrast, the new EPR requirement for **e-bikes** is estimated to **increase their collection rate significantly** compared to the baseline, and thus to reduce GHG emissions.

In terms of **stakeholder acceptance, consumer organisations and environmental NGOs** have consistently supported the adoption of measures ensuring that industrial batteries held by private actors are collected and recycled properly. **Stakeholder groups representing industry,** by contrast, are not necessarily convinced of the need to make the EPR obligations more specific.

Regarding **producer responsibility organisations**, this measure proposes a requirement for PROs within a Member State to coordinate their **awareness raising campaigns** plus a requirement to assess the **distribution of collection points** (network density, convenience, accessibility). The **aim** is to increase the cost-effectiveness of PROs and to facilitate the increase in battery collection rates.

The **economic impact** of the requirements for PROs are expected to be minimal. PROs may incur some additional set-up costs, but they should be offset by a number of factors, such as increased revenue from increased collection, economies of scale and peer learning.

The **environmental impact** of the new requirements for PROs could not be quantified. They are expected to be positive through their contribution to increased collection rates.

This measure responds to **a request from some PROs to ensure a level playing field** within the internal market. Coordinated nationwide campaigns and standards were the preferred options, based on their proven effectiveness without distorting competitiveness.

7.11. Measure 11: Design requirements for portable batteries

Measure 11 covers design requirements for portable batteries aiming at facilitating their circularity at end-of-life (reduce, reuse, recycle). **Option 2** includes a strengthened obligation on battery removability (compared to the current Article 11 in the Batteries Directive) and Option 3 proposes to add a new obligation on battery replaceability. **Option 4**, a requirement on interoperability – which in theory could trigger a reduction in the number of batteries needed to operate a certain number of appliances – was not analysed in further detail because of the far-reaching consequences it would have in terms of design and product compliance obligations (including liabilities).

In terms of **environmental impact**, Measure 11 would lead to **an increase in the number of batteries recycled and appliances that can be repaired** by facilitating removability and replaceability. WEEE would reach the treatment plants with lower volumes of non-removed batteries, expected to result in a fall in the number of safety accidents. This, in turn, would lead to **a decrease in environmental pollution**, such as emissions to air and water.

The economic costs of Measure 11 are considered to be negligible. Given that the costs of (re)design make up only a very small fraction of total production costs, it would not have a significant impact on producers. The fact that requirements will be clearer and easier to enforce would **level the playing field** for companies operating on the EU internal market. In terms of additional **administrative burden**, this measure is not expected to have a significant impact, given that a similar provision already exists under the Batteries Directive.

For **recyclers,** this Measure would generate **benefits**, including lower costs related to battery removal and fewer fires and safety incidents (linked to fewer lithium-ion batteries ending up in the wrong waste stream). Likewise, **consumers** would get net benefits in longer-life products (thanks to replaceable batteries) and easier repair. The latter is also expected to have an impact on **employment**: according to estimates from RREUSE, reuse and repair can create between 5 to 10 times more jobs than recycling.[84]

Based on similar requirements such as eco-design, this measure is considered to be **feasible**.

Stakeholder views vary, depending on the costs and benefits that this measure would entail. **Manufacturers** are generally of the opinion that the level of battery integration in a product should be a manufacturer's decision, based on functionality, durability and safety considerations. **Waste operators, consumer organisations and environmental groups however** emphasise the positive environmental impacts and contribution the measure would make to facilitate reuse, repair and recycling.

7.12. Measure 12: Reliable information

Measure 12 includes a number of provisions that would provide more reliable and comparable information about batteries to economic operators. **The goals of these provisions are multiple and depend on the type of batteries**. They include avoiding regulatory differences between Member States, facilitating sustainable consumption choices, facilitating verification of compliance with legal requirements, facilitating the development of the second-life market and facilitating the sorting of batteries at their end-of-life.

