

Introduction

- “the initiative will modify the Directive or a proposal for a new Regulation repealing the Directive will be prepared, to notably encompass end-of-life and sustainability requirements. (... Q4 2020)” 2020 CWP
- Information from
 - Studies and consultation underpinning the assessment and evaluation of the Directive,
 - Studies and consultation carried out in the context of the ‘eco-design’ process,
 - Extensive consultation processes during and following up to the Strategic Action Plan on Batteries,
 - Two specific studies,
 - *Feasibility of measures addressing shortcomings in the current EU batteries framework system,*
 - *Study addressing particular topics on batteries (legal statuses, restrictions, etc).*

Proposed approaches and measures

- Taken from
 - EU institutions
 - Stakeholders' proposals
 - Technical and scientific publications
- Disclaimer

This document is part of a study which is being prepared for the European Commission. However, the information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this initial presentation of results.

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Batteries Directive 2006/66/EC

Initial results of the study in support of the assessment of the Batteries Directive

23 April 2020



Measure 3

Removability, replaceability and interoperability

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Measure 6 – Ensuring removability, replaceability and interoperability of batteries (I)

General background

- Article 11 of the Batteries Directive (BD) addresses “**removability**”. Provisions requiring removability from appliances are understood to be motivated towards ensuring that batteries can be collected and handled separately at end of life (EoL) and this has been assumed to be the objective of possible future measures for ensuring removability.
- The Batteries Directive currently does not require battery **replaceability**, though in some cases this is achieved indirectly when batteries are readily removable, i.e., without requiring the use of special tools. For the analysis, the aim of replaceability has been assumed to benefit the consumer in terms of ensuring that appliance life is not limited to battery life.
- **Interoperability** is not addressed in the BD. This is understood to allow the use of the same battery in different appliances (i.e., in a drill and in a chain saw) and is applied by some manufacturers within their product lines. Inter-manufacturer operability is analysed when it reduces the number of batteries (e-bike) or appliances (E-scooter) needed per user.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIa)

Problem description – Battery removability

- Though batteries are required to be removable, the use of tools for this purpose is allowed and not limited to tools (usually) in the possession of private consumers. It is also not specified that battery removability needs to be possible without the destruction of the appliance in which it is incorporated, nor that removal needs to be possible through the application of simple steps that do not require significant time.
- These conditions have resulted in a growing trend of batteries that are integrated into the appliance in a way that does not allow simple removal. According to appliance manufacturers this complies with the obligations conditions as the device can be broken open to remove the battery.
- In some cases battery integration results in early EoL of devices once the battery malfunctions – this differs between product groups but also within certain groups. In this case though the battery may be removable, it is not considered replaceable
- Removal at EoL by waste operators is not always sufficiently performed. Recyclers (EuRIC, EERA) state that battery removal is becoming more complicated. Batteries embedded in products are in increase and cannot be removed. For WEEE recyclers this is a problem, particularly due to fire and explosive safety risks. Recyclers recommend more demanding requirements on the removal of batteries, i.e. ‘removable with commonly available tools’.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIb)

Problem description – battery removal at EoL

- **Problems related to removal for recyclers:**
 - Batteries built in are smaller and smaller (increasing the removal cost per weight).
 - The battery is glued in and not well protected (pouch cell) and thus prone to damage when removed (difficulties in dismantling: opening the device can already puncture the battery).
 - Li-Ion types need to be removed to prevent explosions. For glued-in Li-Ion batteries, without housing, braking the device may lead to sparks, smoke, explosions.
 - Removal with non-standard tools is time consuming and increases removal costs;
 - Small devices in mixed WEEE can be overlooked (the battery not removed).
- Technologies mentioned to support removal of embedded batteries:
 - Visual recognitions software for helping in sorting of batteries;
 - Best practice: discharge battery (place in salt water), subject it to cold (12h in a refrigerator). Thermal runaway won't occur when the battery is frozen (though maybe afterwards!). The adhesives become brittle when subject to cold of a certain temperature and time, making removal easier through impacting the device on a hard surface (the battery will detach).

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIc)

Problem description – battery replaceability

- A growing trend of batteries that are integrated into the appliance in a way that does not allow simple removal and replacement is observed. This may result in the product end-of-life when the battery ceases to operate efficiently. Battery failures are common in some EEE, meaning that non-replaceability of the battery may lead to early EoL:
 - ECOS found that 68% of laptop users felt their laptop battery lifetime was insufficient, and battery failures were found to have caused business problems for more than half of all users*.
 - JRC report that over 40% of smartphone malfunctions were related to the battery.

Problem description – Battery interoperability

- Interoperability is understood to be the case where a battery can be used in different products/tools that share the same energy characteristics, (Northvolt: e.g. power output, c-rate, required voltage, current and the operation temperature).
- Introducing interoperability into certain product groups could be beneficial to the environment and to users in so far that it allows POM of a smaller number of batteries or devices per owner – see case of power tools and suggestions for E-scooters and E-bikes in coming slides.

*ECOS, LONG LIVE THE MACHINE How ecodesign & energy labelling can prevent premature obsolescence of laptops, February 2020; Cordella et al. (2020), Guidance for the Assessment of Material Efficiency: Application to Smartphones, [link](#)

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIIa)

Alternative options

- In terms of scope, proposed options address batteries in appliances, i.e. portable batteries,
- **Removability** of the battery is understood to be the case when the battery can be safely removed (with or without the use of tools), in some cases resulting in the destruction of the device.
- **Increased removability** is defined as “removable with tools commonly available for waste operators”, however this also does not guarantee that the device is not destroyed during removal, though it is assumed to ensure that battery removal does not cause safety incidents (explosion, fire).
- **Replaceability** is defined as a battery (or battery pack) being “removable with tools commonly available to the end-user”, thus enabling replacement to support further operation of the device.
- **Interoperability** is understood to be the possibility of using batteries of one device in another type of device. Energy characteristics of both devices (power output of the battery, etc.) and battery format and interface need to be the same for this to be possible. Interoperability can be possible on the manufacturer level (within devices in its portfolio) or between devices of different manufacturers. For the purpose of introducing provisions for batteries, only the latter is considered.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIIb)

Alternative options

- Provisions requiring increased removability are expected to affect appliance design, with an increase in the share of devices designed with removable batteries;
- Increased removability of batteries is expected to have only a mild impact on consumers in terms of extension of product service life as only in some cases would such removability also allow replaceability;
- Increased removability of batteries is expected to have a positive impact on WEEE operators in terms of:
 - increase of the share of batteries removed safely from WEEE and sent to battery recycling operators;
 - Increased costs for battery removal but in total below the costs of damages related to explosion and fire incidents attributed to non-removal of Li-Ion batteries (expected to decrease).
- Replaceable batteries are also removable but not necessarily interoperable.
- Interoperability achieves both removability and replaceability.
- Both replaceability and interoperability benefit the consumer, however provisions have been formulated with the understanding that a certain environmental benefit is generated as well to be in line with the intention of the BD to protect the environment.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIc)

Alternative options

Baseline (BAU)

Article 11 remains unchanged. Under this scenario it is assumed that the share of integrated batteries shall continue to increase.

- The share of non-removable batteries increases from now until 2035.
- Based on EuRIC statement, the number of explosions and fires is assumed to increase particularly in mixed WEEE and small household appliance fractions. For the purpose of the analysis, it is assumed that
 - Explosion and fire incidents in other than WEEE facilities assumed to consist;
 - Only 10% of explosions and fires occur in other WEEE fractions.
 - The average annual damages per WEEE management facility increase from now until 2035 as battery removability decreases.
- Replaceability would be expected to decrease further, as more devices are designed with integrated battery. Differences exist however for various product groups:
 - No change expected in power/ garden tools (battery replaceable & interoperable);
 - E-bikes – stakeholders stated that non-replaceability is increasing;
 - E-scooters – batteries were non replaceable but this is changing;
 - Mobile phones – batteries are usually not replaceable though there are different views if the phone lifetime is usually longer than battery lifetime or not;
 - Lap-tops, wearables, toys, blue tooth devices – here problems with replaceability were reported and can be considered to increase.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIId)

Alternative options

Option 1: Provisions to require increased removability from all appliances

- Adjustment of Article 11 clarifying that to comply with removability, a battery must be “removable with tools commonly available for waste operators”, specifying exemption criteria.
- This provision is understood to affect all battery operated devices and is assumed to impact all such devices similarly, i.e. in product groups where removability is currently time consuming (costly) and/or associated with a higher safety risk of explosions and fires, removability would be assumed to improve in the following manner:
- The share of non-removable batteries assumed to decrease from 30% at present to 15% in 2035.
- Based on EuRIC statement, there are more explosions and fires occurring in mixed WEEE and small household appliance fractions. For the purpose of the analysis, the following impacts are spread evenly between all fractions :
 - 50% of explosions and fires to occur in WEEE management facilities are avoided.
 - The average annual damages per WEEE management facility decreases between until 2035 by 50%.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IIe)

Alternative options

Option 2: Provisions to require increased removability product groups where explosion and fire incidents are more common

- Adjustment of Article 11 adding an obligation that increased battery removability (with tools commonly available for waste operators) is required from any appliances not collected as separate WEEE and from small household appliances, specifying exemption criteria.
- This provision is understood to affect only battery operated small household appliances and all battery operated WEEE not collected as a separate product-group fraction:
- The share of non-removable batteries in mixed WEEE and in small household appliances is assumed to decrease from 30% at present to 15% in 2035.
- For the purpose of the analysis, the following impacts are expected in mixed WEEE and small household appliance fractions:
 - 50% of explosions and fires to occur in WEEE management facilities for the above fractions are avoided. The average annual damages for such WEEE management facility decreases to 50% by 2035.

Measure 6 – Ensuring removability of batteries (IVa)

Main assumptions

- The **scope of batteries** looked at under this measure is portable batteries used in the following product groups:

- Smart phones;
- Power tools;
- E-bikes;
- E-scooters;

For other product groups general estimations are made in some cases.

- Provisions shall be looked at qualitatively in relation to:
 - Impacts on number of batteries placed on the market;
 - Impacts on design and where relevant number of products placed on the market;
 - Impacts on consumers (e.g., product longevity);
 - Impacts on removal of batteries at EoL and separate treatment – it is assumed that in the baseline about 45% of batteries are currently collected and treated separately and an additional 20% are collected and treated with WEEE (not removed). Impacts on batteries that end up in other streams (municipal waste, export) are not investigated.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IVb)

Main assumptions

Mobile(smart)-phones

- In mobile(smart)-phones it has become quite common that the battery is integrated and sealed into the device. Some stakeholders explain that this increases device durability, seeing as in past years the most common failures were caused by liquids and display cracks. However JRC quote a later survey (OCU 2018) reporting that the highest number of problems was related to the battery (42%) and state that liquid and display failures reported in earlier years (Watson et al. 2017 based on statistic data for 2013) may be less representative today due to development of new technologies and designs. In this sense, battery replacement is still seen as relevant, and should as a minimum be possible to perform by a qualified professional (repairs, refurbishment).
- In the waste phase it is understood that smartphones are collected as a separate fraction and that battery removal can be ensured though costs may vary depending on whether dismantling is manual or automated. Stakeholders have also not specified such waste as a common fraction for occurrence of explosions and fires.
- Though interoperability could be beneficial for end-users, it is not expected to have environmental benefits, while affecting a function that is of relevance to competition of manufacturers. It is thus excluded from the scope of this analysis.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IVc)

Main assumptions

Power tools

- Around 60% of all power tools placed on the EU market are cordless and it has been stated (EPTA) that in most of these the battery pack is replaceable.
- In power (and garden) tools interoperability is common at the manufacturer level, between different devices in the portfolio, e.g., for devices operated with a 18V battery. The charger, the battery and the tool build a unit. Interoperability requires the devices have the same: engineering concepts, battery cell adjustment, use of battery cells, charging procedures, battery cooling concepts, weight distribution of battery cells, etc. For power tools this is intellectual property of each company. (EPTA).
- Professionals working with such power tools usually have one battery in operation and another 1-3 batteries being charged to ensure continuous work. Batteries are interchangeable between various devices, also allowing the owner of several devices of the same manufacturer to own less batteries.
- It is unclear how commonly cordless devices are used by private consumers.
- Since the battery pack is usually replaceable and often also interoperable, it is assumed that battery removal at EoL is not a problem.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IVd)

Main assumptions

E-scooters

- E-scooters were initially manufactured for private consumers with integrated battery. The trend towards E-scooter sharing in cities has started a shift towards removable and replaceable batteries. This allows the enterprise owner to base recharging of vehicles on replacement of an empty battery with a recharged one instead of replacing an “empty” vehicle with a recharged one, i.e., the enterprise will purchase more batteries, but less vehicles to provide the same range of services. This can be expected to affect transport costs (scooters are heavier and bulkier than batteries). More importantly, this allows extending the lifetime of the E-scooter beyond the lifetime of the battery.
- Battery interoperability would further allow enterprises to work with various models, opening the field for more competition while also allowing a diversity of models within the fleet without overcomplicating the charging of vehicles.
- At EoL, the fact that still not all batteries are replaceable means that battery removal will sometimes require destroying the device. Information is not yet available as to explosions and fires caused in E-scooter waste. It is possible that sharing enterprises discarding of faulty devices contribute to a separate fraction of such devices, making it easier to ensure battery removal from each item.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IVe)

Main assumptions

E-bikes

- In the E-bike sector it is observed that different manufacturers use different batteries in terms of form and characteristics (energy, recharging). Though battery packs can often be removed and replaced by the user (also to avoid theft), they are usually not interoperable. It is noted that some stakeholders have reported that battery replaceability is decreasing.
- It is assumed that interoperability would be beneficial for users owning more than one E-bike, allowing the use of all batteries with all owned E-bikes. Where an individual possesses more than one type of bike (city-bike, MTB, transporter), this could decrease the number of total batteries in ownership. This would also prevent possible safety risks, when a battery from one bike is falsely inserted into another or into its charger. Benefits for E-bike sharing enterprises expected to be similar to E-scooters.
- In terms of EoL, in some countries voluntary collection schemes are available for separate collection of E-bike batteries. In other cases it is assumed that some batteries are collected by dealers when replaced with a new battery. Removability is understood to be a new and increasing problem as battery packs are usually removable and replaceable. Some stakeholders however, raised concerns regarding collection of E-bike batteries, for example where dealers or collection boxes do not ensure safe removal and storage of batteries.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Va)

Impacts of the options (BAU, OP 1, OP 2)

Initial impacts – part 1

The share of non-removable batteries is assumed to increase in BAU by 10% and to decrease in the other options by 15% (for OP 2 only in certain fractions).

- For OP 1 this is a total difference of 25%
- For OP 2 the difference is smaller as only specific fractions are affected (25% for such fractions).

This in turn shall affect the number of batteries removed and sent to battery waste management.

- A general improvement can be expected to some degree in all WEEE in OP 1.
- In OP 2, in some cases the increased removability will affect the share of batteries removed to some degree and in others it will motivate PROs towards separate collection initiatives. This could be the case for example for hearing aids that could be collected by dealers, thus decreasing the share of small WEEE overlooked in mixed fractions and subsequently increasing battery separation from WEEE.
- Though total costs for removing batteries shall increase (time and resources), costs per battery could decrease where removability is easier with standard tools. This shall also decrease the damages from explosions and fires.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Vb)

Impacts of the options (BAU, OP 1, OP 2)

Initial impacts – part 2

Non-removal can cause explosions in e-waste facilities and these are costly:

- Accidents result in increased insurance costs – some insurance companies refuse to cover costs and in some cases they are reluctant to insure at all (EBRA, EERA).
- EuRIC Survey of WEEE operators (109) on fires related to batteries-containing WEEE. Of 58 respondents, 75% reported thermal incidents increased in the past two years. Mixed WEEE and small household appliances seem to be the waste streams where the vast majority of the fires happen.
 - Sparks, smoke, hot spots in a pile of WEEE - reported as daily incidents.
 - Incidents requiring involvement of fire brigade reported as at least yearly.
- **Cost range: between a couple of thousand € and a few million € per incident.** In Austria the largest incident reported damages of 35 million €.
- The scope of damage can entail : damage to individuals, machinery, containers, bunkers, production lines, buildings, water contamination (high remediation costs).
- 19 facilities in survey reported that only equipment was destroyed (i.e. WEEE). 8-9 facilities also specified site surfaces and buildings being damaged and evacuation being necessary; physical damage to individuals was reported in 2 cases.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Vc)

Impacts of the options (BAU, OP 1, OP 2)

Initial impacts – part 3

- **Batteries of power & garden tools** are expected to remain replaceable & interoperable, thus also removable – **no impacts** expected;
- **E-bikes** – stakeholders stated that non-replaceability is increasing. Some E-bike batteries assumed to be collected separately anyway (replacement by dealers), while E-bikes are also assumed to be easy to identify and thus **removal of battery expected anyway, perhaps with less safety incidents in OP 1**. It is assumed that E-bikes are not necessarily collected separately so that OP 2 may have a similar affect to OP 1 (decrease in incidents but not in number of batteries removed).
- **E-scooters** – batteries were non-replaceable but this is changing. It is assumed that **battery removability would improve in BAU through increased replaceability, but that a further improvement would be expected in OP 1 & 2** for slower manufacturers;
- **Mobile phones** – batteries are usually not replaceable though there are different views if the phone lifetime is usually longer than battery lifetime or not. **Smartphones** are assumed to be collected separately (at least in part, due to resource value) and would thus **only be affected in OP 1**. Here **removability could improve** in light of need to use standard tools, but removal **still assumed to be time consuming**;
- **OP 2 Costs for removal in mixed WEEE and small household appliances to decrease** (e.g. wearables, toys, blue tooth devices, medical devices, electric toothbrushes) though expected to be more effective where separate collection initiated.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Vd)

Impacts of the options – initial results

Environmental impacts

Manufacture

- In OP 1 and 2 Devices will in part be redesigned to allow better removability and avoid safety incidents associated with removal. This can be expected to require the use of additional resources for casings or for solutions ensuring easy removability such as pressure sensitive adhesive tape.

Collection and recycling

- The decreased removability in BAU will result in a lower share of removed batteries and thus in a loss of resources – though such batteries will be recycled with WEEE, it is assumed that separate treatment allows targeting valuable resources more effectively and increasing recovery rates.
- In OP 1 and OP 2 in contrast, removability is improved and thus more batteries are sent to separate treatment resulting in better recovery rates of resources. The decrease in damages from explosions and fires will also save resources where damages are to WEEE, to equipment, buildings and surfaces.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Ve)

Impacts of the options – initial results

Economic impacts – part 1

Device Manufacturing

- In Option 1 and 2, manufacturers are expected to have redesign costs, at least in the first years after the provisions come into force.

Collection and recycling

- In Option 1 and 2 the tonnage of batteries available for collection is to increase and thus revenues from recovered resources are to increase. In parallel, the total costs of battery removal could increase (more batteries removed) though possible with a decrease in cost per unit where removability is improved. A decrease in damage costs is also expected and this may have a positive affect on the insurance of waste management facilities in relation to explosions and fires. It is possible that in the first years that operators would have costs for acquiring tools and equipment to support battery removal. In total, OP 1 and OP 2 are expected to show financial benefits for waste management operators (WEEE; batteries)

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Vf)

Impacts of the options – initial results

Economic impacts – part 2

Consumer costs

- Consumers may have some benefits as removability may also improve replaceability in some cases, but this is expected to be a marginal impact in light of general trend towards battery integration and in comparison with possible replaceability provisions (see next slides). Consumers may also be shifted the costs of redesign, i.e., through small increase in device costs.

Administrative costs

- Option 1 and 2 would lead to one-time costs for MS for transposition and to operative costs (increase) in relation to enforcement of implementation. Costs for implementation shall depend on the detail of provision and how practical enforcement is (in BAU enforcement of removability assumed to have low practicability).

Safety risks

- As increased removability is assumed to decrease the number of explosion and fire incidents, a positive benefit is expected in terms of safety risks in OP 1 and OP 2. Despite OP 2 only affecting certain WEEE fractions, it is assumed to target the high risk areas, particularly where it shall result in separate collection initiatives of small devices that are easy to overlook in mixed WEEE.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (Vg)

Impacts of the options – initial results

Social impacts

Employment effects

- Option 1: Here a temporary increase in employment is expected for device manufacturer redesign, though this impact will be more relevant in the first years after implementation. A further increase in employment would be expected for WEEE operators for removal of batteries. Currently 80% of battery removability is performed manually – even if more automation is to be introduced, a complete shift to automated removal is not expected.
- It is difficult to estimate the differences in employment between OP 1 and OP 2. In OP 2 employment impacts on device manufacturers can be expected to be of a lower range as the provision applies to a smaller scope of devices. In contrast, battery removal can be expected to be more cost intensive as devices with batteries need to be sorted out of mixed WEEE and as small amounts of similar devices mean that different tools must be applied for different devices. Where separate collection of devices is initiated, automated separation may also be introduced, but seeing as this is currently not very common differences are not expected to be significant between options.

Measure 6 – Ensuring removability of batteries (VI)

Comparison of options

Impact	Baseline	Option 1	Option 2
Environmental impacts	/	--	-
	Resources for device redesign		
	-	++	+
	Resources recovered from removed batteries		
	---	-	--
Damages from explosions/fires			
Economic impacts	/	--	-
	Costs for device redesign		
	- (- - -)	-- (- -)	-- (- -)
	Total costs for battery removal (in brackets per unit)		
	---	-	--
	Safety risks: Damages from explosions/fires		
	/	+	+
	Consumer impacts – benefits from increased replaceability		
	/	-	-
	Additional costs for devices (shift of redesign costs)		
/	-	-	
Administrative costs (transposition, enforcement)			
Social impacts	---	-	-
	Safety risks		
	/	+	+
	Employment – device redesign		
	/	++	+
Employment – waste operators			

Measure 6 – Ensuring removability of batteries (VII)

Initial conclusions

- ✓ In relation to environmental impacts, though OP 1 and OP 2 will have negative impacts in terms of need for resources for redesign allowing better removability, the benefits from secondary materials recovered from additionally removed batteries and from the reduction in safety incidents and physical damages thereof is expected to set-off such impacts. In OP 1 benefits may be a bit higher than in OP 2.
- ✓ In relation to economic impacts:
 - ✓ Manufacturers expected to have redesign costs in OP1 (lower in OP 2);
 - ✓ Waste operators may have higher removal costs than BAU but these can be expected to be set-off by benefits from higher material recovery and from the decrease in damages from safety incidents.
 - ✓ Consumers may benefit from better replaceability but may also have higher product costs where redesign is performed. Both are not expected to be very high and thus expected to set off each other in both OP 1 and OP 2.
 - ✓ Additional administrative costs expected in OP 1 ad OP 2
- ✓ In relation to social impacts, safety risks (e.g., employees of waste management) expected to decrease; Increase in employment (device redesign, removal, enforcement).

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (VIII)

Alternative options - battery replacement

Option A impacts regarded as additional to BAU, Option 1 or Option 2:

Option A: Provisions for replaceability are added through product legislation (Ecodesign)

- Obligations to require “removable with tools commonly available to the end-user” without destruction of the device in cases where the battery operation life is below a specified product lifetime.
- This could be done on the horizontal level to address a wider range of product groups or through product specific regulation. In any case, requirements need to differ for various product groups. For example JRC* suggest various battery lifetime requirements and disassembly requirements but also leave room for exemptions for durable devices.
- Product design applies to product groups addressed but affects only non-durable products. The manufacturer could choose:
 - to increase product durability so as to avoid compliance; or
 - to comply with battery requirements.
- It is noted that applying this approach to inexpensive low quality products will not necessarily lead to longevity results – a high performance battery in a low performance device does not guarantee longevity – but it will support easy removal of the battery.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IXa)

Impacts – OP A - battery replaceability

Initial impacts – stakeholder estimations:

General:

- Manufacturers selling batteries would probably increase their sales if replaceability is increased. (EEB, ECOS)
- Higher replaceability would make life easier for recyclers – removability would be easy, explosions and fires in WEEE recycling facilities would decrease. (EERA)
- Higher replaceability would however also effect device design (device manufacturers) and consume additional materials. For example smart phones with re-placeable batteries are not as thin.(EERA)

Product specific:

- Especially for scooters batteries are highly integrated by design. Manufactures use integration design for theft protection but also have no economic or commercial motivation on replaceability of batteries used. A replacement of a defect scooter is cheaper than repair. (SLG)
- Lap-tops, wearables, toys, blue tooth devices – here problems with replaceability were reported and can be considered to increase in BAU but to decrease in OP A.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IXb)

Impacts of the options – initial results

Environmental impacts

Manufacture

- In OP A, device manufacturers can be expected to redesign products for higher replaceability or higher durability and this shall require the use of additional resources.
- Where replaceability is possible, a larger number of batteries are to be used per product (service life extension), but these would probably be used in a new product in BAU. In this case, however total device POM may decrease, subsequently reducing the use of resources for new products. It is possible that a demand shall evolve for higher quality batteries with a certain affect on the choice of battery chemistries and materials.

Collection and recycling

- As removability is possible and easier where the battery is replaceable and as a replaced battery is separated and hopefully brought to battery collection, the number of separately collected batteries is expected to increase, with a positive affect on the amount of recovered materials. Where batteries are removed from WEEE, the risk of explosions and fires assumed lower as removal does not require breaking casings that may puncture battery soft cases.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IXc)

Impacts of the options – initial results

Economic impacts – part 1

Manufacturing

- In Option A manufacturers may have costs for redesign and also lost revenue from sale of less devices. However redesign costs can be expected to be shifted to consumer and prices of more durable devices are often higher than those of less durable (general observation) so it is unclear how high actual costs would be.
- Battery manufacturers are expected to have a similar range of sales as it is assumed that consumers will retain the same range of device services and manufacture remains the same regardless of whether a battery is used in two products or one. In contrast, direct sales to consumers may impact competition (for some positively, for some negatively).

Collection and recycling

- Replacement assumed to have a positive impact on WEEE and battery waste operators as batteries are easier to remove (lower cost for removal) and there will be a lower risk of battery safety incidents. As the total number of batteries removed is expected to increase, so shall revenues from material recovery.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IXd)

Impacts of the options – initial results

Economic impacts – part 2

Consumers

- Here a benefit is expected where batteries are replaceable and product life is extended instead of new purchases. This will not be relevant for all consumers (smartphone often upgraded prior to battery EoL), but will still enable benefits as it allows more refurbishment and sale of second hand devices. Consumers may be passed down redesign costs of products and costs for higher durability, but these are assumed to be set off by benefits.

Administrative costs

- Costs are expected not only for transposition and enforcement, but also for development of provisions. As the introduction of provisions shall depend on the product and its characteristics, this shall need to be investigated before specifying requirements for a specific product group. This should however avoid provisions where this would not increase product durability and service life.

Safety impacts

- As battery removability expected to increase, a decrease in safety incidents is expected. This could be expected where battery cases are added to allow consumer replacement or through safety guidance for qualified professionals performing replacements.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (IXe)

Impacts of the options – initial results

Social impacts

Safety risks for individuals

As the number of safety incidents should decrease where replacement is easy, less damages expected to employees in waste management.

Employment

- Employment shall temporarily increase for redesign of devices;
- Increase is also expected in relation to waste management where more batteries are expected to be removed (more often manual).
- As the development of provisions is product related, this will affect employment related to administration, both for regulators and consultants and for stakeholders involved in such processes.

Measure 6 – Ensuring removability of batteries (X)

Comparison of options

Impact	Baseline	Option A
Environmental impacts	/	-
	Resources for device redesign somewhat set-off by lower sales of devices	
	-	++
	Resources recovered from removed batteries	
	- - -	-
	Damages from explosions/fires	
Economic impacts	/	- -
	Costs for device redesign and losses for reduced sales	
	- - (- - -)	- (-)
	Total costs for battery removal (in brackets per unit)	
	- - -	-
	Safety risks: Damages from explosions/fires	
	/	++
	Consumer impacts – benefits from increased replaceability	
	/	-
	Consumer costs for devices (shift of redesign /durability costs)	
/	- -	
Administrative costs (transposition, enforcement, development)		
Social impacts	- - -	-
	Safety risks	
	/	+
	Employment – device redesign	
	/	++
Employment – waste operators		

Measure 6 – Ensuring removability of batteries (XI)

Initial conclusions

- ✓ In relation to environmental impacts, additional resources are required for device redesign, less resources are used in light of decrease in products placed on the market where replaceability allows extension of service life. Though a change not expected in relation to the number of batteries POM, there may be a change in the type of resources used (and quantities) related to an increasing demand for batteries with higher (longer) performance). In the waste phase, removability assumed to increase causing benefits in light of more batteries safely removed and treated.
- ✓ In relation to economic impacts:
 - ✓ Manufacturers expected to have additional redesign costs but also losses in sales of devices where replacement is possible. Costs probably passed to consumers.
 - ✓ Waste operators will remove batteries more easily and safely with lower costs for removal and incidents than BAU and possibly with additional revenues where more material recovered.
 - ✓ Consumers will benefit from better replaceability in selected products but may also have higher product costs where redesign is passed on and also for more durable devices. