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**on the evaluation of the Directive 2006/66/EC on batteries and accumulators and waste
batteries and accumulators and repealing Directive 91/157/EEC**

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ABBREVIATIONS / GLOSSARY

Accumulator	The terms ‘batteries’ and ‘accumulators’ are considered synonyms and used indiscriminately in this report.
ACEA	European Association of Automobile Manufactures
Automotive battery	Any battery used in vehicles as an automotive starter or for lighting or ignition power.
BAT	Best available techniques.
Battery	‘Battery’ or ‘accumulator’ means any source of electrical energy generated by direct conversion of chemical energy. They may be non-rechargeable (primary) or rechargeable (secondary).
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.
Batteries Directive, the Directive, the 2006 Directive	Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (OJ 266, 26.9.2006).
Battery labelling	The Directive requires that all batteries, accumulators and battery packs be appropriately labelled with certain symbols indicating their capacity, the contents of specific hazardous substances and the need for their ‘separate collection’ and separate waste treatment.
Battery removal	Member States must ensure that appliances are designed so that waste batteries can be readily removed by the end-user, or at least by independent qualified professionals.
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.
CLP CLP Regulation	Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures (OJ L 353, 31.12.2008).
Collection	The gathering of waste, including the preliminary sorting and preliminary storage of waste for transporting it to a waste treatment facility. The Batteries Directive requires producers to establish mechanisms for the separate collection of waste portable batteries and automotive batteries used in private vehicles, which are to be accessible and free of charge.
Collection rate	For a given Member State in a given calendar year, the collection rate 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.

EBRA	European Battery Recycling Association
EEB	European Environmental Bureau
Environmental performance	The Directive encourages improvements in the overall environmental performance of batteries and accumulators throughout their entire lifecycle and the development and marketing of batteries and accumulators which contain smaller quantities of dangerous substances or which contain less polluting substances, in particular as substitutes for mercury, cadmium and lead.
ELV	End-of-life vehicle
ELV Directive	Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles (OJ L 269, 21.10.2000).
EoL	End-of-life
EPBA	European Portable Battery Association
EPR	Extended producer responsibility
EUCOBAT	European Compliance Organisation for Batteries (European association of national collection schemes for batteries)
EV	Electric vehicle
EWC	European waste catalogue
Fitness-check	Commission staff working document SWD/2014/0209 final. Ex-post evaluation of five waste stream directives accompanying the proposal for a Directive of the European Parliament and of the Council reviewing the targets in Directives 2008/98/EC on waste, 94/62/EC on packaging and packaging waste, and 1999/31/EC on the landfill of waste, amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EC on waste electrical and electronic equipment.
HTP	Human toxicity potential
Impact assessment	Commission staff working document COM(2003) 723 final. Extended impact assessment of the Directive of the European Parliament and of the Council on batteries and accumulators and spent batteries and accumulators.
Industrial battery	According to the Batteries Directive, an industrial battery (primary or secondary) is exclusively designed for industrial or professional use or for use in any type of electric vehicle. Batteries for e-bikes, and local energy storage systems (e.g. power walls) are included in this category.
LCA	Lifecycle assessment
LFP	Lithium iron phosphate, cathode active materials of some Li-ion batteries

Lithium batteries, lithium-based batteries	Any battery where the generation of electricity is due to chemical reactions involving lithium, lithium ions or lithium compounds.
LFP	Lithium iron phosphate, cathode active materials of some Li-ion batteries
LMO	Lithium manganese oxide, cathode active materials of some Li-ion batteries
LNCA	Lithium nickel cobalt aluminium oxide, cathode active materials of some Li-ion batteries
LNMC	Lithium nickel manganese cobalt oxide, cathode active materials of some Li-ion batteries
LTO	Lithium titanium oxide, cathode active materials of some Li-ion batteries
LoW List of waste	Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (2000/532/EC). OJ L 226, 6.9.2000.
MS	EU Member State(s)
NiCd batteries	Batteries containing nickel and cadmium
NiMH batteries	Batteries containing nickel metal hydride
PoM	Placed on the market
Portable batteries	Any battery, button cell, battery pack or accumulator that is sealed (i.e. closed), that can be hand carried and that is neither an industrial battery or accumulator nor an automotive battery or accumulator.
PRO(s)	Producer responsibility organisation
Producer	Any person in a Member State that places batteries or accumulators, including those incorporated into appliances or vehicles, on the market for the first time within the territory of that MS on a professional basis.
REACH REACH Regulation	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC
RECHARGE	European Association for Advanced Rechargeable Batteries
Recycling	Any operation which reprocesses waste materials into useful products, materials or substances.

Recycling efficiency	A measurement of the amount of material recovered in a recycling process. The 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 established by Commission Regulation (EU) No 493/2012 of 11 June 2012.
RoHS, RoHS Directive	Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (OJ L 174, 1.7.2011).
SLI	Starting, lighting, ignition batteries (also known as automotive batteries)
SME(s)	Small and medium-sized enterprise(s)
WEEE	Waste electric and electronic equipment
WEEE Directive	WEEE Directive: Directive 2012/19/EU on waste electrical and electronic equipment (WEEE).
Waste batteries	Batteries that have reached the end of their service life (end-of-life) and that are to be disposed of (i.e. to be recycled). Also known as spent batteries.
WFD	Waste Framework Directive: Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008).
WShipR	Waste Shipment Regulation: Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190 12.7.2006).
WStatR	Waste Statistics Regulation: Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics (OJ L 332, 9.12.2002).

1. INTRODUCTION

This report has been prepared in accordance with Article 23 of Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (also referred to as the Batteries Directive, the Directive or the 2006 Directive in this document)¹. This article tasks the Commission with reviewing the implementation of the Directive and its impact on the environment and on the functioning of the internal market.

The Directive specifies that the Commission will evaluate:

- the appropriateness of further risk management measures for batteries containing heavy metals;
- the appropriateness of the minimum collection targets for all waste portable batteries;
- the possible introduction of further targets; and
- the appropriateness of recycling efficiency levels set by the Directive.

It also establishes that — if necessary — proposals for the revision of the relevant provisions of the Directive should be made. The 2006 Directive has already been amended several times².

The evaluation of the Directive has followed the European Commission's better regulation guidelines. Independent consultants have in addition supported the assessment of the information collected³. The general public, industry stakeholders and representatives of national administrations have participated in this process. The evaluation has addressed the usual evaluation criteria of relevance, effectiveness, efficiency, consistency and EU added value along with the topics requested by its Article, mentioned above.

Certain aspects of the Batteries Directive were evaluated in 2014 together with some waste stream Directives (the 'fitness-check')⁴. The results of this fitness-check are one of the inputs for this evaluation, since it already addressed some of the issues identified by stakeholders. However, the current evaluation is more comprehensive in scope. It considers aspects that were not previously addressed and uses more complete and recent information.

¹ The consolidated version is available at:

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02006L0066-20180704>

² 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).

³ Trinomics, (2017), '[Study in support of the preparation of the implementation report on Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators](#)'

H Stahl et al., (2018) '[Study in support of evaluation of the Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators](#)'.

⁴ CSWD/2014/0209, at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2014:0209:FIN>

The strategic action plan on batteries agreed by the European Commission⁵ highlights the importance of this evaluation for ensuring that the EU regulatory framework for batteries is future-proof and innovative.

2. BACKGROUND TO THE INTERVENTION

2.1. The logic of the action⁶

The Batteries Directive is the only piece of EU legislation that is entirely dedicated to batteries. Its provisions address the lifecycle of batteries, i.e. design, placing on the market, end-of-life, collection, treatment and the recycling of spent batteries. It defines objectives, sets targets⁷ and outputs, identifies measures to meet them and establishes additional provisions to enable and complete these key requirements (see the diagram of the intervention logic in Annex B).

The Directive applies to all batteries and classifies them according to their use. Classes of battery include:

- portable batteries (e.g. for laptops, or smartphones or typical cylindrical AAA or AA-size batteries);
- automotive batteries (e.g. for starting a car's engine or powering its lighting system) excluding traction batteries for electric cars; and
- industrial batteries (e.g. for energy storage or for mobilising vehicles such as fully electric vehicles or electric bikes)⁸.

The Directive's primary objective 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. It also aims to ensure the smooth functioning of the internal market and avoid the distortion of competition within the EU (See Objectives 1, 3 and 4 in the intervention logic in Annex B).

The Directive links the environmental impacts of batteries to the materials they contain⁹. Due to the presence of hazardous components, in particular mercury, cadmium and lead, the mismanagement of batteries at the end of their life is the key concern. Batteries are not a particular environmental risk when they are safely used or stored, but if spent batteries are landfilled, incinerated or improperly disposed of at the end of their life, the substances they contain risk entering the environment, affecting its quality and affecting human health.

⁵ Annex 2 to COM(2018) 293 final.

⁶ In addition to the Directive itself, see Section 2.2 of the supporting study.

⁷ In this document, 'objective' means general or aspirational goals to be achieved in the medium or long term; 'target' means concrete goals that will be considered met when parameters defined in the Directive reach pre-established values.

⁸ Directive 2006/66/EC, Article 3.

⁹ See page 7 of the Impact Assessment, CSWD SEC(2003) 1343.

The Directive does not address negative externalities affecting the environment, for example, resulting from the massive extraction of raw materials, or from energy and water extensive recycling processes.

The Directive addresses the risks in two ways:

- 1) by reducing the presence of hazardous components in batteries; and
- 2) by establishing measures to ensure the proper management of waste batteries.

The total prohibition of batteries containing mercury¹⁰ and, partially, of those containing cadmium, is the most effective way of reducing hazardous components. As such, this measure for regulating the placing of batteries on the market is in line with the Directive's objectives to ensure the smooth functioning of the internal market and to avoid the distortion of competition within the EU (Objectives 2 and 5 in the intervention logic in Annex B).

The Directive's labelling requirements¹¹ also intend to harmonise market requirements for batteries (see Objective 5 in the intervention logic in Annex B).

The Directive requires Member States to ensure that appropriate collection schemes are in place for waste portable batteries¹² and sets targets for the collection rates¹³ (25 % in weight of the amount placed on the market by September 2012 and 45 % by September 2016). It also requires Member States to set up collection schemes for waste automotive batteries¹⁴ and to ensure that producers of industrial batteries do not refuse to take back waste industrial batteries from end-users¹⁵. (See measures for Objectives 1, 3 and 4 in the intervention logic in Annex B).

All spent batteries collected must undergo treatment and recycling¹⁶. In this regard, the Directive establishes minimum levels of recycling efficiency¹⁷ and the general obligation to recycle lead and cadmium to the highest degree¹⁸, and requests that all processes concerned comply with relevant EU legislation¹⁹. (See Objective 3 of the intervention logic in Annex A.)

Member States have to monitor collection rates and recycling efficiencies and submit relevant data to the Commission. (See measures for Objectives 2 and 5 in the intervention logic in Annex A.)

¹⁰ Article 4.

¹¹ Articles 20 and 21.

¹² Article 8.1.

¹³ Article 10.

¹⁴ Article 8.4.

¹⁵ Article 8.3.

¹⁶ Article 12.1.b.

¹⁷ Annex III, part B.

¹⁸ Directive 2006/66/EC, Annex III.

¹⁹ Article 12.1.b.

The Directive's overarching objective²⁰ is that Member States take the necessary measures to maximise the separate collection of waste batteries and to minimise the disposal of batteries as mixed municipal waste. However, there is no target or monitoring obligation linked to this objective.

The Directive also seeks to improve the environmental performance of batteries and the activities of everyone involved in their lifecycle²¹, e.g. producers, distributors and end-users, particularly those directly involved in treating and recycling waste batteries. The Directive does not establish any concrete targets for this but it mentions promoting research. (See Objective 4 in the diagram.)

Provisions on extended responsibility²² give producers of batteries and producers of other products that incorporate batteries the responsibility for the end-of-life management of the batteries they place on the market. (See measures for Objectives 2 and 5 in the Diagram in annex A). The Directive specifies the national schemes²³ tasks and objectives, including financial aspects²⁴.

Producers must therefore fund the net costs of collecting, treating and recycling all waste portable batteries and all waste industrial and automotive batteries as well as any public information campaigns on the topic.

2.2. Antecedents

The 2006 Directive builds on the objectives established in the previous Battery Directive²⁵, namely to approximate the laws of the Member States on the recovery and controlled disposal of batteries containing lead, mercury and cadmium. The Directive also intended to help improve waste management in general, which at that time was recognised as a significant environmental challenge at EU²⁶ and international²⁷ level.

The extended impact assessment for the 2006 Directive highlights the importance of the Communications on Waste²⁸ and on Integrated Product Policy²⁹ for preparing the Directive. It also underlines the links with other legislation on specific waste streams (Directives on packaging and packaging waste³⁰, on end-of-life vehicles (ELV)³¹, on

²⁰ Article 7.

²¹ Article 1.

²² Recital 19.

²³ Article 8.

²⁴ Article 16.

²⁵ Directive 91/157/EEC, OJ L 078, 26/03/1991.

²⁶ 6th Environmental Action Programme, OJ L242/1 10.9.2002.

²⁷ e.g. Implementation plan of the World Summit on Sustainable Development (Johannesburg 2002).

²⁸ Communication from the Commission 'Towards a thematic strategy on the prevention and recycling of waste,' COM(2003) 301 final.

²⁹ Communication from the Commission 'Integrated Product Policy', COM(2003) 302 final.

³⁰ Directive 94/62/EC, OJ L 365, 31/12/1994.

³¹ Directive 2000/53/EC, OJ L 269, 21.10.2000.

waste electrical and electronic equipment³² and on restrictions of hazardous substance in electrical and electronic equipment (RoHS Directive³³)).

The proposal for the 2006 Directive took into consideration that the legal instruments in force at the time aimed to reduce or phase-out certain heavy metals in products. This was the case of the RoHS Directive, which phased-out cadmium and lead in electrical and electronic equipment. Likewise, the ELV Directive prohibited the use of mercury, lead, hexavalent chromium and cadmium in automotive batteries and included a mechanism to decide on possible exemptions. Neither these or similar requirements were included in the 2006 Directive.

2.3. Baseline

The impact assessment accompanying the proposal for the 2006 Directive described the expected effect of the proposal's measures compared to the situation at the time. However, as it only provided a qualitative description of the initial and expected conditions it does not allow any detailed judgement on the changes that could have occurred since the Directive's adoption.

Therefore, the assessment of the Directive's actual impact must be based on the analysis of the compliance with the objectives and targets established by the Directive.

3. IMPLEMENTATION AND CURRENT SITUATION

3.1. Levels of compliance³⁴

In 2012, the final year of the first reporting period, 20 Member States had achieved the 2012 target for **collection rates** of portable batteries, set at 25 %. At the end of the period covered by the second implementation report which corresponded to the 2014 collection exercise, most Member States had met or exceeded the target (see table below).

Table 1 EU and Member States collection rates in 2014, 2015 and 2016³⁵

	2014	2015	2016
<i>EU</i>	39.4	41	43.8
Croatia	19	29.3	100.2
Belgium	54.6	55.6	70.7
Luxembourg	65	60.2	63.4
Hungary	37	43.7	53.1
Lithuania	32.8	42.5	52.7
Czech Republic	31.5	36.3	52

³² Directive 2002/96/EC, OJ L 037, 13/02/2003.

³³ Directive 2002/96/EC, OJ L37, 13.2.2003.

³⁴ In addition to the specific sources mentioned in the text, see Sections 5.3 and 12.3 of the supporting study.

³⁵ Data from Eurostat, <https://ec.europa.eu/eurostat/web/waste/data/database>, accessed on 13 October 2018, ordered.

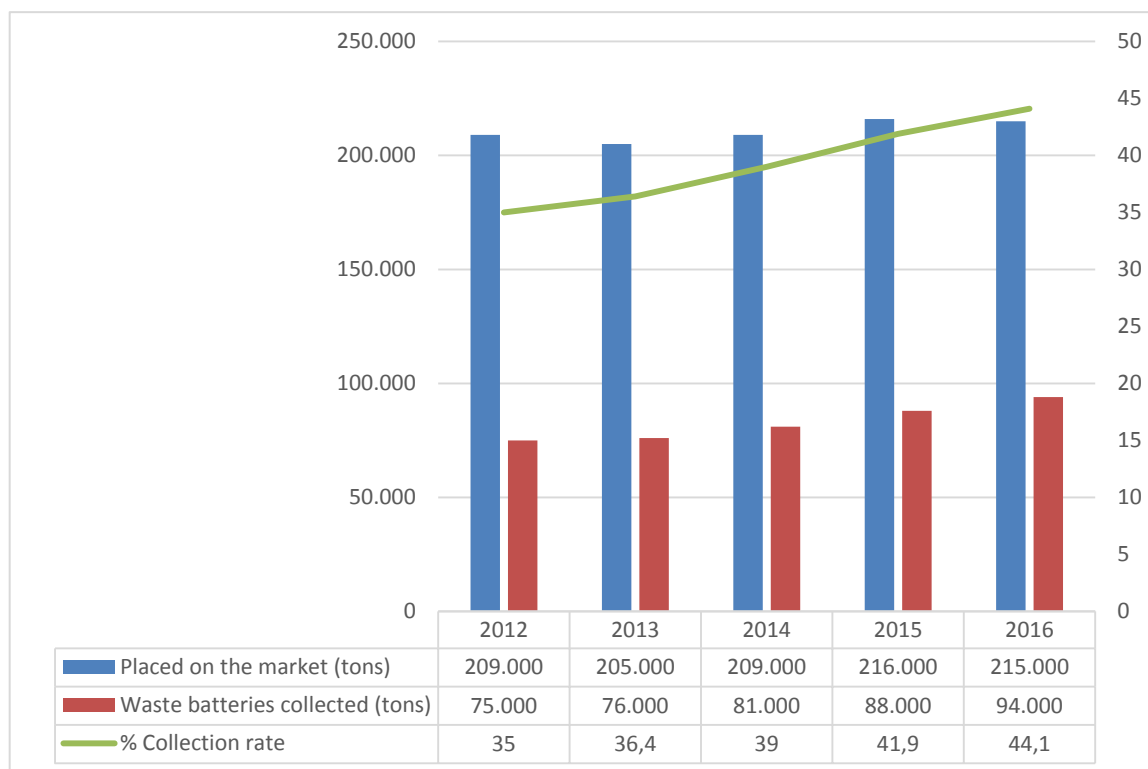
	2014	2015	2016
Austria	53.8	55.1	49.2
Netherlands	45	46	49
Bulgaria	45.3	44.6	48.5
Ireland	32.6	33.2	48
Slovakia	66	53	47.6
Germany	44.2	45.3	46.2
Finland	46	47	46
Sweden	59	61	45.1
Denmark	44.3	45.6	44.6
France	36.8	38.5	44.5
UK	36		44
Portugal	28	31.1	41.6
Poland	33	38	39
Spain	36.4	414	38.2
Slovenia	29	35	36
Italy	34.1	36.4	35.3
Estonia	22.2	41.9	30.6
Latvia	28.4	25	30
Cyprus	19	27	28
Malta	21.3	39.4	27.2
Greece		34.4	
Romania	31.9	20.6	

14 Member States have met the 2016 collection target of 45 %.

The collection-rate trend for the EU in 2012-2016 shows that:

- The amount of batteries placed on the market has increased.
- The amount of waste batteries collected has increased even further, but at a higher rate than the amount of batteries placed on the market.
- Considering the amount of portable batteries placed on the market and of waste batteries collected for the EU as a whole, the collection rate met the Directive's 2012 target (25 %) but not the 2016 target (45 %). Too many waste portable batteries still end up in the wrong waste stream (e.g. municipal waste) and are lost.

Figure 1 Collection rates of waste portable batteries for the EU³⁶



On the **level of recycling**, i.e. whether all collected waste batteries are effectively recycled, according to information provided by Member States, the vast majority of waste batteries collected in the EU are recycled as required by the Directive.

Most Member States met the Directive's **recycling efficiencies** targets. The recycling efficiency for lead-acid batteries was met in almost all Member States, although data are missing in some cases. Data gaps are more frequent for nickel-cadmium and ‘other’ batteries, although the targets for these were also met.

Table 2 Recycling efficiencies reported by Member States in 2014, 2015 and 2016³⁷

	Lead (65 %)			Nickel Cadmium (75 %)			Other (50 %)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Belgium	77.8	80.9	82.2	77	81.6	81.9	54.6	63.4	72.9
Bulgaria	97.8	97.8	98.1	77.7		0	70.9	68.9	68
Czech Republic	65.8	73.5	80.4	94.7	94.6	94.6	58.6	60.4	58.5
Denmark	99.9	80	80.1	83.1	78.9	82.2	57.4	59.3	56.7

³⁶ Developed with Eurostat data, <https://ec.europa.eu/eurostat/web/waste/data/database>, accessed on 13 October 2018.

³⁷ EUROSTAT data, <https://ec.europa.eu/eurostat/web/waste/data/database>, accessed on 13 October 2018.

	Lead (65 %)			Nickel Cadmium (75 %)			Other (50 %)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Germany	82.5	85.1	84.7	80.7	78.5	79	67.3	76.3	77.1
Estonia	80	79.2	79.1		0	80	52.2	54.3	74.1
Ireland	85.9	90	85.7	78.5	78.5	85	77.6	83.4	57
Greece		74.8							
Spain	80	81.5	73.2		78.6			80.4	85.6
France	84.9	81.8	81.4	77.6	80.9	81	58.3	64.1	60.9
Croatia	76.1	76.6	81.9	66.7	74.6	69.9	66.2	66.6	80.7
Italy	89.6	91.4	91	79.1	78.3	79.2	59.8	60	62
Cyprus	84.4	70.4		77.8	75.6		51.1	62.5	
Latvia	66	70	70	76	76	76	51	52	52
Lithuania	4.7	17.8	82.1			76.2			56.6
Luxembourg	83.7	90	92	77.7	80.6	80.3	56.1	58.9	58.4
Hungary	97.8	91.2	94.7	85.8	0	75	62.9	60.2	97.7
Malta		78.9			0			0	
Netherlands	79	78		78	79		56	56	
Austria	84	84.5	84.7	77	81.6	81.9	59.6	82.2	85.7
Poland	77.3	76.5	76.5	85.5	99.5	99.6	56.7	67.4	63.9
Portugal	73.2	70.5	71.1		94.2	76.8		81.4	84.1
Romania	82.5	81.7			85.3				
Slovenia	75.9	77.3	77.1	78.4	78.4				
Slovakia	87.3	92.3	90.5	76.4	80.2	80.9	63.9	61.1	65.3
Finland	81.8	82.9	83.1	79.8	79.7	78.8	93.9	96	95.9
Sweden	75.2	74.2	73.7	75.4	76.5	76.8	40	67.4	67.4
United Kingdom	88.5		89.7	0			88.4		85.6

The Directive establishes that, in addition to meeting the specified minimum values for efficiencies, recycling processes should recover the **metal content** ‘to the highest degree that is technically feasible while avoiding excessive costs’ for lead and cadmium. No other heavy metals are considered. No details are given, and no target has been set for this.

According to Eurostat data, for the 2016 exercise (see Table 3 below), 21 Member States reported rates of recycled lead content between 90 % and 100 %, two reported lower rates and five did not submit data. For cadmium, 12 Member States reported rates of recycled content between 90 % and 100 %, six reported lower rates (including two ‘0’ values) and 10 did not submit data.

It is unclear whether a lack of submission of relevant data indicates that there are no recycling activities in those Member States or that they have difficulties in collecting the appropriate information. Given the difference in values reported (including ‘0’ values in

red in the table), we can conclude that the methodology for calculating the degree of metal recovery is not the same or is not applied in the same way in all Member States.

Table 3 Degree of recovery of metal content in 2014, 2015 and 2016³⁸

	Lead content			Cadmium content		
	2014	2015	2016	2014	2015	2016
Belgium	98.6	98	98.4	100	100	100
Bulgaria	69.8	69.3	65			0
Czech Republic	98.7	98.1	98.5	98.8	98.5	98.5
Denmark						
Germany	97	98.6	99.5	100	100	100
Estonia	99.6	99	99.8		0	100
Ireland	99.8	99.8	100	100	100	100
Greece		88.8				
Spain	99.6		97			
France	98.9	99	99			
Croatia	98.1	98.4	99.1	0	100	100
Italy	97.1	97.1	98.4			
Cyprus	95.9	97.5	93.2	98.8	100	
Latvia	90	90	90	85	85	84.7
Lithuania		14.2	96			98.3
Luxembourg	83.7	90	94.4	77.7	80.6	42.2
Hungary	85	87.2		82.6	0	
Malta	0	90.9		0	0	0
Netherlands	75.1	73	76.2	77.6	78	80.8
Austria	96.8	96.8	96.7	100	100	100
Poland	95.7	96.9	96.9	100	100	100
Portugal	98.2	98.6	98.7		100	100
Romania	87.9	87.8			100	
Slovenia	98	98	98	100	100	
Slovakia	95	98	97	51	46.7	50
Finland	96	96.8	96.8	100	100	100
Sweden	96.8	97.1	97.3	100	100	100
United Kingdom	97.1	97.8	96.6	0	0	

³⁸ EUROSTAT data, <https://ec.europa.eu/eurostat/web/waste/data/database>, accessed on 13 October 2018.

3.2. Current situation

3.2.1. EU manufacturers³⁹

The EU industry manufactures 15 % of the global production of lead-acid batteries, a similar percentage to the EU contribution to the global GDP (16–17 %). The EU is a net exporter of this type of battery. The volume of NiCd (nickel-cadmium), NiMH (nickel metal hydride) and lithium-based batteries manufactured in the EU is around 5 % of the global output, which is lower than the EU's share of global gross national product (GNP). The EU is a net importer of NiCd, NiMH and lithium-based batteries.

Table 4 Battery production (EU-28), import and export values by 2016, million €

	Production	Import million €	Export million €
Lead-acid batteries	5 141	1 346	1 452
Primary cells and primary batteries	812	763	354
Nickel cadmium, nickel metal hydride, lithium-ion, lithium polymer, nickel iron and other batteries	1 083	3 418	738
Total	7 037	5 526	2 545

The import-export imbalances noted are presumed to be understated, as production statistics do not consider the quantities of batteries incorporated into exported and imported products: the EU is a net exporter of vehicles (including lead-acid batteries) and a net importer of consumer electronics (which also incorporate batteries).

The EU however produces battery packs for the electric vehicles industry⁴⁰ for which it uses cells imported mainly from East Asia. There are policy initiatives at EU level to strengthen the EU production capabilities in this area⁴¹.

³⁹ In addition to the specific sources mentioned in the text, see Sections 5.2.1 and 12.2.2 of the supporting study.

⁴⁰ See in this respect JRC (2017) 'Lithium ion battery value chain and related opportunities for Europe'.

⁴¹ EBA, https://ec.europa.eu/growth/industry/policy/european-battery-alliance_en.

3.2.2. Markets⁴²

All available information and data led to the prediction that the number of batteries placed on the EU market will sharply increase in coming years. On average, the worldwide battery market increased by 9 % per year between 2010 and 2017⁴³.

Some global trends explain the growing dynamics of the battery market⁴⁴, namely:

- The additional demands for **mobility and energy** due to the increased global population, particularly the large and increasing part of the population living in cities.
- The shift in the **production, consumption and distribution of energy from renewable sources**.
 - For example, despite the small quantities of electric vehicles in the EU fleet (about 321 000 in 2017) and their small market share (about 1.5 % of new registered passenger vehicles), their registration numbers have increased steadily over the last few years, and the sales of battery electric vehicles in the EU increased by 51 % between 2016 and 2017⁴⁵.
 - The future use of batteries as energy storage systems has been thoroughly analysed for different scenarios⁴⁶. It is estimated that by 2020, the total battery storage capacity in the EU will be between 7 600 MW and 9 800 MW, and that by 2025 this capacity will increase to between 11 500 MW and 14 500 MW. Most of the increase in capacity is likely to occur after 2025.
 - Globally, 96 % of the storage capacity is based on pumped hydro storage (PHS)⁴⁷. More than 70 % of new installations completed in 2014 were PHS. Other technologies, like thermal energy storage, large-scale batteries, flywheels, and compressed air energy storage are the main components of the non-PHS energy storage capacity. Lithium-ion batteries in particular are considered the main future storage technology due ‘to cost reductions and rapid scale-up of manufacturing capacities.’⁴⁸

⁴² In addition to the specific sources mentioned in the text, see Sections 5.1.2 and 5.1.5 of the supporting study.

⁴³ Avicenne (2018) ‘The Rechargeable Battery Market and Main Trends 2017–2025’.

⁴⁴ Avicenne (2017) ‘The Worldwide rechargeable Battery Market 2016–2025’.

⁴⁵ Electric vehicles as a proportion of the total fleet, indicator prepared by the EEA, at: <https://www.eea.europa.eu/data-and-maps/indicators/proportion-of-vehicle-fleet-meeting-4/assessment-2>

⁴⁶ Figures taken from the EC-funded project ‘BATSTORM, Battery-based energy storage roadmap’. http://www.batstorm-project.eu/sites/default/files/BATSTORM_D7_%20SocioEconomicAnalysis_Final.pdf

⁴⁷ EASE EERA (2017) ‘Storage Technology Development Roadmap 2017 HR,’ at: <http://ease-storage.eu/wp-content/uploads/2017/10/EASE-EERA-Storage-Technology-Development-Roadmap-2017-HR.pdf>

⁴⁸ IEA (2017), ‘Tracking Clean Energy Progress 2017’.

For all scenarios, less than 30 % of this storage comes from pumped hydro and roughly 70 % from stationary batteries⁴⁹.

- The increased use of **mobile connected devices**: their number could be more than three times the global population by 2021⁵⁰. In 2011–2020, global sales of batteries for notebooks, smartphones and tablets would increase respectively by 200 %, 160 % and 550 %⁵¹. In 2015, consumer electronics was the biggest sector (50 %) of the lithium batteries global market⁵². Regarding the use of cobalt in batteries, consumer electronics represented 39% of the cobalt market in 2016, with batteries representing 44% of the overall group of cobalt applications.⁵³

3.2.3. Mass flows⁵⁴

The below diagram summarises the mass flows of batteries within the EU. In 2015, around 1.8 million tonnes of batteries was placed on the EU market, of which approximately 1.10 million tonnes were automotive batteries (61 % of the weight of all batteries) 490 000 tonnes were industrial batteries (27 %) and 212 000 tonnes were portable batteries (12 %)⁵⁵. In the EU and globally the lead-acid technology prevails. Lead-acid batteries will still have the biggest market share in 2025 in terms of volume, but from 2018, the lithium market will be higher in terms of value⁵⁶.

Batteries used for starting and lighting vehicles (automotive batteries) are currently mostly lead-acid as, so far, no other chemistries are relevant on the EU market. However, while a tiny proportion of vehicles (0.001 % of the vehicle fleet) use this application, some manufacturers are equipping their high-end models with 48 volt Li-ion batteries, instead of 12 lead-acid ones⁵⁷.

<https://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2017.pdf>.

⁴⁹ Taken from the document ‘In-depth analysis in support of the commission communication com(2018) 773’.

⁵⁰ CISCO (2017) ‘The Zettabyte Era: Trends and Analysis’.

⁵¹ Avicenne (2018).

⁵² Avicenne (2017).

⁵³ Bloomberg. (2018, March 08) ‘Impacts from the surge in lithium and cobalt prices.’ Webinar delivered in 08 March 2018.

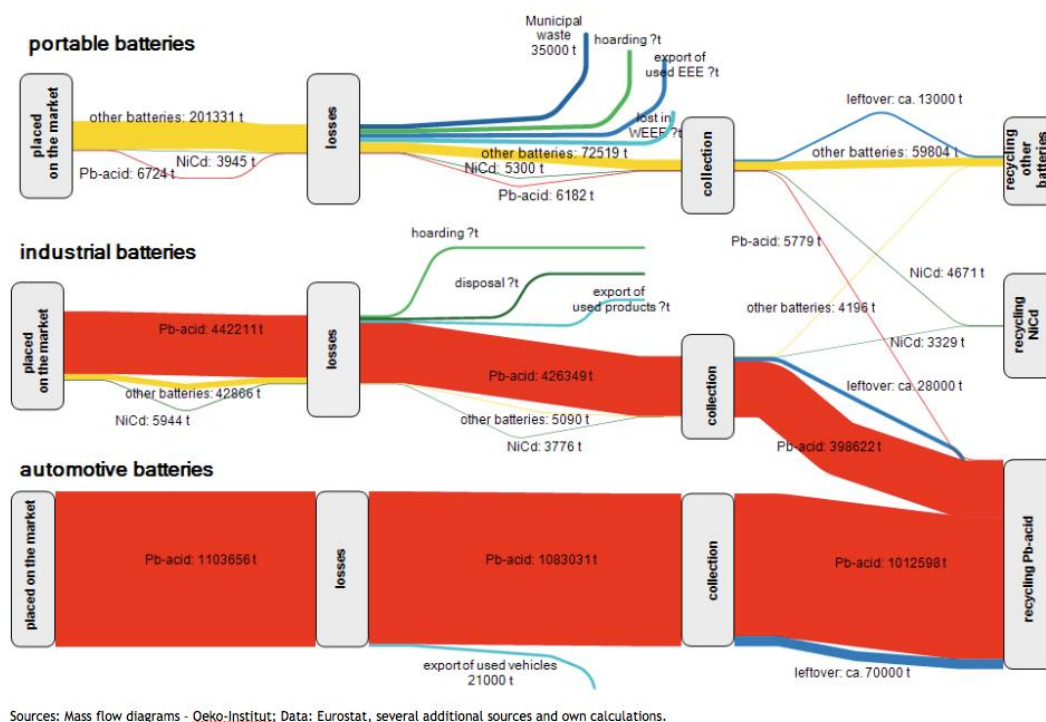
⁵⁴ In addition to the specific sources mentioned in the text, see Sections 5.1.1 and 12.1.1 of the supporting study.

⁵⁵ Study in support of the Evaluation, p 33.

⁵⁶ Avicenne (2018).

⁵⁷ <https://www.greencarcongress.com/2017/07/20170719-sclass.html>

Figure 2 Mass flows of different types of batteries within the EU⁵⁸



The amounts of portable lead-acid (6 700 tonnes) and nickel-cadmium (almost 4 000 tonnes) batteries are proportionally rather small. An overwhelming 95 % of all portable batteries, i.e. 201 000 tonnes, are classified as ‘other’ batteries.

Data reported to Eurostat indicate a decrease of NiCd batteries in the EU⁵⁹. This trend could continue — possibly at an even faster pace — of since the derogation that allowed the use of NiCd batteries in cordless-power tools expired in December 2016.

The number of lithium batteries placed on the EU market per category set out in the Directive, is presented in Table 5 below.

Table 5 Use of lithium batteries placed on the EU market (tonnes)

Uses of Li batteries	
portable batteries	36 950
mobile phones	4 700
portable PC / tablets	24 000
power tools	3 100
other consumer	5 150
industrial batteries	37 956

⁵⁸ The flow diagram for industrial and automotive is based on real data for the ‘placed on the market’ category only while ‘recycled’ data is not available and thus assumptions are made and shown. Section 12.1 of the supporting study presents the method applied.

⁵⁹ <https://ec.europa.eu/eurostat/web/waste/key-waste-streams/batteries>

E-bikes	4 142
electric vehicles (BEV, PHEV)	30 448
electrical energy storage / other	3 366
Total	74 906

Four main chemistries are currently relevant for industrial batteries: lead-acid; Li-ion; NiCd and NiMH. All mobility and transport applications together account for about half of all industrial applications: about 8 % are used for electric cars, hybrid cars and e-bikes; 27 % for forklifts and similar applications; 11 % for railway vehicles and about 5 % for other transport applications. The other half are applications related to power supply: e.g. 30 % are used for uninterruptible power supply (UPS); 8 % for back-up — emergency power supply and 6 % for emergency lighting⁶⁰.

On the use of batteries in electric cars within the EU, it is estimated that there will be 2 million electric and plug-in hybrid vehicles on the road in 2020 (3 % of the fleet) and 28 million in 2030 (31 % of the fleet)⁶¹.

3.2.4. Environmental impacts of batteries⁶²

Batteries can have an impact on the environment and on human health throughout their lifecycle: from the extraction of battery resource materials to the recycling of waste batteries. The particular impacts vary between the different chemistries listed above.

As indicated by the fitness-check, the Directive does not address all environmental impacts and risks of the different stages in a battery's lifecycle. The impact assessment made it clear that the management of chemicals used in batteries falls within the remit of specialised legislation, apart from the ban on using mercury and cadmium.

Some aspects of the placement on the market and end-of-life stages are specifically covered in the Directive while others are considered to fall under other sectoral legislation.

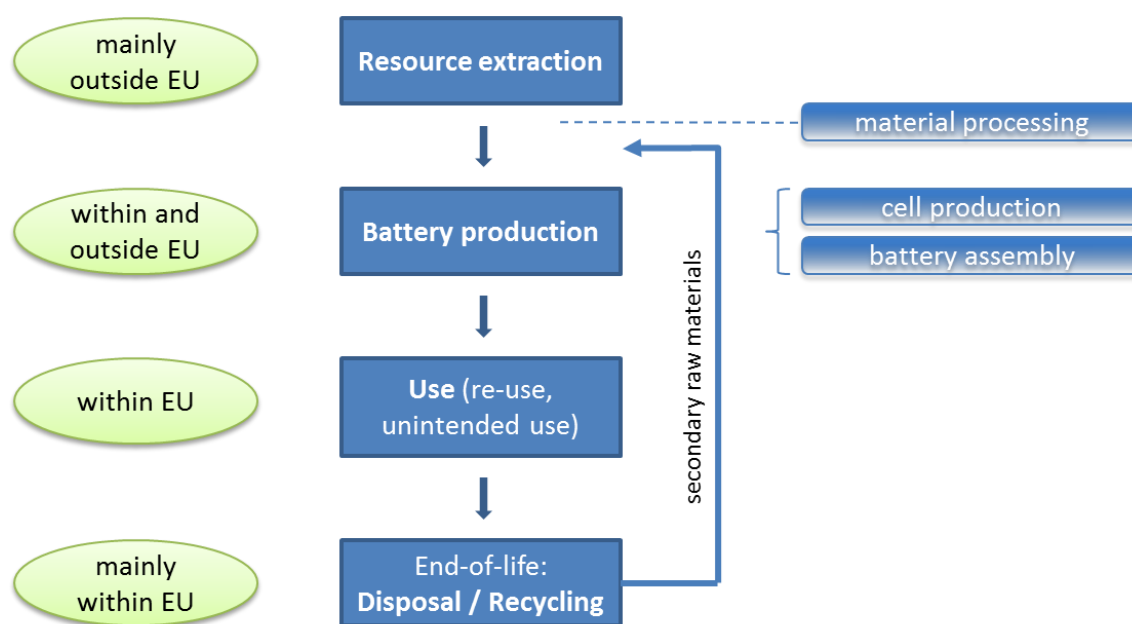
A flowchart of a battery's life cycle showing the stages at which its environmental impacts are analysed is presented in Figure 3 below.

⁶⁰ Applications for industrial batteries are based on data for the reference year 2010 in Germany (GRS 2012). 2015 data on electric cars, hybrid cars and e-bikes were added (KBA 2015, Statista 2015).

⁶¹ Engle, H. et al. (2018) 'Charging ahead: Electric-vehicle infrastructure demand'.
<https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/charging-ahead-understanding-the-electric-vehicle-infrastructure-challenge>

⁶² In addition to the specific sources mentioned in the text, see Sections 5.4.2 and 12.4.2 of the supporting study.

Figure 3 Main stages in the battery life cycle



3.2.4.1. *Extracting activities*

Extracting activities are responsible for most — but not all — virgin materials used in batteries, especially for metals like lead, lithium or cobalt. These activities are often associated with very negative environmental impacts depending on the material extracted, the site and the technology applied. There can be emissions of hazardous substances from extractive facilities (e.g. pyrometallurgical or hydrometallurgical processes) during the production stage.

The Commission considers some of the materials needed to manufacture batteries to be ‘critical’ (e.g. cobalt or natural graphite)⁶³ as they are very important to the EU economy and carry risks if supplies run low.

In the specific case of cobalt, overall demand might increase 3.7-fold between 2017 and 2030 driven by the expansion of electric-vehicle markets globally and in the EU. The structure of cobalt supply is highly prone to disruptions, which will likely persist in the future, despite an expected decrease in the concentration of supply and risk of disruptions beyond 2020 and until 2030.

The mining of most materials needed to manufacture cells and batteries takes place outside the EU. Within the EU, only the production of lead reaches a significant volume. Several pieces of EU environmental legislation apply to the impact of extractive

⁶³ ‘Study on the review of the list of critical raw materials’, European Commission report. 2017 <https://publications.europa.eu/en/publication-detail/-/publication/08fdab5f-9766-11e7-b92d-01aa75ed71a1/language-en>.

activities in the EU, such as the Extractive Waste Directive⁶⁴ or the Water Framework Directive⁶⁵.

Table 6 EU production of minerals for battery manufacturing

	Lead, tonnes (metal content)	Lithium minerals, tonnes	Cobalt, tonnes (metal content)	Manganese ore, tonnes
Bulgaria	15 600			75 000
Finland			2 104	
Greece	16 700			
Hungary				51 000
Ireland	40 500			
Macedonia	43 810			
Montenegro	2 755			
Poland	83 150			
Portugal	3 192	17 459		
Romania				12 662
Slovakia	162			
Spain	1 200			
Sweden	70 848			
UK	100			
Total	343 907	17 459	2 104	458 662

3.2.4.2. *Manufacturing*

Manufacturing and assembly require developed technologies that only few countries can provide⁶⁶ and one can presume that legal provisions on environmental protection and occupational safety are generally applied in these countries⁶⁷.

⁶⁴ Directive 2006/21/EC, OJ L 102, 11.4.2006.

⁶⁵ Directive 2000/60/EC, OJ L 327, 22.12.2000.

⁶⁶ The production of Li-ion batteries, in particular, usually takes place in a protective atmosphere since materials and compounds are sensitive to oxygen and moisture present in uncontrolled environments.

⁶⁷ <http://eippcb.jrc.ec.europa.eu/reference/nfm.html>

In the EU, emissions of hazardous substances are not considered significant as the relevant legal provisions are assumed to be applied. There are several pieces of EU legislation dealing with the impact of manufacturing activities, notably the Industrial Emissions Directive⁶⁸, which has allowed specific best available technologies⁶⁹ to be defined for smelting activities involving lead batteries.

The EU is a net exporter of lead-acid batteries and has a significant role in assembling lithium batteries. However, lithium cells are manufactured mainly outside the EU, with a few exceptions.

3.2.4.3. *Use phase*

During the **use phase** of a battery, barring accidents, only the electricity demand for recharging secondary batteries is relevant. An appropriate assessment of the use phase should also consider the whole product using the battery (e.g. an electric car).

Accidents can destroy the physical integrity of batteries during the use phase leading to potentially hazardous releases, but it is difficult to assess the possible impact. Electrolyte leaks can also have a negative impact.

3.2.4.4. *End-of-life: collection*⁷⁰

Battery waste in the EU rose by 29 % between 2004 and 2014⁷¹. In 2015, according to data reported to the Commission, 45.3 % of **waste portable batteries**, equivalent to 128 000 tonnes in EU-27, were not collected⁷². Based on the waste analysis of seven Member States⁷³ and on other sources, an estimated 35 000 tonnes of waste portable batteries were disposed of as a part of municipal waste. This quantity is equivalent to 27 % of all non-collected waste batteries, to 41 % of the weight of collected waste batteries and to 16 % of the total weight of waste portable batteries placed on the market in the EU-28. If data from other countries with low collection rates and large populations were included, the estimate would be even higher.

The Batteries Directive does not set targets for the collection of waste **industrial or automotive batteries**. While it has been assumed that the rate of collection is high due to their economic value⁷⁴ there is no evidence to support such an assumption. The lack of obligation for Member States to compile and report data on the collection of these batteries makes assessing the situation difficult.

Estimates of losses of **automotive batteries** differ considerably depending on the methodology applied for the collection of information or for the calculation of relevant

⁶⁸ Directive 2010/75/EU, OJ L 334, 17.12.2010.

⁶⁹ <http://eippcb.jrc.ec.europa.eu/reference/nfm.html>

⁷⁰ In addition to the specific sources mentioned in the text, see Section 12.3 of the supporting study.

⁷¹ <https://ec.europa.eu/eurostat/web/waste/data/database>

⁷² On compliance with the targets established by the Directive see Section 5.2 on efficiency.

⁷³ Austria, Belgium, Germany, Denmark, Ireland, Luxembourg and Netherlands.

⁷⁴ Frequently Asked Questions on Directive 2006/66/EU on Batteries and Accumulators (European Commission 2014).

rates. According to the figures disclosed by producers and manufacturers of automotive batteries and vehicles, the ‘collection and recycling rate’ is 99 %⁷⁵. This figure does not seem to incorporate losses due to e.g. exports of used vehicles. There are around four million ‘vehicles of unknown whereabouts’⁷⁶ including unreported exports or illegal scrapping.

Eurostat datasets on waste management operations of end-of-life vehicles are not complete⁷⁷. However, according to the reported data, 'recovery and re-use' accounts for 93.4 % of automotive batteries and 'recycling and re-use' for 87.1 %. Adopting a conservative approach would result in around 2-4 % of the total being lost every year ().

Analyses of the available data for **industrial batteries** reveal differences between the amount of industrial batteries placed on the market and the amount of waste batteries collected⁷⁸. Around 56 000 tonnes (11 %) of industrial batteries placed on the market are not collected, and hence could be lost.

3.2.4.5. *End-of-life: recycling*

The Directive is the only piece of EU legislation that deals with the recycling of batteries. **Recycling** of end-of-life waste batteries is an important stage from an environmental perspective and there could be a significant negative impact if it is not properly carried out. The emissions generated by producing the energy required with the usual pyrometallurgical processes could contribute to global warming. The emissions from smelting or hydrometallurgical processes may directly affect environment acidification potential or increase eutrophication potential.

Recycling facilities in the EU process thousands of tonnes of waste batteries every year. For EV batteries, the EU already holds sufficient recycling infrastructure to enable the recycling of around 160 000 EV battery units. With a large share of recycling capacity located in Europe, it is likely that in the future EU recycling facilities expand their processing capacities and attract significant volumes from abroad⁷⁹.

Secondary materials — mostly metals — are recovered. It is generally recognised that producing these secondary raw materials through recycling is less harmful to the environment than producing the same materials through extracting activities (Recharge 2018). Replacing primary materials with secondary recycled materials could help offset the environmental impact of different stages in a battery's life cycle.

Recycling together with substitution efforts could reduce by 29 % the demand of cobalt for EV batteries between 2020 and 2030 and can improve the stability of raw materials

⁷⁵ ACEA, JAMA, KAMA, EUROBAT and ILA (2016) ‘Position on Lead-based batteries and Exemption 5 of the EU End of Vehicle Life Directive’.

⁷⁶ Mehlhart 2017.

⁷⁷ <https://ec.europa.eu/eurostat/web/waste/key-waste-streams/elvs>

⁷⁸ See discussion in Section 12.3 of the supporting study.

⁷⁹ Alves Dias P., et., al., Cobalt: demand - supply balances in the transition to electric mobility, EUR 29381 EN, Publications Office of the European Union, Luxembourg, 2018

supply. However, although the EU capacity to meet the rising internal demand is projected to increase, the gap between endogenous supply and demand is widening.

The technology of the recycling processes, the performance of individual plants and the chemistry of the recycled batteries will determine the environmental impact of the activities concerned.

- For lead-acid batteries, some estimates indicate that recycling and re-use under integrated recycling processes lower the ecological impact by up to 49 %⁸⁰, due in particular to the reduction of emissions from secondary lead production compared to emissions from primary lead. The human toxicity potential (HTP)⁸¹ for the production of primary lead is about 18 times higher than the HTP of secondary lead.
- For lithium batteries, high amounts of greenhouse gas emissions result from the pyrometallurgical process. The refining of copper, cobalt and nickel is also energy intensive and produces additional greenhouse gas emissions. Replacement of primary production of cobalt and nickel totally or partially compensates for this increase in emissions. Recovering high-grade steel and other materials from the dismantling process creates additional advantages. In total, the process results in a gain of around 0.7 tonnes of CO₂ eq per tonne of lithium battery recycled, not considering a potential recovery of lithium.

Waste electric and electronic equipment shredding facilities can be non-negligible sources of dust and heavy metal emissions if they fail to respect the Directive's obligation to remove batteries before recycling.

Currently complete information of the lifetime of batteries is lacking. It however is a key parameter that determines the availability of EV batteries residual storage capacity for reuse and repurposing and ultimately secondary raw materials availability.

3.2.4.6. *Reuse*

The performance of new lithium-ion batteries usually diminishes with their use. In the case of electric vehicle batteries, when the performance drops to 75-80 % of its original value, the battery is unable to perform as expected. However, this does not mean that the battery has no value left. While reuse of EV batteries is not developed in the European Union, some pilot projects are proving that this option is technically feasible.

Although technical and economic issues remain to be solved, the possibility to give a second life to these batteries in other applications raises high expectations⁸². The environmental impact of repurposing and its economic viability remains under

⁸⁰ Unterreiner et al. 2016, 'Recycling of Battery Technologies — Ecological Impact Analysis Using Life Cycle Assessment (LCA),' Energy Procedia 99 (2016) pp. 229–234.

⁸¹ The human toxicity potential (HTP) is a calculated index, given as 1,4-dichlorobenzene equivalents, that reflects the potential harm of a unit of chemical released into the environment.

⁸² Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB). http://publications.jrc.ec.europa.eu/repository/bitstream/JRC112543/saslab_final_report_2018_2018-08-28.pdf

discussion, but it is widely accepted that the result depends on several scientific, technical social and economic conditions⁸³.

Life-cycle assessments⁸⁴ however indicate that, under certain conditions, second life of batteries for energy storage could help lower their environmental impact, assuring a longer and more efficient use of resources⁸⁵. This would only happen if information of the actual lifetime of the batteries concerned was available, allowing assessing batteries' residual capacity for reuse or repurposing.

3.2.5. Hazardous substances⁸⁶

Chemical reactions involving hazardous substances occur inside the cells that form the batteries. This is a situation common to almost all existing batteries technologies.

- As regards **lead-acid batteries**, lead itself is a toxic heavy metal. It is classified as toxic for reproduction in the classification, labelling and packaging of substances and mixtures (CLP) Regulation. It is also considered 'persistent bio-accumulative and toxic (PBT)' under the REACH registration notifications. Lead oxide and lead dioxide are suspected to be toxic to aquatic life, harmful if swallowed or inhaled, as causing damage to organs through prolonged or repeated exposure and cancer causing.
- **Alkaline batteries** (part of the category 'other batteries') use manganese and other harmful chemicals that make some of their components hazardous. Manganese dioxide is classified under the CLP Regulation as harmful if swallowed or if inhaled. Zinc powder is considered toxic to the aquatic environment. Potassium hydroxide, the electrolyte in alkaline batteries, is classified as harmful if swallowed and as causing severe skin burns and eye damage.
- Current versions of **Li-ion batteries** contain cobalt, nickel or manganese. Lithium hexafluorophosphate (LiPF₆), an electrolyte used in these batteries is also suspected to be hazardous.
- **Nickel-cadmium** batteries contain cadmium, a toxic heavy metal specifically addressed in the Batteries Directive. Their use as industrial batteries that are not part of vehicles is still allowed. Under the CLP Regulation cadmium hydroxide — a particular component of these batteries — is classified as carcinogenic and mutagenic, and harmful if swallowed, inhaled or coming into contact with skin. The chemical is also considered to cause damage to organs through prolonged or repeated exposure and to be toxic to the aquatic environment. Potassium

⁸³ Martinez-Laserna et al. 2018, 'Battery second life: Hype, hope or reality? A critical review of the state of the art.' *Renewable and Sustainable Energy Reviews*. 93. 10.1016/j.rser.2018.04.035.

⁸⁴ Bobba, S. et al. (2018) Life Cycle Assessment of repurposed electric vehicle batteries: an adapted method based on modelling energy flows. *Journal of Energy Storage*. 19 pp. 213–225. <https://doi.org/10.1016/j.est.2018.07.008>

⁸⁵ Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB), http://publications.jrc.ec.europa.eu/repository/bitstream/JRC112543/saslab_final_report_2018_2018-08-28.pdf

⁸⁶ See Sections 12.4.4, 12.4.5, 12.4.6 and 12.4.7 of the supporting study.

hydroxide (see above) is also used in NiCd batteries. Cadmium use is not totally prohibited - it can still be used in industrial batteries that are not placed inside vehicles.

4. METHOD

4.1. Evaluation method

The **roadmap** for the evaluation process was published in August 2018⁸⁷.

To support this evaluation, the Commission awarded a **study contract** in 2016 to a consortium led by Trinomics⁸⁸. The study began in early 2017 (further information is available on the project website www.batteryevaluation-study.eu). A short overview of the method applied is provided below, but more detailed information on the evaluation methodology, the evaluation matrix, etc. can be found in the study supporting the evaluation, in particular Chapters 3 and 4 and Annex A. The information used in this document relies on the results of supporting study. The full details of the sources referred to in the supporting study are not necessarily reproduced here.

In line with the Commission's better regulation policy⁸⁹, the Directive has been assessed according to five **evaluation criteria**: relevance, effectiveness, efficiency, coherence and EU added value. The items for review defined in Article 23 of the Directive were also considered. A specific set of questions was developed for each of the criteria and for each of the items for review.

The **fitness-check** carried out in 2014 identified several challenges that were explored in detail during this evaluation, e.g. the low collection rates of portable batteries (including obligations for Member States), the methodology for calculating collection rates and recycling efficiency, and the need to ensure legal consistency including with other pieces of legislation.

The evaluation focused on eight sub-areas⁹⁰ for which detailed evaluation questions to gather the necessary information, data, details and results were developed. This made it possible to elaborate on the responses to the evaluation criteria and general questions. See Annex C for an overview of evaluation criteria, sub-areas and questions.

For analysing effectiveness, the Commission's key source of information was the details on collection rates and efficiencies submitted by Member States. The evaluation used desk research and consultation activities to assess the remaining criteria.

⁸⁷ http://ec.europa.eu/smart-regulation/roadmaps/docs/2017_env_016_batteries_evaluation.pdf

⁸⁸ Study consortium under the lead of Trinomics, with Ökø Institut and Ernst & Young, under the framework-contract ENV.F.1/FRA/2014/0063.

⁸⁹ <https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines-evaluation-fitness-checks.pdf>
https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-47_en_0.pdf

⁹⁰ These were: (i) impact on the environment; (ii) impact on the functioning of the internal market; (iii) appropriateness of further risk management measures for batteries containing heavy metals; (iv) appropriateness of the minimum collection targets for all waste portable batteries; (v) possibility of introducing further targets; (vi) appropriateness of the minimum recycling requirements; (vii) additional extended producer responsibility; and (viii) emerging trends and new developments.

While subject to certain limitations, namely the comparatively low participation of consumer and environmental organisations, **stakeholders' input** to the evaluation⁹¹ has helped to complete the evaluation's evidence base

The evaluators conducted seven specific interviews with the most relevant stakeholders and consumers associations. National authorities were also invited to provide written comments.

A 12-week public consultation took place between 6 September 2017 and 28 November 2017 using the EU Survey tool. It targeted the general public and industry, and specifically those stakeholders who could not participate in the other types of consultation. It was widely promoted among organisations and individuals. A link to the survey was placed on the waste policy web pages on the Europa website and was made publicly available through the Commission's dedicated consultation website. There were 151 responses to the consultation⁹².

The expert group on waste (batteries) held a specific meeting on the topic on 14 March 2018. The event was attended by approximately 60 participants, including national authorities, industrial operators and their EU umbrella organisations.⁹³

Finally, a specific web page provided information on the status of the evaluation process⁹⁴.

4.2. Limitations

The availability and reliability of data and information are key to ensuring the evaluation's quality. Chapter 6 of the supporting study⁹⁵ gives an overview of the gaps in data and information and the shortcomings in quality. The validity of the conclusions for each general evaluation question are assessed individually in Chapter 7 of the supporting study. These chapters clearly present the gaps in data and information availability and their possible impact on the reliability of the evaluation's main results.

As pointed out in Chapter 6 of the supporting study, most data gaps concern the topic 'economy', often for reasons of confidentiality. The availability of monetised data on e.g. costs and benefits of different sectors or of battery production value chains has been very limited.

The gaps in the information needed to assess efficiency are particularly significant. They include:

- costs and benefits for operators resulting from the ban of NiCd batteries in cordless power tools;

⁹¹ http://ec.europa.eu/environment/waste/batteries/pdf/ConsultationStrategy_finaldraft_ENV_19JUL.pdf

⁹² https://ec.europa.eu/info/sites/info/files/factual_summary_consultation_batteries.pdf

⁹³ See Annex D for a synopsis report of all consultation activities with the main feedback received.

⁹⁴ <http://ec.europa.eu/environment/waste/batteries/evaluation.htm>

⁹⁵ <http://ec.europa.eu/environment/waste/pdf/Published%20Supporting%20Study%20Evaluation.pdf>

- costs and benefits for recyclers compared with other sectors (manufacturers, retailers);
- costs and benefits from restricting the use of hazardous metals in batteries for the recycling sector; and
- additional costs due to the classification of waste batteries as hazardous waste (e.g. Member States where all batteries are classified as hazardous waste versus Member States where not all batteries types are classified as hazardous waste).

Assessing the monetary costs of implementing the Directive has not been possible. The Directive's benefits have also been assessed qualitatively because not all effects can be attributed to the Directive, but rather to 'normal' market activities.

In general, given the complex and specific nature of battery issues, only a relatively small number of organisations and individuals appear to have the technical, practical, and policy knowledge necessary to answer the evaluation questions. Fortunately, relevant economic and industrial partners are well organised and generally willing to provide qualitative information.

Stakeholders' contributions have been particularly important for assessing the Directive's likely contribution to the changes observed in the sector. While an impact assessment was conducted before the adoption of the 2006 Directive, it does not have detailed or quantified information about expected impacts, meaning that a full comparison between expected and achieved results is not possible.

Despite these limitations, the evaluation arrived at solid conclusions by examining the facts and figures in Member States' reports and in specialised publications and studies as well as through expert judgement and plausibility analysis.

5. ANALYSIS AND ANSWERS TO THE EVALUATION QUESTIONS

5.1. Relevance

5.1.1. How well do the original objectives of the Directive correspond to current environmental, technical, economic and social conditions and needs, as regards the use of batteries within the EU?

Given the significant growth in the batteries' market, the presence of dangerous substances in the composition of batteries, and the proportion of batteries that are not properly treated at the end of their life, the Directive's primary objectives continue to be relevant⁹⁶.

This conclusion is shared by the majority of stakeholders consulted and the public consultation participants who consider the Batteries Directive's objectives to still be adequate and relevant⁹⁷.

⁹⁶ See also Section 7.1.1 of the supporting study.

⁹⁷ See Sections C 2.1 and C.2.2 in the analysis of the results of the public consultation.
<http://ec.europa.eu/environment/waste/pdf/Published%20Annex%20Public%20Consultation.pdf>

The use of batteries is unavoidable nowadays and the batteries' market is expected to continue to grow significantly to meet people's demands for connectivity, mobility and decarbonisation, which can only be satisfied with the contribution of batteries-based technologies⁹⁸.

To reduce the environmental risks of using batteries, the Directive: (i) prohibits the placing on the EU market of batteries containing mercury and to some extent cadmium⁹⁹; (ii) promotes the development of batteries that contain smaller quantities of dangerous or polluting substances; and (iii) establishes obligations for collecting and recycling waste batteries.

These measures seem to have been somewhat successful. The content of mercury and cadmium in batteries has diminished¹⁰⁰ and the amount of collected and treated batteries has increased, for example. However, since **batteries still contain hazardous substances**¹⁰¹, the risks persist. The proper disposal of spent batteries is essential for preventing hazardous materials from entering the environment. However, available figures on the collection of waste batteries¹⁰² indicate important losses. Therefore, **the management of waste batteries is still a matter of concern for the EU**.

5.1.2. How relevant are the provisions of the Batteries Directive for achieving its environmental and market-related objectives¹⁰³?

As shown by the logic intervention diagram in Annex A, the high-level objectives, targets, actions and results established by the Directive correspond with each other.

On the validity of the Directive's specific requirements, the results of the public consultation are mixed (only 55 % of respondents considered the requirements to be still relevant). While no general measure or provision was considered obsolete, updates to certain targets and obligations were proposed.

On the **environmental objectives**, all stakeholders agree that the Directive's focus on the end-of-life stage of batteries allows the environmental pressures resulting from the rising number of batteries on the market (see Sections 3.1. and 3.1.3 above) to be addressed. Stakeholders also underlined the need to reduce uncontrolled waste batteries and to address the impact of non-treated waste and the loss of resources.

Some public consultation respondents proposed to explore broadening the Directive's scope, for example to deal with safety concerns about spent lithium batteries¹⁰⁴.

⁹⁸ Section 3.2.1 of this document presents the current status and the expected market developments.

⁹⁹ Industrial batteries not placed in vehicles are still allowed to contain cadmium.

¹⁰⁰ See for instance the answers to questions C-7.1 and 2 in the analysis of the public consultation results. <http://ec.europa.eu/environment/waste/pdf/Published%20Annex%20Public%20Consultation.pdf>

¹⁰¹ See Section 3.2.5 for some of the hazardous components of batteries currently being placed on the market.

¹⁰² See Section 3.2.4.4 above.

¹⁰³ See also Section 7.12 of the supporting study.

¹⁰⁴ See Sections C-1.1 and C-3.2 for the detailed analysis of the public consultation results.

However, most stakeholders consider that this matter could only be covered by the Directive if it concerns labelling.

Stakeholders also suggested that aspects currently dealt with by the Directive, such as the management of hazardous substances, could be addressed by more targeted legal instruments like REACH¹⁰⁵.

Some stakeholders consider the provisions on ‘**material recovery**’ to be insufficient¹⁰⁶. The Directive's requirements on collection and recycling aim to ensure a high level of material recovery, but they do not fully reflect the importance gained by resource efficiency and circular economy policies. Although the environmental benefits of recycling (see Section 3.2.4) are generally acknowledged, the Directive's current provisions are not considered sufficient to maximise them.

The success of circular economy approaches depends on many factors, including scientific and technical factors considerations and also social, economic and legal ones. Experience so far shows that certain key factors seem to determine the success of recycling waste batteries, some of which have been enacted by the Directive (see Table 7 below).

Table 7 Factors influencing the success of waste batteries recycling

Key factor ¹⁰⁷	What the Directive does
Supply of materials at a reasonable cost.	Sets targets for the collection of waste portable batteries.
Sorting waste batteries into different streams, considering chemistry as well as recyclability.	Not present
Specificity of the recycling process (in view of the spent batteries or of the products to be recovered).	Establishes targets for the recycling efficiencies of (only) lead and cadmium.
Competitiveness and marketability of recovered materials compared with raw materials or mining ores.	Not present
Supporting recycling activities by a regulatory mechanism if processes do not produce sufficiently high revenues.	Establishes provisions on extended producer responsibility. Ensures the recycling of all collected waste batteries

¹⁰⁵ See Annex D.

¹⁰⁶ See for instance Section 3.1, Annex D.

¹⁰⁷ Gaines, L. L., & Dunn, J. B. (2014). Lithium-Ion Battery Environmental Impacts. In *Lithium-Ion Batteries: Advances and Applications* (pp. 483-508).

Stakeholders consider that although the Directive supports these recovery policies, it could do it better. For example, they underline the negative effect of limiting recycling efficiencies to lead and cadmium. They also point out that the definition of recycling efficiency in the Directive is not oriented towards material recovery and that high-quality recycling is not established as a priority. Compliance with current targets could be met even in the case of downcycling or ‘cherry picking’ (i.e., the possibility to choose freely the battery parts or materials that are recycled).

5.1.3. How well adapted is the Directive to (subsequent) technical and scientific progress¹⁰⁸?

The Directive establishes the promotion of new technologies for recycling, innovation or environmental performance, but does not develop it in detail or set targets.

Most public consultation participants agreed that the characteristics and features of batteries have changed since 2006. The lifespan of batteries has increased, performance and safety have improved and the consumer-related features have changed.

While it is unclear whether the Directive has contributed to these improvements, none of the changes have been reflected in the Directive. There seem to be difficulties in easily incorporating technical and scientific novelties into the Directive.

Classification of batteries

The Directive classifies batteries based on their use (portable, automotive or industrial). This type of classification creates limitations and problems, such as whether electric bike batteries should be classified as industrial, and unclear limits for industrial and portable lead-acid batteries. However, these challenges are widely known and are relatively easy to address.

However, new types of batteries (printed/thin films batteries with or without hazardous components or batteries for mild hybrids cars, for instance) do not fit into this classification and call into question the validity of the approach, suggesting that the classification system is revised.

Stakeholders consulted do not consider this change necessary¹⁰⁹. It could therefore be preferable to keep the current classification, while introducing improvements. For example, chemistries could be an additional element of classification (allowing more specific targets on collection or recycling to be established), and better (i.e. more logical and more precise) demarcation lines between battery types could also be drawn.

Lithium batteries

Battery use has changed since 2006 and the number of new applications is increasing. New ‘transport’ applications (electric vehicles, e-bikes, drones or robots), new connectivity applications (smartphones and tablets or wearables) and new stationary applications (energy storage systems beyond or behind the meter) along with already

¹⁰⁸ See also Section 7.1.3 of the supporting study.

¹⁰⁹ See Section 3.1 of Annex D.

existing ones (laptops, mobile phones or small home appliances) have grown in number and importance since the introduction of the Directive. Batteries powering these new applications are mostly lithium-based batteries.¹¹⁰

Lithium batteries are classified under ‘other batteries’¹¹¹, which does not reflect their growing importance. In 2015, a large amount of lithium-ion batteries (ca. 75 000 tonnes) was placed on the market. Lithium batteries constitute about 17 % of all portable batteries placed on the market, compared to only 4 % for lead-acid and NiCd batteries combined.

The recycling efficiency target for ‘other’ batteries is 50 %, which does not ensure the recovery of lithium or other valuable (and critical)¹¹² materials contained in these batteries, like cobalt. The situation is aggravated by the vague provisions in the Directive dealing with the collection of waste industrial lithium batteries. These batteries contain significant amounts of lithium and cobalt, but the Directive's current provisions do not set strong incentives to promote their recovery. This is a growing issue in particular in light of the expected increased electric vehicles deployment in the next years resulting from the implementation of the new CO2 emission reduction targets for light commercial vehicles. This will require a significant increase of the supply of zero and low emission vehicles, putting on the forefront the need to develop sustainable and efficient recycling schemes for batteries.

This will be an important issue if the industrial batteries sector grows as expected. The Directive does not set collection targets or reporting obligations for this type of battery. In addition, the producer responsibility provisions that apply to industrial batteries are not as specific as those for other types of batteries.

Second life of batteries¹¹³

According to the public consultation and targeted interviews, most stakeholders think that the Directive does not clearly define the legal framework within which the second life of batteries can develop. Second life of batteries is currently not considered in the Directive as it is an unexpected technical development that current legislation cannot incorporate.¹¹⁴

In the absence of specific provisions for the second life of batteries, general rules laid down in the WFD would apply (e.g. on re-use or on preparation for re-use). Therefore, applying the provisions of the WFD to batteries would mean that batteries for re-use are

¹¹⁰ See the figures on markets and on the applications of batteries in Sections 3.2.1 and 3.2.2 above, and Section 5.12 of the supporting study.

¹¹¹ Strictly speaking, the ‘other’ category also includes older types, like alkaline batteries.

¹¹² ‘Critical raw materials and the circular economy’. JRC Science-for-policy report, 2017. <https://publications.europa.eu/en/publication-detail/-/publication/d0c609d2-f4ef-11e7-be11-01aa75ed71a1/language-en/format-PDF/source-60481865>. JRC108710.

¹¹³ In addition to the specific sources mentioned, see Section C-7.1 of the detailed analysis of the results of the public consultation.

¹¹⁴ The ongoing [Innovation Deal on batteries](#), intended to address specifically this issue, should be mentioned.

not considered as waste whereas batteries prepared for re-use are considered waste. Battery producers underline that this legal situation is unclear and uncertain.

Producers also argue that extended responsibility issues should be addressed¹¹⁵ to avoid the current situation whereby the producers that place the battery on the market for the first time would remain responsible until the battery is eventually scrapped or recycled, independently of the number of ‘intermediate lives’ that it may have had.

The uncertainty generated by the legal issues mentioned above would be preventing the development of re-purposing activities of lithium batteries, according to stakeholders.

Table 8 Summary of the findings on relevance

- *The Directive's environmental protection objectives are still relevant.*
 - *The environmental concerns addressed by the 2006 Directive persist today. Batteries still contain hazardous substances and present a risk to the environment when they are landfilled, incinerated or improperly disposed of.*
 - *The batteries' market is expected to continue to grow significantly. People's demands for connectivity, mobility and decarbonisation can only be satisfied with the contribution of batteries-based technologies.*
- *The two main types of measures established by the Directive (the reduction of hazardous substances in batteries and the collection and recycling of waste batteries) are adequate to address the environmental concerns linked to the use of batteries. The importance given to end-of-life measures allows the environmental pressures related to the management of waste batteries to be addressed.*
- *Several important elements of circular economy approaches are incorporated into the Directive (supply of materials, specific recycling processes or supportive regulatory mechanisms), but not all stages are properly addressed.*
- *This is particularly true as regards recycling: in the light of technical progress and practical experience gained, it can be concluded that the minimum recycling efficiencies are not appropriate to ensure a high level of material recovery. Moreover, valuable components of batteries other than lead and cadmium (e.g. cobalt lithium or critical raw materials) are not specifically considered.*
- *There are difficulties in incorporating technical novelties into the Directive easily, as the case of the growing use of lithium-ion batteries shows. The current system of classifying batteries, however, is overall still relevant.*
- *The Directive does not address the second life of advanced batteries. Most stakeholders think that the Directive does not support re-use approaches.*

¹¹⁵ See Section 3.1, Annex D and Sections 10.1.4 and 10.3.3 of the supporting study.

- *The current system established by the Directive appears not to be suitable to deal with industrial batteries either. There are no detailed provisions regarding collection, the setting up of national schemes and extended producer responsibility for this category of batteries, which in future will be of increased relevance and unavoidable for the implementation of low carbon policies in the EU.*

5.2. Effectiveness

- 5.2.1. What progress has been made towards achieving the objectives and targets set out in the Directive? Have the environmental impacts of batteries been reduced since the introduction of the Directive? To what extent is this progress in line with initial expectations? In particular, what progress has been made to achieve the collection, recycling and recycling efficiency targets?

The environmental impact of batteries has decreased since the Directive came into effect, mainly due to the increase in the collection of waste batteries and to the prohibition of mercury and cadmium. Most public consultation participants think the Directive has been effective in protecting the environment (83 %) and protecting human health (74 %) ¹¹⁶.

Every year Eurostat ¹¹⁷ publishes information on the collection rates of portable batteries and on recycling efficiencies. However, the absence of reporting obligations on the collection of automotive and industrial batteries and on batteries in household waste ¹¹⁸ makes it impossible to have a complete picture of the fate of all waste batteries, per type and per chemistry of battery. The contribution from stakeholders (through targeted interviews and the public consultation) has supplemented the information available.

Collection

Only 14 ¹¹⁹ of the 28 Member States have met the 2016 collection rate target (see Table 1, Section 3.1). Of the remaining countries, 12 ¹²⁰ failed to reach the target and 2 did not report the required data. Progress on collection rates falls short of initial expectations.

The high rate of non-compliance for this target is concerning since it increases the risk of pollution by hazardous components of waste batteries. The successful collection of waste batteries is critical to ensure their correct treatment and hence crucial to meeting the Directive's objectives.

¹¹⁶ See Sections C 6-1 and C 6-2 of the detailed analysis of the public consultation results.

¹¹⁷ <https://ec.europa.eu/eurostat/web/waste/data/database>

¹¹⁸ Note that the Commission proposal, COM(2003) 723 final, required that Member States monitor the quantities of spent portable nickel-cadmium batteries disposed of in the municipal solid waste stream, but the Directive does not contain such an obligation.

¹¹⁹ Croatia, Belgium, Luxembourg, Hungary, Lithuania, the Czech Republic, Austria, the Netherlands, Bulgaria, Ireland, Slovakia, Germany, Finland and Sweden.

¹²⁰ Denmark, France, the United Kingdom, Portugal, Poland, Spain, Slovenia, Italy, Estonia, Latvia, Cyprus and Malta.

It is difficult to identify one single reason that explains the failure of some Member States to meet the collection rate target for waste portable batteries. The 45 % collection target for 2016 worked in some Member States but not in others. Even if current collection targets have increased the collection rate in some Member States, they do not seem appropriate to ensure a high level of collection of waste batteries and accumulators.

The amount of lost waste batteries is too high to not to jeopardize environmental protection. These losses also prevent the achievement of other objectives or targets (such as attaining a high level of material recovery¹²¹ or minimising the disposal of batteries as mixed municipal waste¹²²).

Stakeholders have identified possible factors that explain Member States' collection rates. A large compilation of collection rates, based mostly on figures submitted by producer responsibility organisations (PROs), is the European Portable Battery Association's regular survey (EPBA 2016 a).

One possible explanation is the **difficulty in implementing certain provisions** such as **awareness raising**¹²³ or the **accessibility of collection points** for waste portable batteries¹²⁴, due to the Directive's lack of detail.

Although one can assume that the number of collection points affects the results of the collection (see table below), a detailed assessment of possible mechanisms is not possible since available information on the number and accessibility of these points is incomplete.

Table 9: Number of collection points in a sample of Member States¹²⁵

	Information from national implementation reports	Collection rate (2016)	Population (2016, millions)
AT	2 000 municipal collection points and an unknown number of other collection points	49.2	
BE	Wallonia: 24 000 active collection points for waste portable and industrial batteries (Trinomics 2017)	70.7	11.3
CZ	25 500 take-back points for two collection schemes, including nearly 2 500 stationary containers in municipalities (Trinomics 2017)	52	10.5
EE	100 hazardous waste collection points managed by the municipalities (EPBA 2016)	30.6	1.3

¹²¹ See Recital 15.

¹²² Directive 2006/66/EC, Article 7.

¹²³ Article 16.3 and to some extent Article 20.1.

¹²⁴ Article 8.1. (a).

¹²⁵ Information taken from Trinomics 2017.

	Information from national implementation reports	Collection rate (2016)	Population (2016, millions)
FI	About 10 000 retailers and 3 000 other free collection points	46	5.4
FR	55 000 collection points	44.5	66.7
GR	Approximately 7 000 collection points	34.4 (2014)	10.7
HU	Approximately 41 000 collection points for batteries and portable accumulators, i.e. about one collection point for every 240 citizens	53.1	9.8
IE	10 500 battery collection points, one per 441 citizens	48	4.7
SK	According to national legislation, producers of batteries have to ensure at least one collection point for waste portable batteries and at least one facility for the collection of waste automotive and industrial batteries in each district town	47.6	5.4

Academic literature indicates that the **limitation of the collection targets to only one type of batteries** is the root problem. For instance, one report states that ‘it is not possible to effectively call for the collection of only certain types of batteries’¹²⁶. The Directive's ambition to ‘apply to all batteries’¹²⁷ is therefore contradicted by the fact that it only sets targets for waste portable batteries. It is noteworthy that participants in the SET action plan propose that 70 % of lithium waste batteries of any kind are collected by 2030¹²⁸. The limitation to only one type of batteries also applies to the substantial differences in producers' or end-users' obligations to collect different types of batteries.

Another possible explanation is the **technical difficulty in calculating collection rates according to the Directive's methodology**¹²⁹.

- It has been argued that **the increasing average lifespan of batteries strongly influences the results**. The 3 year average currently in the Directive was based on the ‘normal’ lifespan of batteries when the Directive was adopted. Stakeholders consider that the results do not reflect Member States' efforts. Hoarding behaviours also hamper collection efforts. EUCOBAT has proposed to

¹²⁶ [Lindhqvist, T](#) (2010), ‘Policies for Waste Batteries,’ [Journal of Industrial Ecology](#), vol 14, No 4, pp. 537-540.

¹²⁷ Recital 6.

¹²⁸ https://setis.ec.europa.eu/system/files/set_plan_batteries_implementation_plan.pdf

¹²⁹ See Commission Decision 2008/763/EC, OJ L 262.

change from the number of ‘average’ years to the current lifespan¹³⁰. However, the correlation between the collection and the lifespan of portable batteries is inconclusive according to the supporting study.

- The Directive does not properly consider the possible influence of **portable batteries incorporated in electric and electronic equipment** in the calculation of collection rates, above all when they are exported. Stakeholders suggest a new calculation methodology that would substitute the figures on ‘batteries placed on the market’ with figures on ‘batteries available for collection,’ (EPBA 2016 a) in line with the approach used by the WEEE Directive. At present, since the removability criteria is not sufficiently complied with, neither the collection objective nor the recycling objective can be sufficiently fulfilled. Better enforcement of removability could increase the separate collection and recycling of batteries that are incorporated in appliances.
- The Directive's distinction between **portable** and **industrial lead-acid batteries** is unclear for some Member States and stakeholders. An assessment of the data reported to the Commission on these lead-acid batteries shows that the share of lead-acid batteries out of the total collected waste portable batteries is implausibly high for the Czech Republic, Italy, Malta, the Netherlands and the UK. On the other hand, as pointed out by stakeholders, some portable batteries may be wrongly classified as industrial. Either way, the calculated collection rates would not reflect the performance of collection activities.

At the meeting of the expert group on waste (Batteries Directive) in July 2017, EPBA representatives indicated that, despite some differences, there is a significant convergence of the results of the compliance assessment based on values reported by the Member States and those presented in the EPBA 2016 report.

Recycling efficiencies

In the 2016 reporting exercise, most Member States reported to have met the Directive's targets for recycling efficiency¹³¹. However, data gaps are an issue for some of them. Depending on the battery type, between eight and 12 Member States did not report their values. It is unclear whether the reason for this is that there are no recycling processes whose efficiencies should be reported.

The EU recycling industry appears to be technologically able to meet the Directive's recycling efficiency targets. In the last 3 years, 78 % of the values exceeded the targets. However, current targets could be perceived as not being tough enough in light of the existing technical standards¹³².

¹³⁰ EUCOBAT (2017).

¹³¹ See values for the 2014, 2015 and 2016 exercises above, in Table 2, Section 3.1.

¹³² The Commentry site (VALDI) declares a recycling efficiency of 78 % for alkaline/saline batteries, while the level requested by the Directive is 50 %. More information at:

http://www.eramet.com/sites/default/files/valdi_newsletter_n12_juin_2018_en.pdf

Although the recycling targets have been met, the objective of ensuring a high level of material recovery¹³³ has not necessarily been achieved. Stakeholders underline¹³⁴ that the definitions of recycling efficiencies in the Directive and the Regulation concerned¹³⁵ appear to be oriented towards ascertaining the efficiency of processes as such rather than increasing material recovery. In other words, current recycling requirements do not seem appropriate for ensuring a high level of recycling of and materials recovery from waste batteries and accumulators.

The Directive does not define targets for the recovery of materials that are growing in importance such as those in lithium batteries. Moreover, it does not prioritise high-quality recycling as compared to downcycling. Slags are considered to be an ‘output’ of recycling processes, leaving aside their possible subsequent treatment. Furthermore, there is a lack of harmonisation in that slag is considered as ‘output’ only by some Member States.

National administrations underline the lack of appropriate and high quality data on the recycling that takes place outside the Member States where waste batteries are collected (be it inside or outside the EU)¹³⁶. The geographical origin of waste batteries is not always traceable and although Member States apparently attempt to ensure that the recycling processes carried out abroad meet efficiency targets, no evidence has been found of any control systems in place to certify the validity or the reliability of the values reported.

Certification systems could ensure increased harmonisation of data collection and processing across the Member States, helping level the playing field for recyclers in the EU.

Degree of recycling

The information provided by Member States¹³⁷ indicates high degrees of recycling in the EU. This confirms the technical capability of the EU recycling industry.

This obligation aims to ensure the control of the releases of the two hazardous substances concerned (lead and cadmium) rather than their recovery. Other substances contained in batteries (such as mercury and mercury compounds or lithium salts) are also dangerous but their recovery is not required. If in future batteries continue to contain metals (such as lead, cobalt and other metals) additional recovery obligations could be introduced.

¹³³ As in Recital 14.

¹³⁴ See Annex D, Section 3.1.

¹³⁵ As in its Annex I.

¹³⁶ See Annex D, Section 4.

¹³⁷ See Table 3 above, Section 3.1.

Environmental performance, hazardous substances and innovation

The improvement of the **environmental performance** of batteries and of the activities of all operators involved in their life cycle is one of the Directive's aims. Up to 63 % of the public consultation respondents consider that the Directive has been effective in improving the environmental performance of batteries. There is also a general appreciation that the Directive has helped to diminish the amount of mercury and cadmium in batteries in recent years.

Putting aside the use of hazardous substances and the promotion of more environmentally friendly batteries, the Directive does not define any criteria to assess the performance or set any target. Nor does it address the extraction of materials, which is an important source of the total life cycle impact of batteries.

According to the information submitted by Member States in their national reports¹³⁸ there is a varying understanding of the obligations of Articles 5 and 9 of the Directive on measures to increase the environmental performance of batteries and operators, including promoting the use of less polluting substances. Some Member States submitted information ranging from financial funding of research and development to provisions in legislation and information to the public. Only four Member States¹³⁹ reported that environmental fees are in place. Several Member States also mention certification or participation in environmental management systems.

The use of mercury in batteries is prohibited since the exemption expired in October 2015. A decrease in collected batteries containing mercury has been observed and is expected to continue. When mercury is found in batteries, it is mainly from products placed on the market before 1 October 2015.

The use of cadmium in batteries is only partially prohibited. A decrease in portable NiCd batteries placed on the market has been observed and is expected to continue. However, considering the longer lifespan of these batteries, they would take longer to arrive as waste batteries at recycling facilities.

The Directive does not prohibit the use of **lead** in batteries. Nor does it provide an explanation of why portable NiCd batteries are prohibited, whereas portable lead-acid batteries are allowed. Restrictions for automotive batteries are established in the End-of-Life Vehicles Directive¹⁴⁰.

While the environmental impact caused by mercury and cadmium decreased, **substances** used in Li-ion batteries, such as lithium hexafluorophosphate (LiPF₆) raise new concerns about possible environmental and health impacts¹⁴¹ that the Directive is unable to address.

¹³⁸ Trinomics 2018.

¹³⁹ Lithuania, Malta, Poland and Sweden.

¹⁴⁰ Directive 2000/53/EC, Official Journal L 269, 21/10/2000.

¹⁴¹ Lebedeva, N and Brett, L (2016), Considerations on the Chemical Toxicity of Contemporary Li-Ion Battery Electrolytes and Their Components, J. Electrochem. Soc. 2016 volume 163, issue 6.

While only 36 % of the public consultation participants consider the Directive to be effective in boosting **innovation**, most respondents did not explicitly state that **the** Directive hampers innovation. Most of the respondents that criticised the weak role of the Directive in this respect come from the business sector.

A general principle of the Directive is that Member States should encourage **new recycling technologies**¹⁴² but it does not directly support their application. Only in an indirect way does the Directive promote the use of most environmentally friendly recycling technologies. It does in particular not provide for the adaptation of recycling efficiency targets to technical progress.

The EU actively supports research on batteries, for instance through **research and innovation projects** under successive EU framework programmes in this area, although public consultation respondents appear to be unaware of this. A recently published report¹⁴³ draws the main policy conclusions from 135 projects that received EUR 555 million in EU and private funds in 2007-2018. An additional EUR 200 million will be made available for research and innovation on batteries in 2019- 2020 under Horizon 2020.

The **European Strategic Energy Technology Plan (SET-Plan)**¹⁴⁴ defines research and development priorities on energy and includes a specific action on batteries. This plan aims to promote the competitiveness of EU industry in the global battery sector (e-mobility) by coordinating national research efforts and helping to finance projects.

Removal of batteries from appliances

The wording of the provisions on removability (Article 11) makes their implementation difficult.

The article does not set out reporting obligations and it is impossible to draw conclusions on compliance with the removability requirements. Moreover, the article sets out exemptions but no detailed criteria on when they can be applied, opening up the possibility for different interpretations.

Stakeholders, including Member States, have suggested that there is an increase in cases where batteries cannot be removed from appliances. If true, this situation contributes to the inadequate treatment of these batteries which could prevent higher collection rates. The lifetime of the appliance concerned would also be shortened in this scenario.

This lack of compliance may partly explain the difficulties in meeting the collection and recycling targets. Better enforcement of removability could increase the separate collection and recycling of batteries that are incorporated into appliances.

The Directive does not require batteries to be ‘replaceable.’ Again, if the battery cannot be replaced this could result in the need to replace the entire device once the battery degrades, usually before the end of the ‘normal’ lifetime of the appliance.

¹⁴² Article 13.1.

¹⁴³ <https://trimis.ec.europa.eu/content/batteries-major-opportunity-sustainable-society>

¹⁴⁴ <https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan>

5.2.2. What has been the impact of the Directive towards ensuring the achievement of the objectives? Which main factors (e.g. implementation by Member States, action by stakeholders) have contributed to or stood in the way of achieving any of these objectives?

With the difficulties and limitations mentioned above, the Directive has been instrumental in ensuring the protection of environment from the negative impacts of the use of batteries. It has helped increase the collection of waste batteries, helped ensure their recycling and helped remove cadmium and mercury from the batteries' value chain.

Prohibiting mercury and cadmium and putting in place battery labelling measures across the EU has helped ensure one of the Directive's key objectives, namely the smooth functioning of the internal market.

Information to the public and reporting

More than the half of the respondents to the public consultation consider that there is information available on the collection of waste batteries and a fair share of them (42 %) view it as reliable. On recycling, only the 42 % of respondents consider that there is information available and less than one third (30 %) view it as reliable.

The mandatory data on compliance with collection and recycling targets provides a reliable description of the situation at national level.

However, there are some difficulties in compiling and treating information about compliance with the Directive's targets. The biggest challenge is that the Directive still leaves room for interpretation on the target definitions and the process to measure and calculate compliance levels¹⁴⁵.

- The meaning of recycling efficiency targets is particularly ambiguous and its operationalisation unclear, which could lead to misreporting and even the manipulation of data.
- The concepts that underpin the calculation of sales of portable batteries, as defined in the relevant Regulation are vague ('statistically significant estimates ...') and there has been no guidance to help Member States ensure its proper implementation.
- There is no clear mandate on how the verification processes should be carried out at national level, which increases the risk of misreporting.
- Reporting obligations on the weight of batteries removed by operators from WEEE are not established.
- There is no obligation to compile necessary information on, for example, technical aspects of products containing batteries, on the batteries themselves, or on the economic value of the batteries placed on the market. This prevents operators in the value chain from having the information necessary to plan their activities.

¹⁴⁵ Eunomia Research & Consulting (2017) 'Study on Waste Statistics — A comprehensive review of gaps and weaknesses and key priority areas for improvement in the EU waste statistics'. http://ec.europa.eu/environment/waste/pdf/Eunomia_study_on_waste_statistics.pdf

Labelling

Stakeholders insist that labelling is essential for informing end-users about the chemical content of batteries and about the process of separate collection. They consider it an essential tool for achieving the Directive's environmental objectives¹⁴⁶.

The majority of public consultation participants agree that there have been advances in labelling and information for consumers, but that they may be insufficient. More than half (51 %) of the participants think the requirements are inadequate and not always fit for purpose, whereas 43 % think the labelling requirements are clear. Only 29 % consider that the requirements are sufficient to inform users about battery characteristics, the potential risks of using them or the need to collect and recycle them at the end of their life.

Some stakeholders think that informing people about collecting or recycling batteries needs to go beyond the crossed-out wheeled bin symbol printed on batteries. Successful awareness-raising activities by producer responsibility organisations (PROs) and individual brands in some Member States confirm the validity of these approaches¹⁴⁷.

Stakeholders and national administrations consider that the Directive's labelling provisions should include the obligation to inform people about the potential risks of hazardous substances other than cadmium, lead and mercury and about other safety risks (as in lithium batteries).

According to the Directive¹⁴⁸ the Commission must develop detailed rules to ensure that all portable and automotive batteries indicate their capacity on the label. The Commission must also establish harmonised methods to determine capacity and appropriate use. These rules were adopted in 2010 for portable rechargeable and automotive batteries. After several studies, the Commission concluded¹⁴⁹ that it was not possible to identify harmonised methods for the capacity labelling for primary batteries.

There are no other requirements in the Directive to make end-users aware of the information needed to qualify batteries in relation to their performance or quality. Even where the information on capacity for portable secondary and automotive batteries exists, consumers do not always know how to use it.

Economic measures

The responses provided by Member States within their national implementation plans suggest that not all of them have the same understanding of this concept.

Environmental fees to promote the collection of waste batteries and the use of less polluting substances in batteries have been applied by four Member States¹⁵⁰. Other

¹⁴⁶ See Sections C-14.1 to C-14.5 of the detailed analysis of the results of the public consultation.

¹⁴⁷ Such as Belgium, Germany, Ireland, Spain and the UK, among others.

¹⁴⁸ Article 21(2).

¹⁴⁹ COM(2018) 266 final.

¹⁵⁰ Latvia, Malta, Poland and Sweden.

Member States¹⁵¹ said they took measures to increase environmentally friendly recycling processes and products. Two Member States¹⁵² also mentioned research and development activities carried out by stakeholders (not necessarily promoted or funded by public authorities in the Member States concerned). Finally, eight Member States¹⁵³ mentioned the participation of producers or recyclers in environmental management schemes.

Involvement of producers (extended producer responsibility)

The establishment of ‘national schemes’ to put in place extended producer responsibility (EPR) is one of the Directive's successes. Producer responsibility organisations (PROs) play this role for portable batteries and their activities are essential for ensuring the collection and treatment of waste portable batteries.

There are differences in the way that PROs are organised at national level. Their number or their types can vary (see table below)¹⁵⁴.

Table 10 Organisation of PROs at national level

Member State	Start date of EPR scheme(s)	Number of PRO active in 2015	Characteristics of PROs ¹⁵⁵
AT	2008	4	Collective
BE	1996	1	Both
BG	2009	4	Both
CY	2009	1	Collective
CZ	2002	2	Both
DE	1998	4	Collective
DK	2009	3	Both
EE	2009	2	Both
ES	2000	4	Collective
FI	2009	2	Both
FR	2001	2	Both
GR	2004	1	Both
HU	2005	3	Both
HR	2007	1	Collective
IE	2005	2	Both

¹⁵¹ Austria, Belgium, the Czech Republic, Estonia, Germany, Lithuania and Poland.

¹⁵² Finland and France.

¹⁵³ The Czech Republic, Estonia, Germany, Hungary, Poland, Portugal and Romania.

¹⁵⁴ See Section 12.2.4 of the supporting study.

¹⁵⁵ ‘Collective’ means that PROs are serving different producers; ‘individual’ means that there are PROs responsible for one individual producer only; ‘both’ refers to the situations where the two types coexist.

Member State	Start date of EPR scheme(s)	Number of PRO active in 2015	Characteristics of PROs ¹⁵⁵
IT	2008	13	Both
LT	2009	2	Both
LU	2009	1	Both
LV	2006	3	Both
MT	2014	2	Both
NL	1995	1	Both
PL	2003	0	Both
PT	2002	3	Both
RO	2008	4	Both
SE	2009	1	Both
SI	2009	3	Both
SK	2001	11	Collective
UK	2009	5	Collective

For most portable batteries, the revenue generated by the sale of the secondary materials is not sufficient to offset the costs of collection, recycling and safe transport. PROs advance the funds needed for collection activities, ensuring the supply of waste batteries to recyclers at acceptable prices (or even free of charge).

That said, stakeholders also point out the limitations of the system defined in the Directive. For instance, there are no targets that PROs should meet on awareness-raising activities and setting up collection points. Without additional targets, some PROs could limit their activity to strictly meeting the collection targets of their Member States, minimising their efficiency and their involvement in other types of measures.

Moreover, in cases of competition between PROs that are obliged to achieve some additional targets and others that do not have incentives for meeting higher collection targets, the playing field is not level either at national or EU level.

Some take the view that the waste stream Directives (packaging, ELV, WEEE and batteries) should share a common approach to organising EPR, at least by defining minimum requirements for each EPR system (Trinomics 2016¹⁵⁶). With the modifications to the Waste Framework Directive adopted in 2018, common minimum requirements have been agreed for EPR. These will apply across the board and will therefore complement the Batteries Directive's current provisions.

5.2.3. Beyond the objectives, what other significant changes both positive and negative can be linked to the Directive, if any? Is there any identifiable contribution to

¹⁵⁶ Arcadis (2016), 'The efficient functioning of waste markets in the European Union — Legislative and Policy options', available at:

http://ec.europa.eu/environment/waste/studies/pdf/waste_market_study.pdf

achieving the objectives of EU policies on Climate Change, Resource Efficiency, internal market, innovation and job creation or consumer's rights? On the contrary, does the implementation of the Directive undermine the achievement of the objectives of these policies?

The national administrations¹⁵⁷ consulted broadly agree that the Directive has helped achieve broader EU environmental protection objectives such as fighting climate change, using resources more efficiently, creating jobs, boosting innovation and research and the internal market. According to the stakeholders interviewed the Directive has not brought about significant negative changes.

Overall, the Directive is perceived as supporting resource efficiency/circular economy policies. Most public consultation participants (58 %) consider that the Directive backs resource efficiency and circular economy policies, but there are doubts about the extent to which it has actually influenced their development and implementation. Stakeholders consistently state that the Directive could do more in the area of resource efficiency, but for this, there is a need to strengthen provisions on recycling.

While recognising that the introduction of the extended producer responsibility has set in motion collection and recovery activities, recyclers underline that recycling efficiency is driven by both the Directive's obligations and by other economic considerations (e.g. market prices)¹⁵⁸.

On CO₂, the emissions caused by recycling metals (lead, lithium or nickel) are considered to be offset by the savings in emissions due to the lower need for extractive activities¹⁵⁹. The final balance is therefore positive. On the other hand, transport of waste batteries (intra-EU) has increased by 20 %, and has likely increased CO₂ emissions¹⁶⁰. In any case, although a systematic analysis of battery-related transport does not exist, some estimates indicate a comparably low relevance of emissions from transport compared to other life stages of batteries. Emissions of hazardous substances during recycling, compared with those of raw material processing, are reduced.

The recycling of batteries generally reduces the dependency on primary resources and the need to import raw materials. As stated by the European Commission, '(T)he supply chain of these materials is potentially vulnerable to disruption. In view of the large quantities needed in the future (...) recycling of materials will increasingly become important for reducing the EU's dependency on third country markets and should be encouraged in the framework of the transition to a circular economy.'¹⁶¹

On employment, it is difficult to identify the jobs specifically linked to the management of waste batteries. Some stakeholders consider that the Directive's support for increasing

¹⁵⁷ See Section 7.2.3 of the supporting study.

¹⁵⁸ See Annex D, Section 3.

¹⁵⁹ Environmental advantages of recycling are also presented above, in Section 3.2.4.5.

¹⁶⁰ See Section 7.2.3 of the supporting study.

¹⁶¹ SWD(2018) 245 final.

recycling capacities has led to the creation of additional jobs. One could conclude that jobs are only created when treatment and recycling capacities are created or expanded.

Table 11 Summary of findings on effectiveness

- *The Batteries Directive has contributed to reducing the environmental impact of batteries: the content of mercury and cadmium in batteries has decreased, and the number of batteries that are not treated adequately at the end of life has gone down.*

- *While some Member States have successfully met the collection rate target for waste portable batteries, the difficulties in some others reveal insufficiencies in the Directive:*
 - *Provisions on the collection of different types of batteries are too diverse. Moreover, a target is defined only for the collection of portable batteries.*
 - *There are questions about the validity of the Directive's methodology for calculating collection rates.*

- *Even though current targets for the collection of waste portable batteries have increased the collection rates in some Member States, they are not appropriate to promote a high level of collection of waste batteries and accumulators.*

- *While recycling targets (level of recycling, recycling efficiency and degree of recycled content) are largely met, this does not mean that a high level of material recovery is achieved, because:*
 - *the definitions of recycling efficiencies are oriented towards ascertaining the efficiency of processes rather than increasing material recovery;*
 - *to date, there are targets only for the recycling efficiencies for lead and cadmium but not for other valuable components. Other recycling obligations are not sufficiently detailed; and*
 - *no priority is given to high-quality recycling.*

- *Establishing producer responsibility organisations to implement extended producer responsibility is considered a success of the Directive. The producers' contribution to financing any net costs arising from the management of all waste batteries collected has allowed the roll out of national schemes to collect portable waste batteries.*

- *The Directive does give details on how to increase consumers' understanding of their role in ensuring the collection of spent batteries. The Directive also lacks a proper system to inform end-users of the quality of the batteries placed on the market.*

5.3. Efficiency

5.3.1. What are the costs and benefits (monetary and non-monetary) associated with the implementation of the Directive for the different stakeholders and society at large, at national and EU level?

Assessing the Directive's economic impact is particularly problematic due to the limited availability of quantitative financial and economic information for confidentiality reasons. Real costs, for instance, are hardly available, which makes it very difficult to prepare cost-benefit analyses (see Section 4.2 on limitations above).

In addition to published data (e.g. the PRODCOMM database¹⁶²), a good deal of qualitative information has been obtained from stakeholders.

The results of the public consultation¹⁶³ show that businesses think that complying with the Directive has entailed significant costs, even if they also generally perceive that the Directive has also produced benefits. That said, most public consultation participants agree that the costs involved in implementing the Directive are justified given current and future benefits. A fair share (43 %) think the Directive has led to market opportunities.

The profitability of recycling activities depends primarily on the chemistry concerned and the market conditions for the secondary materials recovered¹⁶⁴.

Data on costs for collection and recycling of portable batteries are available for a limited number of MS only. According to an extrapolation of French data¹⁶⁵ on the collection and recycling of **portable batteries**, are around EUR 118 million per year for EU-28.¹⁶⁶ The fees paid by the producers to the PROs, when the batteries are placed on the market are intended to cover the costs of collection, safe transport and, depending the case, recycling activities. As a general practice, manufacturers incorporate in the price the cost of their contribution to the PROs.

The management of waste portable batteries has generated at least 1 000 to 2 000 full time jobs in the EU, though not all of them are attributable to the Directive.

The collection and recycling of **lead-acid batteries** is usually profitable. The revenue generated by selling the lead and other materials recovered generally offsets the cost of the operations needed to recycle these batteries: buying spent batteries, crushing them, sorting components (plastic, acid and lead), smelting, refining (if appropriate) and disposing non-recoverable materials. Prices for primary and secondary lead must be sufficiently high for the exercise to be profitable.

The situation is different for other battery chemistries (e.g. nickel or lithium). The costs of installing and operating collection systems and of ensuring safe storage and transport of collected waste batteries may offset the benefits of recycling. The volatility of metal

¹⁶² <https://ec.europa.eu/eurostat/web/prodcom>

¹⁶³ See Section C-12 of the analysis of the public consultation results.

¹⁶⁴ The profitability of collection, safe transport and recycling of waste batteries is discussed in Sections 5.2.2 and 12.2 of the supporting study.

¹⁶⁵ Data are available for a limited number of Member States only.

¹⁶⁶ See section 7.3.2.1 of the supporting study.

scrap prices is a concern for recyclers who may question the merits of continuing recycling activities whose profitability is uncertain. That said, the obligation for the collector of waste batteries to ensure the treatment and recycling of all waste batteries collected keeps the system running

The ‘recycling treatment fee’ plays a central role in these cases. Concerning **nickel batteries**, when the recovered material has a high price, collectors sell waste batteries to the recycler (see table below). For recyclers, the profitability is not guaranteed, due to the risks inherent to volatile prices for secondary raw materials. If the price is low, the recyclers will require the collectors to pay the fee or even to deliver the batteries free of charge to ensure the recycling of these batteries, resulting in a revenue for the recyclers in both cases. That way, the recycling activity is stabilised and its dependency on volatile prices lowered.

Table 12 Recycling fees for NiCd and NiMH batteries

	high nickel price (€ 20 000/tonne)	low nickel price (€ 10 000/tonne)
NiCd battery	+500	-500
NiMH battery	+1 200	+800

Recycling costs for portable **cadmium** containing batteries are likely to increase in the future. The prohibition of this type of battery in the EU will decrease the amount of waste batteries available for recycling, to the point that recycling fees for these batteries could become unnecessary. If the existing global market for secondary cadmium declines or is interrupted, the secondary cadmium fraction will then have to be disposed of in a safe (and costly) manner.

For **lithium batteries**, the collection, treatment and recycling of these batteries would offset the revenues generated by selling the recovered materials. Recyclers consider that the lack of specific target for recycling efficiency (and the associated obligation to recover the metals to the highest possible degree) disincentives the recovery and exacerbates the imbalance. As a result, producers actually cover the costs with their contributions to the system via the recycling fees.

The recycling of lithium batteries usually targets their most valuable components (mostly cobalt and nickel, but also copper) as presented in the table below.

Table 13 Revenues from secondary materials from lithium batteries

Secondary raw materials	Market price (€/kg material)	C-LNMC (€/kg battery)	C-LNCA (€/kg battery)	C-LFP (€/kg battery)	LTO-LFP (€/kg battery)
Stainless steel	0.60	0.13	0.17	0.19	0.09
Aluminium	1.30	0.002	0.012	0.016	0.004
Copper	4.90	0.06	0.15	0.19	0.07
Nickel	11.90	0.47	1.03	-	-
Manganese	1.70	0.06	-	-	-

Secondary raw materials	Market price (€/kg material)	C-LNMC (€/kg battery)	C-LNCA (€/kg battery)	C-LFP (€/kg battery)	LTO-LFP (€/kg battery)
Cobalt	23.30	0.92	0.38	-	-
Lithium carbonate or hydroxide	5.20	0.30	0.30	0.17	0.80
Aluminium Cell	1.30	0.04	0.04	0.04	0.07
Copper — Cell	4.90	0.27	0.29	0.25	0.29

According to the information provided by recycling companies during the consultation, recycling lithium was not profitable until 2016 and lithium ended up in the slags of the pyro chemical process, recovered for use as construction material. Recycling lithium from slags has recently begun¹⁶⁷.

Establishing reliable targets for lithium recycling would be a major boost for recycling. For cobalt, the dramatic increase of the price of recovered cobalt in May 2018 could also drive up the recycling of LNMC batteries¹⁶⁸.

Although subject to many assumptions, the impact of recycling and recovery of industrial batteries based on lithium can be assessed, as shown below.

- Assuming a collection rate of 65 % and a recycling efficiency for lithium of 57 %, the valued of recovered materials (cobalt, nickel, aluminium and lithium) in 2030 could amount up to EUR 408 million¹⁶⁹), helping retain these materials in the EU economy and creating 2 618 jobs.
- As regards the contribution of recycling to the security of supply, recycling lithium batteries could decrease the demand of both lithium and cobalt needed to manufacture electrical vehicle (EV) batteries in the EU. A sharp increase in recycling could ensure a significant share of secondary lithium for EV batteries from 2050¹⁷⁰. This would only be possible if specific (and strict) targets for the recycling efficiency of lithium batteries were set.

¹⁶⁷ Hagelüken, Treffer 2017.

In 2016, Accurec opened a recycling plant for Li-ion batteries designed for a treatment capacity of 5 000 tonnes per year.

The integrated recycling process for Li-Ion batteries at the Krefeld production site (ACCUREC Recycling GmbH) declares an efficiency of 59.3 %. If the by-product slag is used for other purposes, 70.6 % could be reached.

¹⁶⁸ ‘Umicore to ramp up recycling of electric car batteries’ Reuters, 7.8.2018.

¹⁶⁹ Drabik, E. and Rizos, V. (2018) ‘Prospects for electric vehicle batteries in a circular economy’ CEPS.

¹⁷⁰ Öko-Institut (2018): Ensuring a Sustainable Supply of Raw Materials for Electric Vehicles: A Synthesis Paper on Raw Material Needs for Batteries and Fuel Cells.

- In the case of cobalt, specifically, the potential recycling volume from end-of-life EV batteries deployed in the EU is estimated at 500 tonnes in 2025 and may amount on average to 5 500 tonnes by 2030. Recycling of EV batteries can provide for 10% of the EU cobalt consumption in EVs in 2030, i.e. the 8% of the total EU demand (EVs + other uses), as long as relevant collection rates are ensured in particular for plug-in hybrid vehicles¹⁷¹.

The main obstacle to making recycling technology cost-effective is the shortage of waste batteries. There are high expectations that the amount of spent batteries available for recycling increases, along with profits¹⁷².

A significant development of repurposing could also have an impact on the availability of secondary raw materials. Analysis based on scenarios highlight that the availability of cobalt and lithium will be delayed significantly¹⁷³.

5.3.2. Are there significant distributional differences between Member States?

The stakeholders consulted did not point out distributional differences between Member States. The Directive would not have influenced the development of manufacturing capacities within the EU.

Europe's battery industry made more than EUR 7 billion in 2016, as summarised in the table below. Germany, France and the UK are the biggest producers of all battery chemistries and Belgium is the biggest producer of primary and secondary portable batteries. Italy, Poland, Spain, the Czech Republic, and Slovenia are the main producers of lead-acid batteries.

However, the Directive has helped set important recycling activities in motion. For example, recycling activities for lithium-ion batteries, which are mainly concentrated in Germany, Belgium and France.

Table 14 Battery production, import and export value (2016, Million €)

	Production	Import	Export
Lead-acid batteries	5 141	1 346	1 452
Primary cells and primary batteries	812	763	354

¹⁷¹ Alves et al. (2018)

¹⁷² Harveys, J (2017), 'Metal recyclers prepare for electric car revolution,'.
<https://www.reuters.com/article/us-batteries-recycling-analysis/metal-recyclers-prepare-for-electric-car-revolution-idUSKBN1DH1DS>

¹⁷³ Bobba,S., et al. How will second-use of batteries affect stocks and flows in the EU? A model for traction Li-ion batteries. Resources, Conservation & Recycling 145 (2019) 279–291.
<https://doi.org/10.1016/j.resconrec.2019.02.022>

See also section 3.2.4.6 above and 12.2.5 of the supporting study

	Production	Import	Export
Nickel cadmium, nickel metal hydride, lithium-ion, lithium polymer, nickel iron and other electric batteries	1 083	3 418	738
Total	7 037	5 526	2 545

The EU industry manufactures 15 % of global production of lead-acid batteries, which roughly aligns with the EU contribution to global GNP (16-17 %). The EU is a net exporter of this type of battery. The volume of NiCd, NiMH and lithium batteries manufactured in the EU is around 5 % of the global output, which is lower than the EU's share of global GNP. The EU is a net importer of NiCd, NiMH and Li-ion batteries.

The import-export imbalances could be wider as available statistics do not consider the quantities of batteries incorporated into exported and imported products. The EU is a net exporter of vehicles (including lead-acid batteries) and a net importer of consumer electronics (which also incorporate batteries).

5.3.3. How are costs and benefits distributed between the different sectors involved¹⁷⁴?

The public consultation participants did not express a clear opinion on which types of operators bear the costs or benefit from the Directive's implementation. Only 18 % answered this question, most of whom singled out the manufacturing sector. Only 10 % of participants answered the question about benefits. Of these, most think the Directive benefits recyclers of waste batteries first, followed by consumers. Similarly, less than one third of respondents think that the Directive has levelled the playing field for all operators involved.

Producers of portable batteries have established producer responsibility organisations (PROs) in all Member States. These PROs organise their contribution to ensure the funding of the collection, treatment and recycling of all collected waste portable batteries. The fees paid by the producers vary between the Member States. The total cost for the producers is estimated at around EUR 118 million in the whole EU¹⁷⁵.

Some PROs optimise their activities by setting collection rates at the minimum amount. They do not raise them higher as there are no additional benefits to exceeding these targets. In worse cases, PROs may decide to focus on the most profitable type of batteries to reach their objectives. Both cases would lead to an amount of uncollected waste portable batteries. This situation undermines the performance of the PROs and of the entire collection scheme, but the Directive does not include provisions to avoid it. Once collection targets are met, competing PROs may be highly selective of which batteries they accept, allowing free riders¹⁷⁶ to enter the market.

¹⁷⁴ The economic conditions of the batteries sector are discussed in Section 12.2 of the supporting study.

¹⁷⁵ Sections 7.3.2 and 8.3 of the supporting study present the calculation of the amounts concerned.

¹⁷⁶ i.e. non-registered operators that do not undertake battery collection activities but trade with surplus collection volumes only.

Producers of portable batteries have to finance public information campaigns¹⁷⁷. Spending on this type of activity varies widely across Member States, and not all have specified the amount to be spent by PROs.

For **industrial batteries**, the Directive requires that the end-user ensure the safe collection, storage and transport of spent batteries to the producer, who is obliged to take them back. The Directive does not explicitly require producers to collect industrial waste batteries, which creates risks for private owners of industrial batteries (e.g. people who buy e-bikes or have power storage batteries in their homes). The Directive does not specify who is responsible for providing collection infrastructure. Neither is there any specification of the characteristics of such infrastructure. The Directive vaguely indicates who is in charge of bearing the costs of safe storage and transport to collection points (recyclers in both cases).

This absence of a specific provision in the Directive could make it difficult to ensure that all industrial waste batteries are properly collected and therefore recycled.

The value chain for **automotive batteries** used for starting, lighting and ignition, the majority of which are lead-acid batteries, is apparently cost-effective, even if the volatility of the prices of lead could jeopardise the economic viability of recycling. The lack of a proper definition of ‘vicinity’ in the Directive could nevertheless affect the collection in areas with a low-density population. If this is the case, it is possible that not all waste automotive batteries are recycled properly and, instead, are disposed of illegally.

The insufficient harmonisation of compliance and reporting systems requires companies operating in different Member States to face adjustment costs for the specific national compliance systems that coexist in the EU.

5.3.4. To what extent are the costs associated with the Directive proportionate to the benefits it has brought?

Most public consultation respondents consider that the Directive has brought various benefits. They think it has, in particular¹⁷⁸:

- helped to protect the environment (84 %) and human health (76 %);
- improved the corporate image of the different sectors involved (manufacturers, producers, collectors and recyclers (59 %));
- improved the environmental performance of batteries and operators (73 %) and enhanced innovation (54 %);
- led to market opportunities (47 %); and
- levelled the playing field for all EU operators (29 %).

Most respondents agree that the Directive's current and future benefits outweigh the costs of implementing it.

¹⁷⁷ Article 17.3.

¹⁷⁸ See Section C -12 of the detailed assessment.

5.3.5. Are there any good or bad practices that can be identified in terms of efficiency in the achievement of results? If there are significant cost/benefit differences between Member States, what is causing them?

It is impossible to identify good or bad practices that fully explain the differences in **collection rates** between Member States. All of them have introduced rules on producer responsibility organisations (PROs). The Directive leaves it up to Member States to organise their national schemes, which are often very autonomous. The efficiency and effectiveness of these schemes determine how successfully Member States meet the collection rate target.

Some Member States have a single non-competitive organisation, but most have several schemes. Single, non-competitive schemes appear to perform better than competitive ones in terms of awareness campaigns and number of collection points.

Some countries have established minimum objectives for awareness-raising activities and set up collection points. In competitive situations, PROs in Member States with no set objectives could compete with each other by making minimal efforts in these areas.

The possible link between costs and collection rates has been regularly assessed¹⁷⁹. For this evaluation, comparable information is only available only for a few Member States, so general conclusions cannot be drawn (see table below).

Table 15 Cost efficiency of selected EPR schemes for portable batteries¹⁸⁰

	Year	Austria	Belgium	France	Netherlands
First year of EPR scheme		2008	1996	2001	1995
Number of PROs	2015	4	1	2	1
Portable waste batteries collected	2011	1 738	2 406	17 397	3 385
	2016	-/-	3 153	13 677	3 946
Collection rate	2011	49 %	52 %	36 %	42 %
	2016		70.7 %	46.4 %	49.0 %
Total fee in 1 000 €	2011	1 987	21 810	11 300	5 400
	2016	-/-	17 674	15 586	8 610
Inhabitants in 1 000	2016	8 772	11 268	66 940	16 979
Portable batteries collected per inhabitant in kg / year	2011	0.198	0.214	0.260	0.199
	2016		0.280	0.204	0.232

¹⁷⁹ See, for instance, ‘Development of Guidance on Extended Producer Responsibility (EPR)’. http://ec.europa.eu/environment/waste/pdf/target_review/Guidance%20on%20EPR%20-%20Final%20Report.pdf

¹⁸⁰ Section 12.2.45 of the supporting study discusses the economic aspects of the collection of waste portable batteries schemes.

	Year	Austria	Belgium	France	Netherlands
Fee per inhabitant in € / year	2011	0.23	1.94	0.17	0.32
	2016		1.57	0.23	0.51
Fee per collected portable batteries in € / tonne	2011	1 143	9 065	650	1 595
	2016		6 917	826	1 368

As expected, Member States who spend more achieve better results but incur high specific costs. For example, Belgium has the highest collection rate of the Member States in the above table, but also has the highest specific costs (both per inhabitant and per tonne of collected portable batteries). Belgium also had higher collection rates in 2011, but not significantly higher than the other countries.

The number of operating PROs (Belgium and the Netherlands have only one system and obtain better results) might also affect the cost efficiency of waste batteries management, even if their costs are very different.

In Belgium, more than 20 % of the total fee is spent on awareness-raising activities, which could help explain its success.

For **recycling**, the main differences are between chemistries and not necessarily between Member States or even operators. For instance, it is generally assumed that the level of recycling of lead-acid automotive batteries in the EU is high, although no official figures are available¹⁸¹. Several factors explain this assumption.

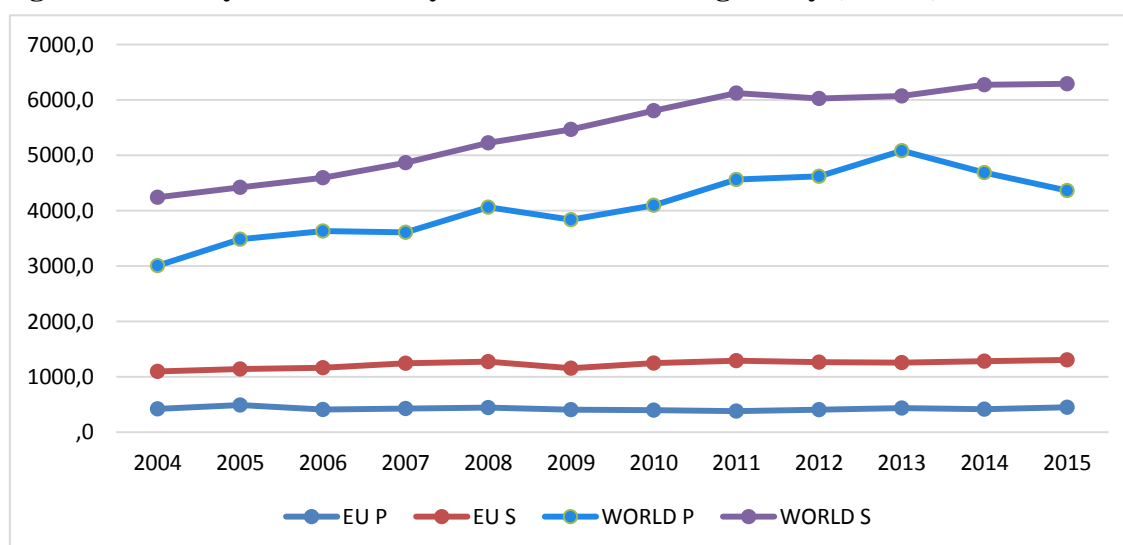
- The collection rate is high.
- These batteries consist of few materials and have a basic design that is standardised across the market and their dismountability and recyclability is high.
- The recovery is based on pyrometallurgical processes capable of producing high quality secondary lead.
- A well-established professional network ensures high levels of collection of waste automotive batteries.

Operating under these conditions, the use of secondary lead in the EU exceeds the use of primary lead (see Figure 4 below¹⁸²).

¹⁸¹ Section 3.2.4.4 above discusses the collection figures for waste automotive batteries.

¹⁸² Developed using data from the 'International Lead and Zinc Study Group'.
<http://www.ilzsg.org/static/home.aspx>.

Figure 4 Primary and secondary lead in the EU and globally (tonnes)



5.3.6. Is there any evidence that the implementation of the Directive has caused unnecessary regulatory burden or complexity? What factors identify this burden or complexity as unnecessary or excessive?

According to the tailored questionnaire¹⁸³, national administrations do not perceive the Directive's implementation to create unnecessary regulatory burden.

However, it has entailed new tasks for producers and national administrations, above all in Member States that did not have similar national legislation (or practices).

National administration representatives argue that if the responsibility to ensure particularly complex operations lies with local authorities, they may have to bear disproportionate costs. Organising collection activities could be one example.

5.3.7. To what extent does the Directive support the EU internal market and the creation of a level playing field for economic operators, especially SMEs?

Those involved in the manufacturing and sale of batteries show a clear preference for EU harmonised approaches that regulate the placement of new batteries on the market and the management of waste batteries.

However, national differences in enforcing some of the Directive's provisions, such as labelling rules and rules on metals in batteries, weakens the internal market. This enforcement gap puts the producers that strictly comply with the Directive at a disadvantage.

Sub-standard practices and different levels of recycling might cause unfair competition¹⁸⁴. There are no end-of-waste criteria set at EU level for the recycled parts of batteries (lead, plastics, etc.). The lack of such provisions in the Directive can distort the

¹⁸³ See Section 7.3.1 of the supporting study and Annex D, Section 4.

¹⁸⁴ Arcadis 2016.

way in which recycling efficiencies are calculated. Stakeholders think that there should be a certification system for recycling plants inside and outside the EU to ensure that the same standards for battery recycling are applied in all countries.

Online sales could also lead to distortion. Although the Directive applies to online retailing, it is difficult to ensure that online sellers contribute financially to national PROs. The absence of minimum penalties established at EU level is a possible loophole.

While many public consultation respondents (59 %) think that some of the Directive's requirements have resulted in significant costs for their organisation¹⁸⁵ several stakeholders considered labelling to be necessary to the single European market.

Collecting and sorting waste involves many groups and individuals and is usually a fragmented activity. Many **SMEs** coexist with large companies. Few companies in few Member States are able to conduct proper recycling of other than lead-acid batteries. However, newcomers can enter this emerging market provided they overcome the usual barriers, such as¹⁸⁶:

- the need to use advanced systems to recycle increasingly complex products, which would require heavy investments in research and development; and
- the high capital investments, which reduces the number of possible operators, and this could weaken the SMEs potential to play a significant role.

However, as shown by the emerging companies dealing with the collection and recycling of lithium batteries, SMEs are entering the market.

5.3.8. To what extent do emerging business-models (on e.g. transport or energy distribution) accommodate to the Directive?

Stakeholders broadly agree that the current regulatory framework is unsuitable for handling the expected rise in industrial batteries, although their views on how to address this situation vary.

The number of batteries placed on the EU market will increase sharply in the near future, including those used in transport and for energy storage. These batteries fall under the 'industrial batteries' category for which the Directive only vaguely regulates the obligations stemming from the extended producer responsibility principle¹⁸⁷.

The Directive notably places the responsibility for returning waste industrial batteries on the end-user. This raises questions on the suitability of obliging end-users to return powerful and large batteries.

Stakeholders underline that the different responsibilities in place should be clarified¹⁸⁸. In some Member States the PROs' mandate is extended to accept collecting industrial

¹⁸⁵ See Section C-11b for a detailed analysis of the results of the public consultation.

¹⁸⁶ Taken from Sørensen, S. Y.; Olsen, S. M. et al, 2013.

¹⁸⁷ See Section 5.3.3 above.

¹⁸⁸ The different concepts of EPRs applied in the Directive depending on the type of batteries are explained in Section 5.2.3 of the supporting study.

batteries, but it is unclear whether this also includes for instance lithium-based batteries for electric vehicles. Since the amount of industrial batteries belonging to particular end-users is expected to increase in the near future, addressing this issue has become a priority.

Many of the industrial batteries will use lithium-ion technologies. The lack of specific provisions on treatment and recycling of these batteries may create uncertainty for producers and users on the end-of-life conditions for these batteries. This uncertainty should be removed to increase the uptake of e.g. electric vehicles within the EU.

Table 16 Summary of findings on efficiency

- *The Directive's implementation has an impact on the economic viability of the battery manufacturing and recycling sectors. It remains to be seen whether the global result is positive or negative or whether all types of batteries and operators are equally affected.*
- *Businesses consider that implementing the Directive has entailed significant costs. However, according to the results of the public consultation, these costs are justified in light of the Directive's current and future benefits.*
- *The recycling system set in motion by the Directive, in particular its obligation to recycle all waste batteries collected, has been key to achieving the current performance of the EU battery recycling industry. It ensures the supply of materials to recyclers even when the revenue from these activities is low.*
- *Relevant provisions for placing industrial batteries on the market and on the management of waste industrial batteries are too ambiguous to support fully the implementation of the extended producer responsibility obligations. This is even more problematic given that their number is expected to increase sharply in the near future.*
- *Recycling also has environmental benefits and helps ensure the security of supply of secondary materials. Higher collection rates of all types of batteries would increase cost efficiency, which in turn could ensure better results for recycling activities.*
- *There are no provisions incentivising PROs to reach collection rates higher than those established at EU or national levels.*
- *Member States do not perceive the implementation of the Directive to bring unnecessary regulatory burden.*

5.4. Coherence and internal consistency

5.4.1. To what extent does the Directive complement or interact with other EU sectoral instruments? Are there de facto or de jure overlaps, contradictions, missing links ...?

Basic concepts, the Batteries Directive and the Waste Framework Directive (WFD).

Although the fitness-check does not find implementation problems, it suggests ways to improve the relationship between the Directive and the WFD. It notes that the Directive introduced concepts in 2006 that were later developed by the WFD (such as recycling or treatment) and that the definitions are not exactly the same. However, some important ideas in the WFD, like the waste hierarchy or waste reduction, have not been incorporated into the Directive.

The Batteries Directive complements WFD provisions. For that reason, full legal consistency should be ensured and any discrepancy in definitions should be avoided (e.g. recycling, treatment or even producer). Moreover, the Directive could incorporate concepts established by the WFD (such as re-use or waste hierarchy).

The new legislative framework

The Directive is not covered by the new legislative framework adopted in 2008¹⁸⁹ to improve the internal market for goods and strengthen the conditions for placing a wide range of products on the EU market.

This evaluation does not assess the consequences of this situation. . Other products associated with batteries are covered by this new legal framework (e.g. electronic and electric equipment) and batteries' exclusion establishes a de facto difference of the basic legal provisions applied to them (e.g. 'CE' marking).

Legislation on chemicals: the Directive, REACH and RoHS.

Until now, there has been no duplication or contradiction in the management of hazardous substances between the Directive and the other instruments mentioned.

Despite its general recommendation to encourage the development of batteries containing smaller quantities of dangerous substances, the Directive does not specify any criteria to identify the substances concerned or the type of management measures that could be adopted. Moreover, batteries still contain hazardous substances¹⁹⁰ and the management of the risks posed by chemicals contained in batteries is concerning.

For RoHS, duplication or contradiction is practically impossible, since their scope is mutually exclusive, as laid down in recital 14 of the RoHS Directive, and in recital 29 of the Batteries Directive.

REACH already establishes in its Annex XVII several restrictions to the use of mercury, cadmium and lead compounds, but does not duplicate or contradict the prohibitions and exemptions for mercury and cadmium established by the Directive.

¹⁸⁹ Regulation (EC) No 765/2008, OJ L 218, 13.8.2008; Decision No 768/2008/EC, OJ L 218, 13.8.2008; Regulation (EC) No 764/2008, OJ L 218, 13.8.2008.

¹⁹⁰ See Section 3.2.5 above.

The vast majority of the stakeholders consulted and many public consultation respondents agree that REACH is more suitable for managing chemicals in batteries, even if this instrument has a substance-based approach, not article-based one.

Such a shift should also consider that REACH follows a risk-based approach. When risks can be controlled there is no need to take regulatory action. Introducing a risk-based framework for batteries requires criteria to assess possible risks for the environment (and human health) posed by substances in batteries and procedures to define restrictions or authorisations. Socio-economic conditions should also be considered. REACH has all of these and could therefore easily manage hazardous substances in batteries.

The Batteries Directive and the Directive on the management of Waste Electric and Electronic Equipment (WEEE)

These two legal acts possibly have the biggest potential overlap. The industrial operators of the waste streams concerned are also often related. It is not surprising that stakeholders want these directives to harmonise definitions and concepts as much as it would be feasible.

There are difficulties in differentiating the scope of the two directives. Devices like power banks could be considered both a battery and an electronic appliance depending on the directive concerned. The more advanced the technological developments, the more difficulties will appear unless the Batteries Directive specifies its scope better.

According to the Batteries Directive, batteries incorporated into electric and electronic appliances should be removed from WEEE.¹⁹¹ However, the Directive does not indicate when the removal should take place (in technical terms, it should be before WEEE recycling takes place).¹⁹² This situation leads to confusion and misreporting since not all batteries removed from WEEE are considered as ‘collected’ and considered to calculate the collection rate.

The definition of ‘producer’ differs between the Batteries Directive and the WEEE Directive, while in many cases the same article is placed on the market and covered by both directives (e.g. any appliance with a battery inside). Moreover, the WEEE Directive establishes the role of ‘authorised representative’. This role is not present in the Batteries Directive and some national administrations think it should be incorporated.

Batteries Directive and the End of Live Vehicles (ELV) Directive

Automotive batteries are subject to the same requirements as other vehicle parts and also, therefore, to the relevant provisions of the ELV Directive, particularly those on recycling and the use of certain substances. Batteries of any kind used in vehicles are therefore subject to both directives.

While there have not been major examples of overlapping in the past, this possibility is becoming considerably more plausible with the technical developments in cars and batteries. It is difficult for instance to correctly classify new types of batteries in some (mild) hybrid cars, since they could simultaneously serve as starting-lightning-ignition batteries and as electromobility batteries. The calculation of the amounts of batteries

¹⁹¹ Article 12(3)

¹⁹² Recently developed standards for WEEE treatment also cover battery removal guidance, as EN50625-1, but its implementation remains limited.

placed on the market and of the parts of vehicles that undergo recycling and recovery could be affected.

Two of the substances prohibited by the ELV Directive, namely cadmium and lead, are relevant for batteries. The ELV Directive also establishes exemptions to prohibiting these two heavy metals (also in automotive batteries) including an exemption for the use of lead in (most) automotive batteries¹⁹³, which is to be reviewed in 2021.

On recycling, the fitness-check highlighted the risk of the double counting of batteries against the targets established by the two Directives. Automotive batteries retired from end-of-life vehicles are counted against the quotas set by the ELV Directive, and when they are recycled, they are counted against the targets of the Batteries Directive. There should be no double counting problems but in practice, they exist. Some stakeholders prefer that only the Directive establish in detail recycling obligations for batteries.

The classification of waste batteries as waste: the Batteries Directive, the 'list of waste', the Waste Shipment Regulation (WSR) and the Waste Statistics Regulation (WStR)

The categories of batteries used by the Directive, the WSR and the WStR are not consistent, which increases the risks of misreporting and prevents the comparability and complementary use of data.

The Batteries Directive defines three types of batteries (portable, automotive and industrial) while the list of waste classifies batteries according to their chemical composition. Problems are due to the existence of different chemistries within the same class of batteries established by the Directive. Reporting figures for the Batteries Directive and figures on batteries according to waste statistics, which are based on the list of waste, are not consistent.

For the WSR, the differences concern the classification of batteries for their treatment, recycling and disposal. This leads to the same types of waste batteries being classified differently by waste exporters and competent authorities. It also makes managing notifications under the WSR particularly difficult, since the codes needed for individual notifications do not correspond.

Ecodesign measures and the Batteries Directive

With the recently adopted strategic action plan for batteries, the Commission has decided to explore the possibility of establishing ecodesign requirements for batteries, without precluding the legal framework upon which to base them (the Batteries Directive, the Ecodesign Directive or a self-standing regulation).

While the focus on end-of-life measures suitably addresses the environmental pressures related to the management of waste batteries¹⁹⁴, it does not sufficiently integrate the life cycle concept, as pointed out by the fitness-check. The Directive addresses battery design for removability, but a life cycle approach would have to consider a full range of design

¹⁹³. DIRECTIVE 2000/53/CE, Annex II

¹⁹⁴ See Section 5.1.1 above.

aspects, pertaining to durability, recyclability, design for disassembly and toxicity. Important design features such as durability or recyclability are not dealt with.

Some stakeholders have suggested that these measures are introduced through the Ecodesign Directive, since requirements on the ‘design phase’ are typical conditions for products to be placed on the EU market. Action on design features could be better achieved at EU level because of its possible scale or effects.

Specific aspects to consider for a possible legal instrument include:

- battery removal and replacement;
- the environmental quality of batteries, i.e. restriction of hazardous substances, recyclability, minimum level of recycled content, etc.; and
- the performance of batteries, i.e. the minimum lifespan or number of cycles, roundtrip efficiency, etc.

Labelling of battery parameters to help inform consumers’ choice of products in terms of performance and quality could also be considered.

5.4.2. To what extent is the Directive internally consistent? Are there any overlaps, contradictions, missing links?

The Batteries Directive appears to be fairly well constructed and has no obvious contradictions or duplications. Nevertheless, a detailed analysis of certain provisions raises some questions.

The Directive's two broad objectives are (i) to minimise the negative impact of batteries and waste batteries on the environment; and (ii) to ensure the smooth functioning of the internal market and avoid distortion of competition. At an operational level, the Directive's overarching requirement is that Member States maximise the separate collection of waste batteries and minimise the disposal of batteries as mixed municipal waste in order to achieve a high level of recycling for all waste batteries.

The Directive sets targets for the separate collection of portable waste batteries and the recycling efficiencies of certain types of collected waste batteries. However:

- there is no target for the reduction of the disposal of batteries as municipal waste;
- there are no targets for the separate collection of automotive and industrial batteries; and
- the target of ensuring the treatment and recycling of ‘all’ collected waste batteries is only formulated in passing.

Reporting obligations are only defined for explicitly established targets. Since these obligations provide the best information on the Directive's implementation, the lack of appropriate targets makes it difficult, even impossible, to assess Member States' performance. Moreover, the deadline for meeting the targets (26 September of the years concerned) prevents the use of data from calendar years, obliging the Member States to close the reporting exercises artificially. This is exacerbated by the different deadlines for submitting the information, namely 18 months after the end of the calendar year concerned for the WStR and 6 months for the Directive.

Stakeholders have raised several potential challenges relating to **lack of detail or of detailed obligations**. These include:

- The lack of more detailed criteria to distinguish different types of batteries might create problems to ensure the implementation of some provisions. For example, at least five Member States currently apply (different) thresholds by weight as criteria for distinguishing between industrial and portable lead-acid batteries.
- The lack of detail on the exemptions from the removability obligation opens a loophole for manufacturers designing appliances in a way that does not support battery removal by the end-user.
- The labelling obligation does not apply equally to all types of batteries. For example, no obligation for labelling is defined for industrial batteries, no labelling is required for portable rechargeable batteries incorporated or designed to be included in electric and electronic appliances.

The calculation and reporting of recycling efficiencies, although sufficiently clear in theory, has had some problems in practice. The Commission Regulation¹⁹⁵ that details the rules for making the calculation uses concepts that are not defined by the Directive. In addition, the comprehensive nature of the definition of ‘recycling process’ makes its application difficult. The Commission¹⁹⁶ and key stakeholders (EBRA 2014)¹⁹⁷ have issued guidance to address these problems.

In some cases, instead of calculating recycling efficiencies for individual processes, values for the entire plant are used since this simplifies the whole calculation process¹⁹⁸.

Table 17 Summary of findings on coherence

- *Stakeholders call for the legislative framework for batteries to rely on a reduced number of legislative acts dealing with batteries, in particular regarding chemicals and end-of-life issues, with clearly defined boundaries.*
- *Many efforts have been made to improve coherence, avoid contradictions and ensure clarity in the interaction between the Directive and other legal instruments. However, this may not be enough to guarantee that the requirements from the different instruments concerned are adequately implemented by Member States and that all possible synergies are effective.*
- *In spite of the provisions encouraging the development of batteries containing smaller quantities of dangerous substances, the Directive does not specify criteria to identify the substances concerned or the type of management measures that could be adopted. In this respect, most stakeholders consider that REACH is a more adequate instrument to manage chemicals in batteries.*

¹⁹⁵ Regulation 493/2012, OJ L 151, 12.6.2012.

¹⁹⁶ <http://ec.europa.eu/environment/waste/batteries/pdf/Guidelines%20on%20RE.pdf>

¹⁹⁷ EBRA (2014) ‘Recycling Efficiency for Batteries’. <https://www.ebra-recycling.org/recycling-efficiency-batteries>

¹⁹⁸ See Sections 7.3.1 and 7.3.5 of the supporting study.

- *The development of new technologies in the fields of batteries, cars and electrical and electronic equipment may exacerbate the (already existing) problems to establish clear demarcation lines between the products and related obligations.*

Table 18 Summary of findings on internal consistency

- *The Directive neither presents its long-term goals and objectives properly nor links them with operational objectives or targets. Some of the objectives in the Directive are vague and do not have associated targets, which prevents the assessment of compliance later on.*
- *Furthermore, depending on the types of batteries concerned, the Directive establishes different obligations for producers or national authorities, without justification. This absence of full consistency could affect the ability of the regulatory framework to deal appropriately with the expected growth of the industrial batteries sector in the future.*
- *There are cases where the lack of detail or of detailed obligations may distort the internal single market for batteries (e.g. classification of batteries, consideration of recycling slag, exemptions to removability or labelling).*
- *The Directive does not sufficiently integrate life cycle concepts, in particular those dealing with ecodesign aspects.*

5.5. EU added value

5.5.1. What has been the EU added value of the Batteries Directive compared to what could be achieved by Member States at national level? To what extent do the issues addressed by the Directive continue to require action at EU level?

The majority of stakeholders who answered the public consultation recognise the advantages of having a unified regulatory framework. There is a general preference to keep that framework at EU level.

For example, 63 % considered that the protection of the environment would be worse without the Directive and 55 % thought the same about human health¹⁹⁹.

In some Member States, the Directive has led to the first legal provisions on batteries or on the extended producer responsibility principle being adopted. For example, a few Member States established higher and/or interim collection targets.

¹⁹⁹ See Section C 18 of the detailed analysis.

The Directive replaced national measures likely to discriminate against imports, with EU-wide rules. In particular it harmonised the content and labelling of permissible hazardous substances, substituting the individual national regulations.

With some variations between Member States a level playing field for producers and importers placing batteries on the EU market has been established, namely by introducing and harmonising the restrictions for hazardous substances, labelling and collection and recycling targets.

The environmental problems addressed by the 2006 Directive are still relevant today. Action at EU level continues to be pertinent in the light not only of the problems, but also of the measures that were proposed to address them.

5.5.2. Is the EU single market for EU batteries fully functioning? Is the Directive responsible of any barriers that prevent trade of batteries and waste batteries?

Stakeholders have not claimed the Directive's implementation to be the origin of any barrier to competition in the EU. On the contrary, they are consistently interested in ensuring the effective and equal enforcement of the Directive by all national authorities. Whether the Directive has reduced costs for the batteries sector (e.g. due to harmonised rules and facilitation of intra-EU trade) is a point of dispute.

Only 30 % of the participants in the public consultation²⁰⁰ considered that the internal market would work better without the Directive. Some stakeholders indicate that the obligation for PROs to register individually in each Member State is cumbersome and unnecessarily affects the free market. The EU framework has substituted or incorporated prior national systems and therefore few (and small) differences exist at present in the registration processes. After the 2013 modification²⁰¹, the procedural requirements for registration are established by the Directive itself.

Compliance with the Directive's collection and recycling rates has not led to higher costs for EU producers compared to single national regulations. Moreover, the progressive harmonisation of requirements defined at EU level is leading to some convergence for the costs of schemes.

Several stakeholders underline the role of national authorities on enforcement. Existing gaps in enforcing the Directive could distort the internal market and force producers that strictly follow the provisions in the Directive to compete with producers who do not make the same efforts. Portable batteries that do not respect the maximum levels of heavy metals or that are not properly labelled have been found²⁰², for example.

There is also the risk that differences in the understanding and implementation of the Directive affect the single market for batteries. The operational concept of recycling is understood differently by different Member States. Consulted stakeholders report that in

²⁰⁰ See Section C18.3 of the detailed assessment.

²⁰¹ Directive 2013/56/EU, OJ L 329, 10.12.2013.

²⁰² Recknagel and Radant, 2013.

some Member States the slag is accounted for as part of recycling but in others is not. Such differences hamper the development of a true level playing field for recyclers.

It is therefore interesting that only 21 % of the public consultation participants think that the Directive has reduced costs for the batteries sector due to harmonised rules and facilitation of intra-EU trade²⁰³.

Table 19 Summary of findings on EU added value

- *There is broad support that conditions for the placing on the market, collection and recycling of batteries continue to be set at EU level.*
- *Most stakeholders are convinced that the Directive has significantly contributed to the good functioning of the single market for batteries and that trade barriers are lower than would be the case with national regulations.*
- *However, there are cases where the lack of detail or of detailed obligations may distort the single market for batteries (e.g. lack of classification of batteries, consideration of recycling slag, exemptions to removability or labelling).*

6. CONCLUSIONS

The Batteries Directive has been evaluated to assess whether it delivers its intended benefits and to identify possible ways to improve its functioning.

The evaluation considered five criteria, namely the Directive's relevance, effectiveness, efficiency, coherence, and EU added value, and it also addressed particularly relevant issues. Several evaluation questions were developed, an evaluation method was established and possible problems and limitations of the whole exercise were identified.

Through extensive consultations, stakeholders expressed support for the evaluation method, ensuring a well-founded outcome. The evaluation also considers the well-documented status of implementation.

See the summary of the lessons learnt and of the answers to the evaluation questions below.

LESSONS LEARNT

Although the Directive has provided a broad EU framework, it is too general on the nature and extent of the objectives to be achieved and on important measures that the Member States have to implement. The Directive has problems with definitions, which hinders the achievement of its objectives.

For example, the links between long-term goals, quantified targets and the measures to reach them are not always suitably or clearly formulated. Nor is the expected outcome of

²⁰³ See Section C-12.8 of the detailed analysis of the results of the public consultation.

the Directive detailed in depth. Key objectives, such as achieving a high level of material recovery — and obligations, such as ensuring that all collected waste batteries are recycled — are not sufficiently highlighted. Considerable time and effort has been devoted to discussing basic concepts with the Member States and the results were not always convincing. A clearer description of the Directive's internal logic and links would have improved its transposition and implementation.

The evaluation process has pinpointed some concepts in the Directive that are understood differently by different Member States — the role of producers' organisations (PROs) for example. Our assessment shows that the overall organisation and requirements imposed on PROs vary widely between Member States. This helps explain the differences in Member States' performance and the internal market's current imbalance and distortion risks. The recently adopted provisions on extended producer responsibility in the WFD will help to address these risks.

Some Member States and businesses have a different understanding of whether slags should be considered as recycled products. The situation is similar for the obligations on collecting waste industrial batteries or for classifying spent batteries (as wastes). These differences contribute to the distortion of the internal market, cause misreporting and lessen the Directive's impact. The Commission issued guidance to address these and comparable issues, but it does not seem to have been enough. A more detailed definition of the concepts concerned would have helped to avoid these problems.

Experience with the Directive shows that producing information depends on establishing precise targets and metrics, and clear and meaningful reporting obligations. The Directive's relatively small number of measurable targets makes assessing its implementation and impacts challenging. Directive's overarching objectives such as reducing the amount of waste portable batteries that are disposed of in municipal waste streams, are not quantified and there are no reporting obligations associated. Additional and more detailed reporting obligations could have ensured better information on the EU batteries sector including on the Directive's impact on the sector.

While the Directive has been effective in ensuring that portable and automotive batteries are labelled, ensuring that information reaches end-users could be improved. Labelling alone is not enough. Other activities, like public information campaigns would increase effectiveness. A clear definition of producers' obligation for financing these activities would have helped to inform end-users better on their expected role on ensuring spent batteries are collected.

RELEVANCE

The environmental concerns addressed by the Directive are still relevant today: batteries contain hazardous substances and present a risk to the environment when improperly disposed of. While mercury-containing batteries are being phased-out, old and 'new' batteries still contain other hazardous substances.

The two main approaches to facing these risks (i.e. the reduction of hazardous components and the management of waste batteries) **are suitable**, even if new and stronger complementary measures are needed to deal with the huge amount of waste batteries that is expected to be generated in the coming years.

Several important elements of the Directive's circular economy-related approaches correspond to the **main elements of the circular economy policy**, to address material

recovery, set conditions for recycling processes or establish supportive regulatory mechanisms, for example. However, not all stages are included in the Directive and provisions on sorting or other pre-recycling stages of waste batteries, for example, are lacking.

The evaluation also shows that **the Directive cannot sufficiently incorporate easily technical novelties**. For instance, lithium-based batteries are included in the scope of the Directive but not specifically considered. Likewise, the Directive does not address the possibility of giving advanced batteries a second life, making developing re-use approaches more difficult.

EFFECTIVENESS

The Directive contributed to reducing the use of hazardous substances in batteries and to preventing waste portable batteries from being landfilled or incinerated, but this was not achieved up to the level expected.

Only half of Member States have met the Directive's target on collection of waste portable batteries. An estimated 56.7 % of all waste portable batteries are not collected, of which around 35 000 tonnes enter municipal waste streams annually, resulting in environmental harm and loss of resources.

The problems to meet the collection rate target reveal **deficiencies in the Directive**. The **current targets for collecting waste portable batteries do not promote a high level of collection**. Furthermore, the Directive has different approaches for managing end-of-life batteries. The fact that collection rate targets only exist for spent portable batteries could be confusing and prevent the achievement of the Directive's objectives.

The **Directive's methodology for compiling, assessing and reporting information on waste portable battery collection rates** creates some practical difficulties. As reporting obligations only apply to portable batteries, it is even more difficult for public authorities and industrial operators to access reliable information on the collection of waste batteries.

On the other hand, **the Directive has ensured the highly efficient recycling of collected waste batteries**. Current targets of recycling efficiencies appear to be easily achievable by the EU industry.

However, the general objective of achieving a high level of material recovery has not been achieved. Recycling efficiencies are defined for only two substances: lead and cadmium, ignoring other valuable components such as cobalt and lithium. In addition, these definitions are not oriented towards increasing material recovery. Therefore, **current recycling requirements are not considered appropriate to promote a high level of recycling and recovery from waste batteries and accumulators**.

The **implementation of extended producer responsibility** has taken place through collective producer schemes in many Member States. This is a success of the Directive. The positive role of these organisations could be strengthened if the Directive provided incentives to increase collection rates above established minimum values.

Problems to reach the Directive's targets indicate that **end-users do not always receive adequate information** about their expected contribution. Defining in detail Member States' awareness-raising obligations, establishing clear objectives and making use of

more up-to-date means of communication, notably social media, could help increase the end-users' involvement and hence collection rates.

The Directive also lacks a proper system to inform end-users of the quality of the batteries placed on the market.

EFFICIENCY

The efficiency analysis shows that the Directive has had an impact on the economy of batteries' manufacturing and recycling sectors. Businesses consider that implementing the Directive has entailed significant costs but they and other stakeholders broadly agree that these are outweighed by present or future benefits.

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.**

The Directive's provision on recycling all collected batteries is key to ensuring the viability of recycling activities. This obligation actively contributes to ensuring the supply to recyclers and its absence could cause investment risks. If higher levels of supply, i.e. higher collection rates of all types of batteries were achieved, better results for recycling activities would have been expected.

In addition to lowering the reliance on imports of particularly important raw materials, including critical ones, recycling may have economic benefits. However, the Directive unnecessarily limits these benefits, as it only establishes efficiency targets for lead and cadmium. The recovery of other valuable materials, such as cobalt, lithium or critical raw materials is not specifically promoted.

Extended producer responsibility obligations for industrial batteries are not well-defined. There are no detailed provisions for collection, setting up national schemes and financing aspects for industrial batteries, which will be increasingly relevant in future as using these batteries is considered vital for low carbon policies in the EU.

This absence of a specific provision in the Directive makes it difficult to ensure that all industrial waste batteries will be properly collected and recycled (or reused) in the future and affects regulatory framework's ability to appropriately deal with the expected growth of the industrial batteries sector.

COHERENCE WITH OTHER LEGISLATION

Stakeholders generally want the provisions on batteries to be concentrated in fewer legislative acts, particularly for chemicals and end-of-life issues, and that the relationships between these acts are clearly outlined.

While the Directive encourages developing batteries with smaller quantities of dangerous substances, it does not specify any criteria for identifying the substances concerned or the type of management measures that could be adopted. **It should therefore be considered whether REACH is more adequate for managing chemicals in batteries.**

Guidance documents have been prepared to ensure consistency and avoid contradictions between the Directive and other legal instruments. However, this may not be sufficient to

guarantee that the requirements of the instruments concerned are fully implemented and that possible synergies are effective.

The development of new batteries, cars and electric and electronic equipment technologies requires clear demarcation lines for the obligations that apply to the products concerned, independently of the legal instrument concerned (i.e. the directives on Batteries, WEEE and ELV).

INTERNAL CONSISTENCY

The Batteries Directive has no obvious contradictions or duplications. However, **some of its basic concepts are not well-defined and some objectives remain vague, particularly when there are no specific measures to be implemented or targets to be met.**

The Directive only sets targets for the separate collection of portable waste batteries and the recycling efficiencies of certain types of collected waste batteries. In particular:

- there is no target for reducing the disposal of batteries as municipal waste;
- there are no quantitative targets for the separate collection of automotive and industrial batteries; and
- the obligation to ensure the treatment and recycling of ‘all’ collected waste batteries is not explicitly spelled out.

Reporting obligations are only established when targets are set. The absence of quantified targets makes it very difficult to assess Member States' performance on these particular aspects.

There are cases where the **lack of detail in the definition of the obligations may distort the internal market** such as the classification of batteries, exemptions to obligations on removability or labelling, and the consideration of slag as a recycled product.

EU ADDED VALUE

There is significant support for **the conditions for the sale, collection and recycling of batteries to continue being set at EU level.** Stakeholders consider that the Directive has been the major contributor to ensuring the harmonisation of the batteries market. Most stakeholders also consider that the Directive has contributed to the well-functioning of the single market for batteries and that **trade barriers are lower compared with what national regulations could have achieved.**

ANNEXES

A. PROCEDURAL INFORMATION

The evaluation has been coordinated by the European Commission's Directorate-General (DG) for Environment supported by an interservice steering group involving representatives of DG Internal Market, Industry, Entrepreneurship and SMEs, DG Climate Action, DG Energy, the Joint Research Centre, Eurostat, DG Justice and Consumers, DG Research and Innovation and the Secretariat-General. The group steered and monitored the evaluation's progress and ensured that it met the necessary standards for quality, impartiality and usefulness.

A Europa webpage was set up to provide information on the evaluation process²⁰⁴.

The roadmap was published on 16 August 2016, with a four-week period for people to give feedback.

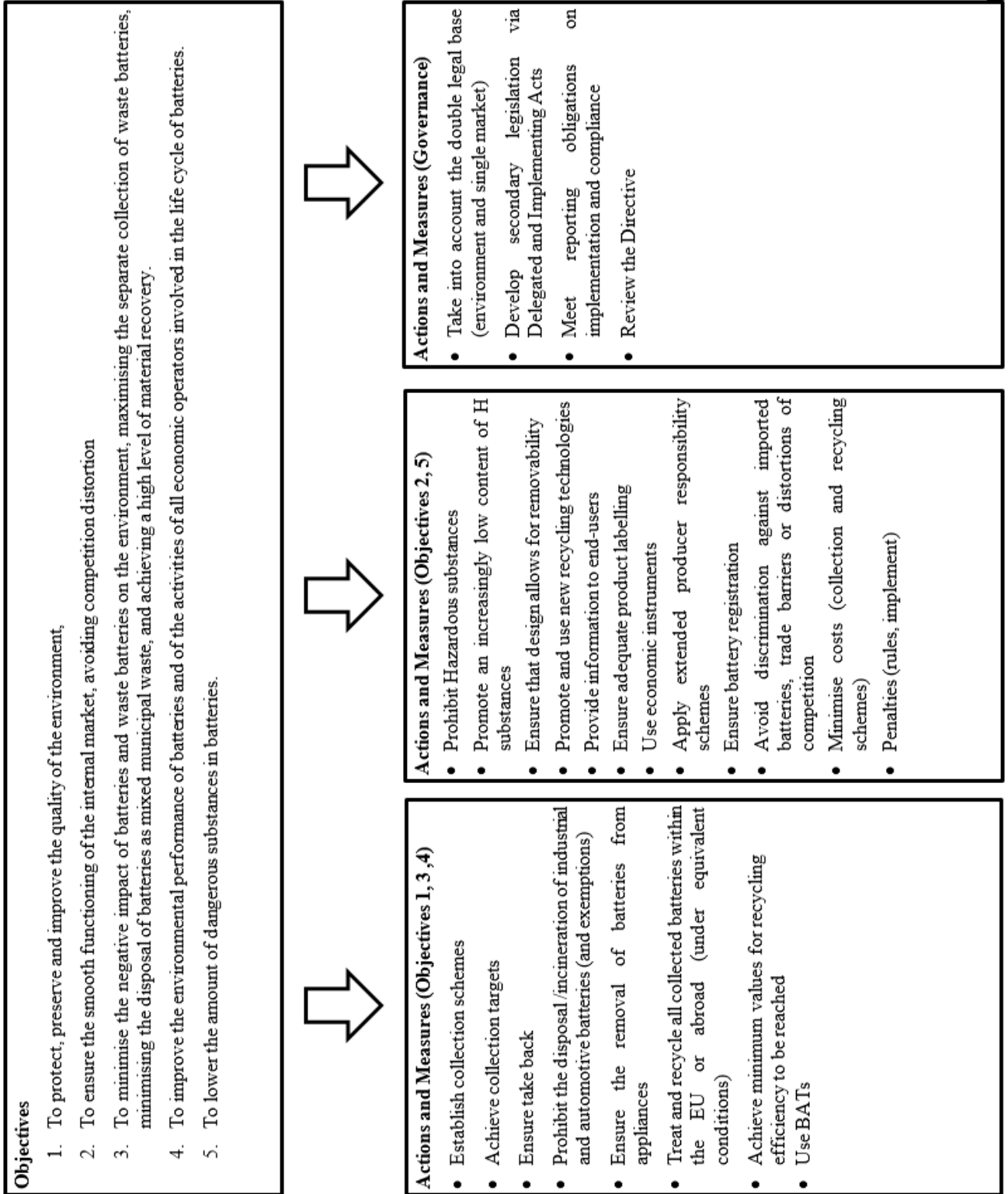
The evaluation exercise was presented to the members of the expert working group on waste (batteries), at its meeting of 20 June 2017.

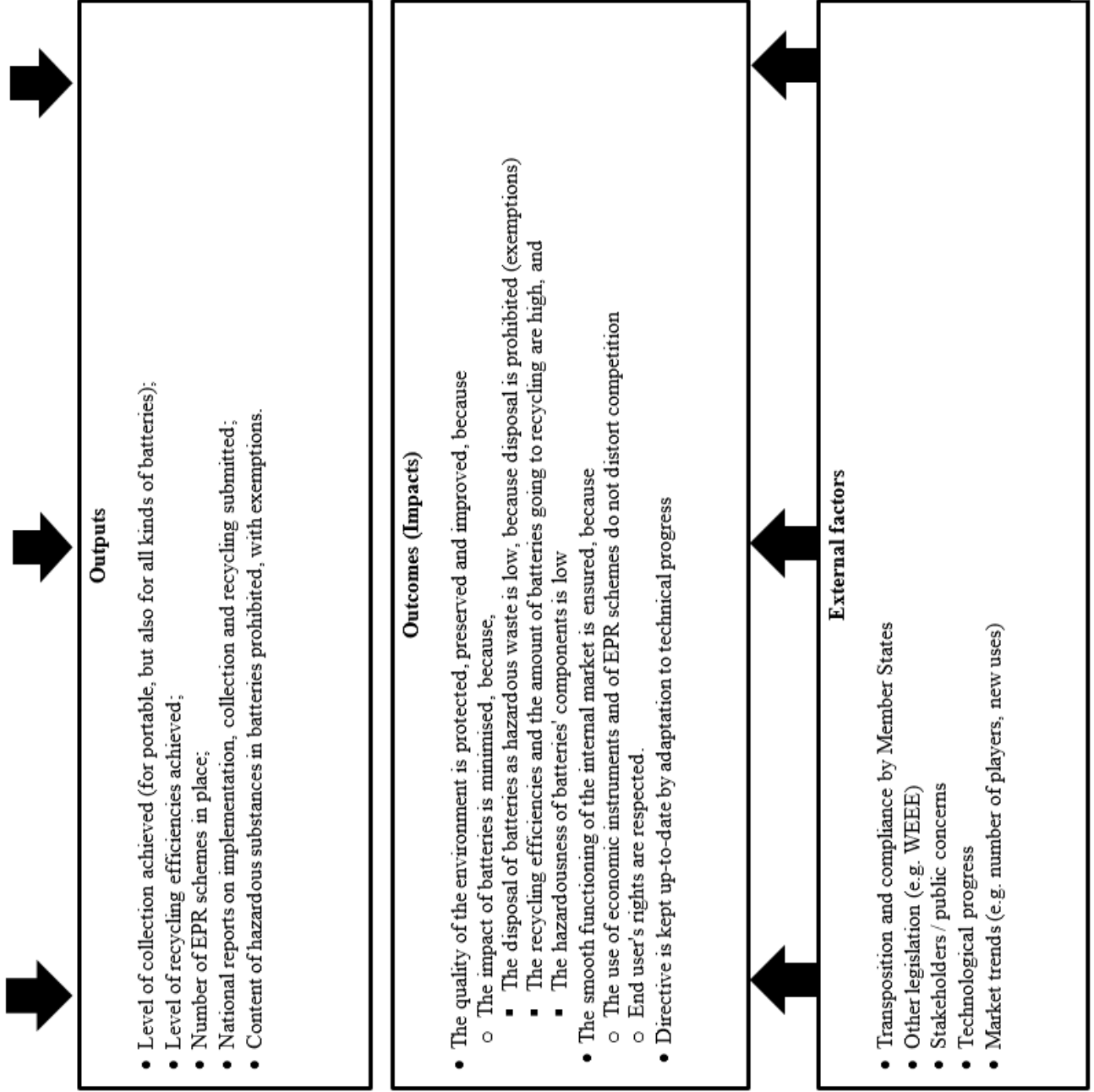
The 12-week public consultation took place between 6 September 2017 and 28 November 2017, targeting the general public and organisations, using the EU Survey tool.

The expert group on waste (batteries) held a meeting on 14 March 2018 to discuss the results.

²⁰⁴ <http://ec.europa.eu/environment/waste/batteries/evaluation.htm>

B. LOGIC OF THE ACTION





C. CRITERION AND SUB-AREAS FOR THE EVALUATION

Annex A of the supporting study provides all details of the evaluation question and of the evaluation matrix.

Criterion Sub-area	A. Relevance	B. Effectiveness	C. Efficiency	D. Coherence	E. EU added value
Impact on the environment	--	B11 Improve environmental performance B12 Positive changes B13 Negative changes	--	--	--
Impact on functioning of the internal market	A21 Most frequent use for batteries A22 Design features A23 Consumer expectations	B21 Functioning of internal market B22 Consumer information and awareness	C21 Operators C22 Cost and benefits at national level C23 Cost and benefits at EU level	--	--
Appropriateness of further risk management measures for heavy metals	A31 Status of hazardous substances A32 Battery labelling	B31 Hazardous substances prohibition B32 Battery labelling	C31 Hazardous substances C32 Battery labelling	--	--
Appropriateness of the minimum collection targets	--	B41 Waste batteries collection rates B42 Collection schemes B43 Remove batteries	--	--	--
Possibility of introducing further targets	A51 Resource efficiency A52 Calculation methodologies	--	--	--	--
Appropriateness of the minimum recycling requirements	--	B61 Recycling efficiency targets B62 Ensure recycling within EU or abroad B63 Prohibit disposal B64 BAT	--	--	--

Criterion Sub-area	A. Relevance	B. Effectiveness	C. Efficiency	D. Coherence	E. EU added value
Extended producer responsibility	A71 Safety risks	--	C71 Good practices for cost effectiveness C72 Less cost-effective provisions	--	--
Emerging trends and new developments	A81 Emerging trends A82 New battery systems A83 New applications for batteries A84 New recycling technologies	--	--	--	--
Other, cannot be allocated to a specific sub-area	--	--	--	D1 Interaction D2 Reporting obligations D3 Internal consistency	E1 Effectiveness E2 Efficiency E3 Synergy E4 Other

D. SYNOPSIS REPORT ON CONSULTATION ACTIVITIES

This annex provides a synopsis of the stakeholder consultation carried out as part of the ex-post evaluation of the Batteries Directive. Most activities referred to in this document are also presented in the study in support of the evaluation ('the supporting study').

The approach for the stakeholder consultation was outlined in the consultation strategy. It was based on the evaluation roadmap and on the terms of reference for the supporting study.

1. EVALUATION ROADMAP AND CONSULTATION STRATEGY

The roadmap²⁰⁵ was published on 16 August 2018 with a four-week period for people to give feedback. Six reactions were submitted by²⁰⁶:

1. The Centre for Economic Development, Transport and the Environment (Finland)
2. EPBA — the European Portable Battery Association
3. EUROBAT
4. OVAM
5. The Portuguese Environment Agency
6. Zentralverband Elektrotechnik — und Elektronikindustrie e.V (Germany)

The respondents underlined that the evaluation processes needed to take account of the new political and technical landscape, such as the circular economy and new battery technologies. They also highlighted areas that they thought the evaluation should cover, notably implementation factors (such as reporting or how to classify batteries in practice) and enforcement.

The inter service group (ISG) steering the evaluation considered the reactions to be supportive of the exercise as described in the roadmap. There was no need to modify the roadmap since all the points proposed could be accommodated in the version published. The ISG also discounted from the ongoing evaluation those comments that directly jumped to possible conclusions of the evaluation itself or on elements of the future legal system for batteries.

The consultation strategy was developed during the inception phase of the study, initiated in January 2017. A draft consultation strategy was circulated to the members of the ISG and eventually published in July 2017²⁰⁷.

2. IDENTIFICATION OF STAKEHOLDERS

205 http://ec.europa.eu/smart-regulation/roadmaps/docs/2017_env_016_batteries_evaluation.pdf

206 The submissions can be found at: http://ec.europa.eu/environment/feedback_en.htm#roadmaps

207 http://ec.europa.eu/environment/waste/batteries/pdf/ConsultationStrategy_finaldraft_ENV_19JUL.pdf

Stakeholders were grouped according to the extent to which: (i) they had an influence on the Directive's implementation (or were influenced by this implementation); and (ii) they have specific knowledge of / experience on the issues dealt with by the evaluation.

The main stakeholder groups were categorised as follows:

- **Public administrations.** The experience gathered by national administrations in implementing the Directive was considered to be very relevant and highly specific. National administrations were consulted during meetings of the expert group on waste, a consultative group to the European Commission, made up of experts designated by Member States.
- **Industry associations** (producers, waste batteries collectors and recyclers, including small and medium enterprises). The experience and knowledge of the industry was deemed to be very important to assess the Directive's impact on the different stages of battery production and use.

It was noted that industrial operators constitute a well-structured sector and that there were several organisations at EU level that covered the whole life cycle of batteries and that were able to convey the different interests and views of their members.

- **General public, consumers, environmental protection organisations.** The views of end-users and consumers, who are directly affected by the Batteries Directive, were recognised as crucial for assessing whether the Directive had met its objectives. Interestingly, their views go beyond purely technical considerations.

Environmental NGOs' contributions were useful for linking batteries policy with broader considerations about the circular economy, pollution, waste management, environmental legislation, etc.

- **Other stakeholders** e.g. academia, think-thanks, etc., who may have an interest in the Batteries Directive could be consulted on specific issues.

Several tools for engaging stakeholders were used to ensure a successful consultation on the evaluation. They included (i) interviews with selected stakeholders; (ii) a questionnaire for national administrations; (iii) a public consultation; and (iv) a workshop to present and discuss the study's initial findings. More information on each of these tools is given below.

3. TARGETED INTERVIEWS

Interviews (telephone interviews and in exceptional cases face-to-face interviews) were conducted with relevant stakeholders (e.g. industry associations, consumer organisations and environmental NGOs). The purpose was to validate and clarify matters that arose from the initial assessment of data and the cross-referencing of data from different sources, and to gather additional information and details where necessary.

Specific guidelines were developed for each interview and submitted to interviewees in advance to familiarise them with the aspects to be discussed. Minutes of the interviews were prepared for the reporting exercise.

The evaluation roadmap identified seven active stakeholders who were interested in providing information on batteries and the implementation of the Directive. Particular care was taken to ensure that the stakeholders concerned were representative (regarding

the batteries' life cycle stages) and balanced (to confirm the representation of all groups). The stakeholders interviewed were:

1. the Battery Recycling Association (EBRA);
2. the European Portable Battery Association (EPBA);
3. the International Association for Advanced Rechargeable Batteries (Recharge);
4. the European association of national collection schemes for batteries (EUROBAT);
5. the European Automobile Manufacturers' Association (ACEA);
6. the Association of European Automotive and Industrial Battery Manufacturers (Eurobat); and
7. the EU Association representing Consumers; European Consumer Organisation (BEUC).

Interviews were held in English and all were completed by September 2017.

Finding an environmental NGO with a clear focus on batteries proved rather difficult. As the EEB completed the public consultation and provided comprehensive written input, it was decided that no additional interview was required.

For the consumers' perspective, only the European Consumer Organisation BEUC was targeted. No EU-level representatives were identified for organisations of small and medium enterprises specific to this field. However, as some EU-level battery organisations include enough SMEs, this was not considered to be a problem.

The targeted interviews with stakeholders have been key to make up for the lack of detailed economic information. Although very limited monetised information was disclosed, the hints and the explanations provided have been very useful to draw a sufficiently reliable picture of the economic relations between the different groups and organisations involved.

Some conclusions

- The **recyclers'** representatives underlined the limitations in the current Directive that prevent reaching its objective of a 'high level of material recovery'. In their understanding the recycling efficiencies targets are not formulated to ensure materials recovery but as a way to remove dangerous substances from industrial cycles.

They also emphasise the absence of specific treatment for lithium batteries, above all in terms of targets.

Recyclers underline that the obligation to treat and recycle all waste batteries collected plays a key role in keeping the system running. That said, recyclers also reminded us that their activity is not only driven by legal considerations or policies but mostly by economic considerations.

- Representatives of **collectors** raised the problems posed by the Directive's current system of measuring collection rates. They share the national administrations' opinion that that the current system cannot adequately reflect their efforts to meet the Directive's collection target for waste portable batteries. Their proposals to

change the timeframe for averaging the values to 6 years or to apply the ‘batteries available for collection’ concept are not clearly supported by national administrations.

These stakeholders also point out the limitations of the EPR system defined in the Directive. Where there are different PROs competing, some of them may limit their activity to strictly achieving the minimum targets while others can be obliged to reach higher targets or even to provide awareness-raising activities and establish collection points.

Collectors underline their importance in terms of ensuring that sufficient amounts of waste batteries are available for recycling in addition to meeting specific obligations set out in the Directive,

- Representatives of battery **producers** highlighted the importance of strengthening the elements of the Directive that work properly and of considering that any modification should only be introduced after establishing that the provisions concerned do not work as expected.

For example, they underlined that the current system of battery classification is flexible enough as it is and that it only requires the introduction of new elements of differentiation between batteries.

However, they raised the need to ensure that some provisions in the Directive that define their obligations on the extended producer responsibility principle are adapted to new technical situations, such as the re-use of industrial batteries.

- Several of the stakeholders consulted think that the Directive's scope should not be excessively broadened. Matters such as safety of use should be dealt with under other EU legislation.

4. QUESTIONNAIRES FOR NATIONAL ADMINISTRATIONS

A questionnaire was developed and circulated to all members of the expert group on waste (Batteries Directive). Special focus was given to reporting. Parts of the questionnaire were discussed at the expert group’s meeting held on 20 June 2017 in Brussels. 10 Member States provided answers to the questionnaire and/or provided additional information on some waste streams.

Main results

National administrations are a source of important information. Their input provides a deep understanding of the Directive's shortcomings and the consequences of such shortcomings, namely:

- New technical developments such as second life or an increase in lithium-based batteries are a challenge for those implementing the Batteries Directive. However, any changes should aim to simplify the provisions and make them easier to apply.
- While the Directive has required a number of new activities to be set in motion new procedures to be applied, this is not considered particularly burdensome. When local administrations have to ensure that tasks requiring major investment are carried out, their costs can become disproportionate.

- The difficulty in distinguishing different types of batteries, namely portable and industrial lead-acid batteries is generally recognised. Since the Directive does not require separate reporting mechanisms for these two types of batteries, there is a risk of misreporting. Concepts in the Directive should be therefore be revised. Some participants, however, indicated that any additional criteria to distinguish between the different battery types should be easy to put into practice.

Further harmonising the Directive's reporting requirements with those of other legislation, namely WEEE or the list of waste would improve the reports. This harmonisation should ensure that that the definitions and methodologies are equally applied in all Member States (which is apparently not the case at present).

- The reliability of collection rates results is a concern for administrations. Some think that the current system could not adequately reflect their efforts to meet the collection target for waste portable batteries.

Changes in the methodology, including basic definitions, may be needed but a cautious approach will be necessary. Although the aim should be to obtain accurate information, other aspects such as reducing the complexity of the process should be considered.

According to the replies to the questionnaire, the theory and methodology for calculating recycling efficiencies are clear. However, they are difficult to implement and there is a risk that Member States apply the system in different ways. It was also very challenging to submit the information within the very short period specified in the Directive. This raises doubts on the reliability of the results of the Directive's recycling efficiencies reporting system.

- The system of reporting recycling efficiencies for processes taking place abroad is generally considered inadequate. According to some administrations, it is impossible to apply due to the considerable efforts needed to find out the fate of batteries treated in other countries. This situation increases the risk of misreporting.

While acknowledging the difficulties, some pointed out that Eurostat's statistics are the main if not the only source of information on recycling efficiencies in processes both inside and outside the EU.

- Some national administrations highlight the need to improve labelling to simplify sorting, optimise recycling processes and improve safety. A colour-based system to distinguish chemistries, similar to the one promoted by the Battery Association of Japan is proposed.
- Relevant entries in the list of waste for spent batteries are not considered sufficient to ensure that waste batteries receive the same classification in different Member States, notably on their level of hazard. This creates administrative complexities for the cross border trade of waste batteries (including transport).

5. PUBLIC CONSULTATION

A 12-week online public consultation took place between 6 September and 28 November 2017. It targeted the general public and organisations and was available in German, French and English.

The public consultation was aimed at stakeholders who could not have participated in other forms of consultation. Organisations and individuals affected by the Batteries Directive were identified early on in the study (see above) and informed of the consultation. National authorities were also informed. To maximise the response rate, a link to the survey was placed on the waste web pages of the Commission's Europa website.

The questions were grouped under two separate sections. One was for the general public and had a limited number of more general questions. The other had more specific and detailed questions on batteries and waste batteries²⁰⁸. The questionnaires were available in English, French and German. Participants could also provide written comments (including position papers) and additional data.

A total of 151 participants responded to the consultation²⁰⁹ before the deadline.

- 15 participants submitted the completed survey for ‘citizens with a general interest on batteries and waste batteries’;
- 136 participants submitted the completed survey for ‘citizens and organisations with specific interest and knowledge on batteries and waste batteries’; and
- 27 participants submitted additional written contributions.

The consultation notably also elicited consolidated contributions from industry organisations, which account for a sizeable proportion of the total replies received.

On the origin of the responses, 96 % of the participants were based in the European Union (EU-28). Within the EU, the most responses were from the UK (18 %), Belgium (13 %), France (13 %) and Germany (12 %).

Many of the participants are based in Belgium, presumably because Brussels hosts many EU interest groups such as industry associations, non-governmental and consumers’ organisations, etc.

Main results

The survey results were compiled and checked. The data were analysed and summary statistics were produced for each question. The detailed results are annexed to the supporting study²¹⁰.

²⁰⁸ https://ec.europa.eu/info/sites/info/files/batteries_online_questionnaire.pdf

²⁰⁹ The factual summary of the consultation can be found at:
http://ec.europa.eu/environment/waste/batteries/pdf/Factual_summary_consultation_9_2_18.pdf

²¹⁰ <http://ec.europa.eu/environment/waste/pdf/Published%20Annex%20Public%20Consultation.pdf>

The aspects most frequently raised by the participants in their comments to (open) questions and in their written contributions are summarised below.

- There was a consistently strong call to ensure that the Directive's provisions be equally implemented through the EU. Possibly confusing definitions were highlighted, such as those for the classification of batteries. For example, some Member States use weight criteria to distinguish between batteries, which is not explicit in the Directive. Different interpretations by Member States could affect the reporting results for collection rates and recycling efficiencies, preventing the comparison of results across the EU. This could affect market surveillance and enforcement efforts, resulting in risks for the internal market.
- Several stakeholders underlined their preference that markets move away from situations where collection rates and recycling efficiencies stick to the minimum values established. They think that the Directive lacks a clear indication that recycling operations that achieve higher rates are preferred. The competition between operators is driven by prices and costs, and not by efficiency and technological excellence.
- Stakeholders are clearly in favour of keeping the current definitions of the three battery types, even if they raise some shortcomings that need to be addressed. Establishing clear demarcation lines and criteria, even with examples, would be the definitions to be adapted to new technological situations and to preventing divergent interpretations of the legal concepts concerned.

That said, several stakeholders raised the challenge for the Directive to keep pace with technological evolution such as battery miniaturisation or printed/film batteries. These and similar trends raise questions about the definition of batteries in the Directive, on the applicability of (all) provisions, etc.

- Many stakeholders highlighted the growing importance of some chemistries, namely lithium-based batteries, which are not specifically addressed in the Directive. Several stakeholders also pointed out the absence of provisions for second life batteries (and the related responsibilities in the supply chain) in the Directive.
- There appears to be broad agreement on the Directive's insufficiency in the area of chemicals management. Some stakeholders would clearly prefer the REACH Regulation to be the prevailing piece of legislation for chemical products. In this scenario, there would be no need to incorporate risk management measures for new substances in the Directive. Their management would simply need to be transferred to REACH. However, views differ on the substances that are currently under restricted use (cadmium and lead).

Stakeholders' divergent views mainly concern the exemption of lead for automotive batteries that is currently regulated through the ELV Directive.

- Stakeholders underline the need to ensure better coordination with the Directive on Waste Electrical and Electronic Equipment at several levels. There is the practical issue of ensuring that batteries incorporated into waste electric and electronic devices are removed before being treated and recycled. Moreover, the legal challenge of differentiating electric and electronic devices from batteries could prevent proper collection and reporting in future.

- Removability and replaceability were generally considered as pending issues. The increased number of cases where batteries are not removable shows, for some stakeholders, the insufficient development of related provisions in the Directive.
- Stakeholders also discussed the role of labelling to inform consumers and encourage the sorting of different types of batteries. They generally recognised the need to improve information to general public (via labelling and other means). Better labelling (e.g. colour coding for different chemistries) could ensure better sorting and increased safety during the recycling process.

6. WORKSHOP

An extraordinary meeting of the Commission's expert group on waste (batteries) took place on 14 March 2018. It had a single point in the agenda – a presentation of the initial results of evaluation's supporting study.

Experts from 22 Member States²¹¹ and 21 representatives of EU organisations and firms attended. National experts and representatives of industrial operators could exchange information and views on the initial results of the supporting study.

Oko Institut circulated their presentation²¹² on the Batteries Directive's shortcomings, inconsistencies and problems, which served as basis for discussions.

Main results²¹³

- Collection rate

Several participants agreed with the initial finding that the calculation methodology for the collection rate (of portable batteries) does not accurately reflect the actual situation. Several reasons were given to explain that situation, one being that the batteries' longer lifespan delays their return. The participants did not object to the general finding that alternative calculation methodologies for the collection rate should be assessed and compared to the current methodology.

- Recycling efficiency

The participants did not object to the consultants' statement that Member States count output fractions of the battery recycling processes (in particular slag) differently.

Other key challenges include the lack of data available on recycling abroad and missing certifications. Participants generally supported the consultant's analysis

²¹¹ AT, BE, BG, CY, CZ, HR, DK, EE, FI, FR, IT, LV, LT, MT, NL, PL, PT, RO, SK, SP, SE, and UK.

²¹² <http://www.batteryevaluation-study.eu/index.php?id=4>

²¹³ See also the analysis of the results of the public consultation, at: <http://ec.europa.eu/environment/waste/pdf/Published%20Annex%20Public%20Consultation.pdf>

that recycling efficiency is related to a process/ recycling plant and less to a Member State's efficiency.

- Distinction between industrial and portable batteries

The discussion on industrial and portable batteries concluded that the distinction between these types of batteries is not coherent across the EU. Member States gave examples of the distinction between 'portable' and 'industrial' batteries during collection not always being applied in practice.

Batteries used in applications like personally owned e-bikes, EV traction/propulsion batteries and photo-voltaic energy storage, present a challenge in determining who is responsible for providing the collection infrastructure.

- New developments

Li-ion batteries are considered as the main new battery type since the entry into force of the Batteries Directive.

Other new policy developments since 2006 affecting the Directive include resource efficiency and critical raw materials. Participants raised and discussed issues such as the importance of quality of recycling outputs and the specific materials to be recovered, the fact that current battery composition might change and the potential challenge of miniaturisation (e.g. printed batteries).

- Consumer information

Consumer information does not only involve labelling. It may include general public awareness, e.g. awareness-raising campaigns. Overall, the participants did not raise objections to the contractor's initial conclusion that information for consumers is not sufficiently available. One point raised was that information should either serve consumers' needs or influence their behaviour. Participants were reminded that several Member States did not reach the collection targets and that consumers therefore need to be encouraged and informed so that they contribute to proper collection.

- Labelling

Participants confirmed that capacity labelling for primary batteries is currently not possible. On labelling batteries with their battery chemistry, several attendees supported the position that this would improve battery sorting and subsequently lead to better recycling results.

- Battery removability

The participants did not object to the initial findings that, although data on battery removal is lacking, it is observed that non-removability is increasing. There were heated discussions on other aspects of removability, mainly on the differences between the WEEE Directive and Batteries Directive and whether to address removability in the Ecodesign Directive and/or in the Batteries Directive.

- Hazardous substances

Initial findings indicate that the Batteries Directive addresses mercury, cadmium and lead as hazardous substances without providing specific guidance on how to define hazardous substances. There were no objections to the suggestion to develop documents or refer to existing acts (e.g. REACH/CLP Regulation) for guidance on criteria to define the hazardousness of substances present in batteries.

- Second use — re-use / preparation for re-use

It was generally agreed that the current legislation is not sufficient to deal with the new situation of the re-use/ second use of batteries from electric vehicles. In this context, the ‘innovation deal’ — a new project by the European Commission and partners including companies and national and regional authorities to tackle the problem of recycling and reusing electric vehicle batteries — was mentioned.

7. SUMMARY

The number of EU stakeholders dealing with batteries in a professional capacity is assumed to be rather small. In principle, all the relevant stakeholders provided input to the public consultation and many of them submitted additional written comments. The input to the public consultation and the interviews therefore overlap considerably.

The public consultation results, the interviews and the questionnaire completed by national administrations can therefore confidently be assumed to provide comprehensive and sufficient information on stakeholders’ opinions and positions.