Option 2 covers **two provisions** to ensure the provision of **static information**, both printed and online (e.g. through a QR code). The **first provision** (sub-measure a) is an extension of the existing labelling provision under the Batteries Directive, aimed at private consumers. It covers all **basic information** about a battery, such as the battery's chemistry, charging capacity and carbon footprint. The **second provision** (sub-measure b) covers **more**

84 'Briefing on job creation potential in the re-use sector', RREUSE, 2015.

specialised information such as a detailed list of hazardous chemicals, standards, technical norms or any other guidance for dismantling and sorting, etc. The proposed digitalisation (included in both provisions) would help simplify administrative processes and reduce the cost of information.

The **economic impact** of **Option 2** for **manufacturers** is estimated to be minor, as several battery manufacturers already provide additional information online to consumers and/or to registered dealers/repairers. The software to generate QR codes exists, as do the apps for users to read them. Essentially, the information is currently available to manufacturers, and it is just a question of them providing it systematically and transparently. For **consumers**, better information about batteries' expected performance, durability and associated carbon footprint would enable them to take better-informed decisions and possibly to reduce the total cost of battery use and ownership. For **recyclers**, harmonised, improved labelling including accessible and more detailed information on battery chemistries would have **a positive effect on the profitability of recycling**, because it would improve battery sorting, the health and safety conditions of operations and even has the potential to increase the purity of the recyclable fraction.

In terms of **environmental impact**, this measure would stimulate **a market shift towards more environmentally sound batteries** by enabling consumers to take better-informed purchasing decisions. Consumers are increasingly aware of the environmental impact of their consumption and it is likely that more and more consumers will wish to know before they purchase batteries what they can expect in terms of and what choices they have in terms of the environmental impact of their purchase. Improved labelling of batteries would also contribute to **better battery collection and recycling**.

Option 2 is considered to be fully **feasible**, given that energy labels have been common in appliances for the last 15 years and are accepted as being useful. All **stakeholders** generally accept the provisions of this option.

Option 3, which is complementary to Option 2, proposes the creation of an electronic information exchange system (mostly based on the information generated by the provisions of Option 2), and for industrial and EV batteries also a battery passport scheme. The **electronic information exchange system or battery dataspace** would include static information, such as material composition by element (including recycled content and CRMs), information on dismantling and recycling (including the producer organisation that would finance the cost of collection and recycling), hazard and safety information, battery efficiency (consumer information) etc. This type of information applies to all models of batteries. The **battery passport** would generate a unique digital ID for each industrial and EV battery, which would ensure that each battery has an individual (digital) record holding static and dynamic information that would be added to throughout its lifecycle.

The **economic and administrative costs** of Option 3 for economic operators and public authorities would depend on how the battery passport and the supporting IT infrastructure is implemented. This would require a dedicated discussion with stakeholders and an assessment of the different implementation options, which exceeds the scope of this evaluation.

These costs can be justified by the **economic** and **environmental benefits** that the battery open dataspace and passport would generate, including optimising the operational life and the use of materials in batteries, facilitating the second-life battery market and improving the availability of data for recyclers. It would give public authorities a powerful tool to enforce the obligations in the proposed regulation, as well as a market intelligence tool to revise and refine the obligations in the future. Producers, recyclers and re-purposers could have first-hand information on the technical characteristics of the different models, and could anticipate the expected volume of batteries reaching the end-of-life.

In terms of **feasibility**, this option is **ambitious and costly but not impossible**. In January 2020, 42 global organisations expressed their support for the idea of an interoperable battery passport as proposed by the Global Battery Alliance[85]. This option is **favoured in particular by the businesses that stand to reap more gains** from creating a battery passport and a traceability management system, such as second-life battery operators and recyclers. By contrast, some battery manufacturers expressed concerns about the cost of developing and maintaining the battery database and the battery passport system.

7.13. Measure 13: Supply-chain due diligence for raw materials in industrial and EV batteries

For Measure 13, **Options 2 and 3** propose bringing in either a **voluntary** or a **mandatory** supply-chain due diligence approach for raw materials in industrial and EV batteries. No Option 4 was considered for this measure.

Table 7 summarises the **cost categories and the cost ranges** provided by a study on the costs and benefits of due diligence carried out for the OECD[86]. The cost ranges include the cost of collecting information and reporting, IT systems and software, strengthening internal management systems, consulting and training and possibly audits and are **relatively low**.

Overall, the number of battery and vehicle manufacturers that would be directly affected by this obligation is estimated to be around 50. Extrapolating the OECD cost estimates gives a range of between €2-15 million in one-off costs and between €2-20 million in annual costs. The expected costs are commensurate with those identified by some of the studies carried out to quantify the cost of implementing the non-financing reporting Directive[87] (NFRD), which imposes greater obligations than due diligence in the supply chain. It found that **the annual cost of non-financial reporting (at company level) ranged from €155,000-€604,000**.

Table 7: Cost estimates related to supply-chain due diligence at company level[88]

Cost category	Typology	Cost range	One-off/recurring
Changes to corporate compliance policies and supply-chain operating procedures	Staff time Consultants fees Training	€3,150 to €205,000	One-off
Setting up the	Procurement,	€36,000 to	One-off

85 https://www.weforum.org/press/2020/01/42-global-organizations-agree-on-guiding-principles-for-batteries-to-power-sustainable-energy-transition/.

86 'Quantifying the Costs, Benefits and Risks of Due Diligence for Responsible Business: Conduct, Framework and Assessment Tool for Companies', study for the OECD, University of Columbia, School for International Affairs, 2016.

87 Directive 2014/95/EU lays down the rules on disclosure of non-financial and diversity information by large companies.

88 'Quantifying the Costs, Benefits and Risks of Due Diligence for Responsible Business: Conduct, Framework and Assessment Tool for Companies', study for the OECD, University of Columbia, School for International Affairs, 2016.

necessary IT systems	installation and support of IT systems	€90,000	
Data collection and verification	Staff time Consultants fees	€12,600 to €72,000	Annual
Audits	Third-party fees	€13,500 to €22,500 for small companies €90,000 for large companies	Annual
Carrying out due diligence and reporting	Staff time Consultants fees	€12,500 to €365,000	Annual

For companies implementing a supply-chain due diligence framework, there are also **economic benefits**, which include the company's improved knowledge of its operations and supply chain as well as its ability to detect problems and risks early. The prevention or/and mitigation of these risks reduces a company's exposure to potentially high remediation costs that it could incur if the risk were not addressed and protects the company from long-term damage. These benefits may translate into increased transparency, credibility, reputation and public image and higher levels of trust in supply-chain partners.

The main **social and environmental benefits** of this measure could not be quantified. They include improving political and social stability for local operators and communities in conflict regions (including protecting human and labour rights), strengthening environmental aspects, reducing contamination and health issues. These benefits are expected to be **greater for Option 3**.

In terms of stakeholder views, **60% of respondents** to the public consultation held in 2019 were **in favour** of setting reporting obligations on the responsible sourcing of raw materials. Multiple public stakeholder meetings and informal meetings held with stakeholders during the regulatory process indicated **a fair degree of consensus on mandatory supply-chain due diligence provisions** for battery manufacturers/importers, rather than a voluntary system.

8. PREFERRED OPTION

8.1. Conclusions based on the analysis of the impacts of all options

Table 8 gives an overview of the analysis of the impacts as discussed in Section 7 and Annex 9. It summarises the conclusions on the economic and environmental impacts, on feasibility and on stakeholder acceptance. **Table 9** gives an overview of the preferred option.

The preferred option is a combination of Option 2 and Option 3. The blend of the medium and high-level ambition options chosen would result in a balanced approach in terms of effectiveness (achievement of the objectives) and efficiency (cost-effectiveness). It would facilitate the EU's response to fast-changing market conditions and ambitiously support a switch towards a more low-carbon economy, without risking excessive costs or disruption.

The objective of **Measure 1** on classification and definition is to clarify the current provisions on battery categories and update them in line with the latest technological developments (**Option 2**). The administrative changes to some provisions in the current Batteries Directive would **improve the effectiveness of several other provisions**, without generating any significant economic costs or administrative burden. Stakeholders have said that they fully accept this measure. The possibility to set a new methodology for the collection rates based on "available for collection" (**Option 3**) is proposed to be re-assessed through a **review clause**.

For **Measure 2** on second life of industrial batteries the estimated **economic and environmental benefits** for Options 2 and 3 would be **equivalent** (assuming equal levels of market penetration). The **administrative costs of Option 3** – in which batteries are not necessarily considered as waste at the end of their first life (only when the battery holder decides to discard the battery) – are **significantly lower** than those for Option 2. This is also why **most stakeholders** believe that Option 2 – in which batteries become waste, leading to extra costs for permits needed to deal with hazardous waste – would for many prevent the development of this technology since it would make it non-viable from an economic point of view. This is why the preferred option for this measure is **Option 3**.

For **Measure 3** on a collection rate target for portable batteries, the preferred option is **Option 2**, a 65% collection target in 2025 and **Option 3**, a 70% target in 2030. These options are estimated to cost around €1.09 and €1.43 per capita per year respectively, to be financed through the mechanism of Extended Producer Responsibility. The reason for increasing the collection targets significantly compared to the baseline is twofold. First because the **environmental benefits increase in a non-linear way** due to the increased collection of lithium-ion batteries. Second because evidence shows that there are **economies of scale and efficiency gains** to be made. As a generally accepted principle, **stakeholders accept higher collection targets** as long as they are realistic and they have enough time to meet the targets. This is considered not to be the case for Option 4, a collection target of 75% by 2025.

The preferred option for **Measure 4** is **Option 2**, a new reporting system for automotive and industrial batteries. This measure is not expected to give rise to any significant economic costs or administrative burden but they would result in increased collection rates. **Option 3**, a specific **collection target for batteries used in means of light transport**, is expected to lead to significant increase in collection rates. However, due to the need to first develop the "available for collection" methodology, this Option is proposed to be re-assessed through a review clause.

The preferred option for **Measure 5** on recycling efficiencies and material recovery is **Option 2**, increasing the targets for lead-acid batteries and **Option 3,** bringing in new targets for lithium-ion batteries, cobalt, nickel, lithium and copper. Option 2 sets targets for 2025 based on what is currently technically feasible, while Option 3 sets targets for 2030 based on what will be technically feasible in the future. Due to the **high degree of uncertainty** on a number of variables, quantifying the economic and environmental impact of these options has proven difficult. Modelling estimates indicate that, **even under the most conservative assumptions, it would have a positive impact**.

For **Measure 6** on the carbon footprint of EV batteries, the preferred option is **Option 2**, a mandatory declaration, possibly complemented, over time, once sufficient market knowledge has been acquired and once further assessment is carried out,, with **Option 3**, setting carbon footprint performance classes and maximum threshold values as a condition for the placement of batteries on the EU market. These options are essential **to achieve the objective of carbon neutrality and environmental protection**, which were set out for example in the as stated in the new Circular Economy Action Plan for a cleaner and more competitive Europe[89]. This will be carried out first by bringing about **carbon footprint transparency** and later on enable a **verifiable regulatory framework** to reward batteries with relatively lower carbon emissions.

For **Measure 7** on the performance and durability of rechargeable industrial and electric-vehicle batteries, the preferred option is **Option 2**, bringing in information requirements in the short term. This would help harmonise the calculation and availability of performance and durability characteristics of batteries and hence enable consumers and businesses to take informed decisions. Once the necessary information is available and the standardisation work has been completed, it will be possible to introduce **minimum performance requirements** (Option 3) at a later stage. The Commission concluded this option is more effective in the long term to **help the market switch to better-performing batteries**, and so trigger a shift to a lower environmental impact.

For **Measure 8** on **non-rechargeable portable batteries**, the preferred option is **Option 2**, setting electrochemical performance and durability parameters to minimise the inefficient use of resources and energy. These parameters will also be taken up by the labelling requirements that are covered by Measure 12 to inform consumers' batteries' performance. With regards to **Options 3 and 4** the conclusion is that there is currently insufficient evidence available to demonstrate the effectiveness and feasibility of a partial or complete phase out of non-rechargeable batteries. Producers and recyclers of non-rechargeable batteries are opposed to these two more ambitious options.

The preferred option for **Measure 9** is both **Option 2**, bringing in a mandatory declaration of recycled content, in the short term, and **Option 3**, setting mandatory targets for recycled content for lithium, cobalt, nickel and lead in 2030 and 2035. The two options are complementary and would contribute to providing **a predictable legal framework that would encourage market players to invest** in recycling technologies that would otherwise not be developed because they are not cost-competitive with the production of primary raw materials.

For **Measure 10** on **extended producer responsibility and producer responsibility organisations,** no high level ambition option was proposed since it mostly involves fine-tuning existing provisions under the Batteries Directive. The proposed measure would **level the playing field** for EPR schemes for EV and industrial batteries that are currently classified as industrial batteries and for PROs for portable batteries. The **economic costs** of this measure are expected to be **negligible** and **largely offset by the environmental benefits** of increased collection rates.

For **Measure 11** on design requirements for portable batteries the preferred option is a strengthened obligation of battery removability (Option 2) and a new obligation of battery replaceability (Option 3). The economic costs of these options are negligible, while they will generate **environmental benefits and resource savings**. It will do so by facilitating the reuse, repair and recycling of batteries and the appliances in which they are integrated.

[89] COM (2020) 98 final

For **Measure 12** on the provision of reliable information, a combination of both Option 2 and Option 3 is preferred. **Option 2**, bringing in a printed and an online labelling system providing basic and more tailored information is preferred because it would help provide better information to consumers and end users and stimulate **a market shift towards more environmentally sound batteries**. The principle of **Option 3**, an electronic exchange system and battery passport, as proposed by the Global Batteries Alliance, is accepted by several global organisations. The **electronic exchange system** will have a one-off administrative cost for setting it up, but will lead to administrative simplification and lower implementation costs in the long term. The **battery passport** should furthermore enable second life operators to take informed business decisions and allow recyclers to better plan their operations and improve their recycling efficiencies.

For **Measure 13** on due diligence for raw materials, the preferred option is **Option 3**, a mandatory approach. There is a **fair degree of consensus** among stakeholders that this option would be **more effective** in reducing the social and environmental risks related to raw material extraction.

Table 8: Overview of the analysis of the impacts of all options

Measure	Option 2			Option 3			Option 4		
	Economic impact	Environmental impact	Feasibility & acceptance	Economic impact	Environmental impact	Feasibility & acceptance	Economic impact	Environmental impact	Feasibility & acceptance
1. Classification and definition	**~0**	**+**	**+**	**~0**	**~0**	**+**	**/**		
2. Second-life of industrial batteries	**+**	**+**	**-**	**+**	**+**	**+**	**/**		
3. Collection rate target for portable batteries	**-**	**+**	**++**	**- -**	**++**	**+ & -**	**- -**	**++**	**-**
4. Collection rate target for industrial batteries	**+**	**+**	**+**	**+ & -**	**+**	**+ & -**	**+**	**+**	**-**
5. Recycling efficiencies and materials recovery	**+ & -**	**+**	**+**	**+& -**	**+**	**+**	**/**		
6. Carbon intensity of industrial batteries	**+ & -**	**+**	**++**	**+ & -**	**++**	**+**	**/**		
7. Performance and durability of rechargeable batteries	**+ & -**	**+**	**+ & -**	**+ & -**	**++**	**+ & -**	**/**		
8. Non-rechargeable batteries	**-**	**+**	**+**	**- -**	**?**	**-**	**- -**	**?**	**- -**
9. Recycled content of industrial batteries	**-**	**~0**	**+**	**+ & -**	**+**	**+ & -**	**/**		

Measure	Option 2			Option 3			Option 4		
10. Extended producer responsibility	+ & -	+	+	/			/		
11. Design requirements for portable batteries	+	+	+ & -	+	+	+ & -	-	~0	-
12. Provision of reliable information	+	+	+	+ & -	+	+ & -	/		
13. Supply-chain due diligence requirements for raw materials in industrial batteries	-	~0	+	-	+	+	/		

Legend: green = preferred option; light green = preferred option pending a revision clause; all symbols indicate impact relative to the baseline situation, with "+ & -" = positive and negative impacts, "~0" = negligible, and " ?" = further assessment needed

Table 9: Preferred option

Measures	**Option 2 - medium level of ambition**	**Option 3 - high level of ambition**	**Option 4 – very high level of ambition**
1. Classification and definition	New category for EV batteries Weight limit of 5 kg to differentiate portable from industrial batteries	New calculation methodology for collection rates of portable batteries based on batteries available for collection	/
2. Second-life of industrial batteries	At the end of the first life, used batteries are considered waste (except for reuse). Repurposing is considered a waste treatment operation. Repurposed (second life) batteries are considered as new products which have to comply with the product requirements when they are placed on the market	At the end of the first life, used batteries are not waste. Repurposed (second life) batteries are considered as new products which have to comply with the product requirements when they are placed on the market.	*Mandatory second life readiness*
3. Collection rate for portable batteries	65% collection target in 2025	70% collection target in 2030	75% collection target in 2025
4. Collection rate for automotive and industrial batteries	New reporting system for automotive, EV and industrial batteries	Collection target for batteries powering light transport vehicles	Explicit collection target for industrial, EV and automotive batteries
5. Recycling efficiencies and recovery of materials	<u>Lithium-ion batteries and Co, Ni, Li, Cu:</u> Recycling efficiency lithium-ion batteries: 65% by 2025 Material recovery rates for Co, Ni, Li, Cu: resp. 90%, 90%, 35% and 90% in 2025 <u>Lead-acid batteries and lead:</u> Recycling efficiency lead-acid batteries: 75% by 2025 Material recovery for lead: 90% in 2025	<u>Lithium-ion batteries and Co, Ni, Li, Cu:</u> Recycling efficiency lithium-ion batteries: 70% by 2030 Material recovery rates for Co, Ni, Li, Cu: resp. 95%, 95%, 70% and 95% in 2030 <u>Lead-acid batteries and lead:</u> Recycling efficiency lead-acid batteries: 80% by 2030 Material recovery for lead: 95% by 2030	/
6. Carbon footprint for industrial and EV batteries	Mandatory carbon footprint declaration	Carbon footprint performance classes and maximum carbon thresholds for batteries as a condition for placement on the market	/
7. Performance and durability of rechargeable industrial and EV batteries	Information requirements on performance and durability	Minimum performance and durability requirements as a condition for placement on the market	/
8. Non-rechargeable portable batteries	Technical parameters for performance and durability of portable primary batteries	Phase out of portable primary batteries of general use	Total phase out of primary batteries

Measures	Option 2 - medium level of ambition	Option 3 - high level of ambition	Option 4 – very high level of ambition
9. Recycled content in industrial, EV and automotive batteries	Mandatory declaration of levels of recycled content, in 2025	Mandatory levels of recycled content, in 2030 and 2035	/
10. Extended producer responsibility	Clear specifications for extended producer responsibility obligations for industrial batteries Minimum standards for PROs	/	/
11. Design requirements for portable batteries	Strengthened obligation on removability	New obligation on replaceability	*Requirement on interoperability*
12. Provision of information	Provision of basic information (as labels, technical documentation or online) Provision of more specific information to end-users and economic operators (with selective access)	Setting up an electronic information exchange system for batteries and a passport scheme (for industrial and electric vehicle batteries only)	/
13. Supply-chain due diligence for raw materials in industrial and EV batteries	Voluntary supply-chain due diligence	Mandatory supply chain due diligence	/

Legend: Green = preferred option; light green = preferred option pending a revision clause; italics = discarded at an early stage

8.2. Regulatory burden and simplification

In terms of the overall **regulatory burden**, although the financial costs and benefits of the overall package is uncertain, it appears likely that **it would not have a significant impact on the price of batteries**.

The **current annual market volume** of the EU batteries market is **€12 billion** and set to grow. The impact assessment shows that the cost of the legislative proposal is mostly determined by the cost of the collection target for portable batteries, which is estimated to be EUR 1.09 per capita per year. Adding this up to the **cost estimates** of the measures for which there are currently no provisions in the Batteries Directive, like for example the measures on second life, carbon footprint, supply chain due diligence etc, – for which the impact assessment shows that the regulatory cost is **negligible** – a prudent estimate for the regulatory cost of the entire package would be around EUR 500 million per year (not taking into account the investment costs for Measure 5 on recycling efficiencies and material recovery).

Cost estimates are in any case highly uncertain as markets and technologies are still developing and likely to become more efficient. Likewise it is rather difficult to monetise the environmental benefits or the improvements in batteries' efficiency and performance.

Three further qualifications can be made regarding the administrative burden and simplification potential related to this policy proposal:

1) The evaluation of the Batteries Directive[90] found that "*Implementing the Directive involves necessarily complex procedures that could sometimes entail significant costs for local authorities. However,* ***national administrations do not perceive that implementing the Directive results in unnecessary regulatory burdens***."

2) This policy proposal includes several **measures that cover areas identified in the evaluation of the Batteries Directive where the lack of harmonisation or insufficiently detailed provisions** leads to sub-optimal outcomes in terms of a level playing field and cost-efficiency (e.g. producer responsibility organisations). Likewise, it includes a number of **measures that ensure that the regulatory environment is up-to-date and fit for purpose to adapt to technological novelties,** such as EV batteries, light transport vehicles or second-life industrial batteries.

3) This policy proposal makes maximum use of the potential of **digitalisation** to reduce administrative costs. To this end, Measure 12, for example, proposes setting up **an electronic information exchange system or battery dataspace** of information on every portable and industrial battery model placed on the market and a battery passport for each industrial battery placed on the market. Although developing this tool would entail some costs to both the Commission and to economic operators, it would provide Member State authorities and the Commission with **a powerful tool to enforce the obligations** in the proposed regulation, as well as a market intelligence tool to feed into future revisions and refinements of the obligations.

8.3. Future proofing

Future proofing legislation means striking a proper balance between **predictability and legal certainty** and allowing the sector to respond to **technological progress**. This is especially important for the battery sector, which is undergoing fast-changing demand, and innovation in battery characteristics and performance. Careful consideration has been taken of the market and of Europe's research agenda (see Annex 8) in particular, so the revision is careful to avoid being overly prescriptive / restrictive in order to support innovation.

The proposed Regulation has **two features that should combine to make the policy framework future proof and innovation friendly**:

1) **All measures** except Measure 11 on design requirements for portable batteries would be further fleshed out in **secondary legislation**, which would facilitate adaptability and regulatory responsiveness in line with technological and market developments.
2) For some measures, the impact analysis found that an **incremental approach** is the most suitable. For instance, this is the case for the discussion on performance and durability requirements, which involves setting information obligations as the first step and then setting or enforcing limit values later on when more information is available.

8.4. International competitiveness

An assessment of the economic impact demonstrates that **the proposed regulation would not affect production costs in a significant manner**. The proposed Regulation would thus not affect the EU's international competitiveness.

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[90] SWD(2019) 1300 final.

Requirements would apply in a proportionate manner both to European producers and to importers, and would be consistent with the **EU's international obligations**. Likewise, **European producers would not be disadvantaged** in their ability to function inside or outside Europe.

9. MONITORING AND EVALUATION

9.1. Arrangements

The aim of the proposed change to the **classification of batteries** is to update the existing rules to ensure they cover all batteries, including possible new battery types. Monitoring arrangements would need to ensure that the new measures are implemented and enforced as intended.

Setting **a new collection rate target for portable batteries** requires monitoring the collection rate in Member States. This was set up for the current target of 45% and involved Eurostat collecting information from Member States on a yearly basis. Setting a new target would therefore not entail additional reporting obligations.

Creating **a reporting system for automotive and industrial batteries** requires collecting information that is already generated at national level. Moreover, for automotive and EV batteries, the reporting system could be built on top of the system set up by the End-of-life Vehicles Directive.

The **recycling efficiency** target for lithium batteries is set at 65% starting in 2025. Eurostat has collected data on recycling efficiencies for lead, cadmium and other batteries on a yearly basis since 2014. It would therefore be a minor addition to include the recycling efficiency of lithium to the established data collection procedure.

The obligation to report the **carbon footprint** associated with the overall lifecycle (excluding the use phase) of batteries placed on the market requires developing an IT tool that allows manufacturers to enter the information directly. The Commission intends to offer a web-based tool and free access to the libraries of secondary datasets to facilitate the process of calculating carbon footprint, based on the adopted rules. The data submitted could be used to set benchmarks for GHG emissions, to assess whether bringing in classes of GHG intensity performance would be useful to improve the carbon footprint and environmental performance of batteries and to assess the need for additional incentives and/or market conditionality measures.

Similarly, the obligation to provide information on **performance and durability** should form part of the technical documentation. Depending on the type of battery, this information should also be made available online in a battery database and/or in the battery passport.

The obligation for producers to provide information on the volume of **recycled content** would follow a harmonised methodology.

Provisions on the carbon footprint and recycled content declarations, and on the due diligence policy for the responsible sourcing of raw materials would require **third-party verification**, in principle, via notified bodies.

National market authorities would be responsible for checking the validity of the information provided to fulfil all the obligations in the regulation. The regulatory proposal would include the option for the Commission to carry out additional compliance checks, as it does for type-approval legislation for vehicles.

9.2. What would success look like?

The aim of the monitoring arrangements detailed above is to **collect factual data on the implementation** of the new provisions on batteries. This would help assess whether the new provisions achieve the intended objectives and help identify any unintended consequences.

As part of a future evaluation of the new rules, **the Commission would expect to observe the following improvements as a measure of the success of the new rules**:

- Quality of batteries: increased quality of primary batteries placed on the market;
- Raw materials: better recycling efficiency and better material recovery for nickel, cobalt, lithium and copper (batteries would contain a higher degree of recycled and recovered materials);
- Collection: more portable and industrial batteries collected and recycled at a lower unit cost; light personal transport batteries would also be collected and all industrial batteries would be counted, tracked and reported;
- Recycling: all collected batteries would be recycled. The recycling processes would be highly efficient and pose lower occupational health and safety risks, contributing to supplying materials to the battery industry and reducing the environmental burden of their production from raw materials;
- Information: end users would have better and more accessible information on the batteries they buy: what they are made of, how they will perform (including expected durability) and how their production meets environmental and social standards;
- Health, environmental and social impacts: all industrial batteries would have a calculation of their CO_2 footprint and manufacturers of industrial lithium batteries, except light personal transport batteries, would also provide information on responsible sourcing;
- EU batteries market: battery manufacturers would have a clear and predictable legal framework that supports innovation and competitiveness in a growing market.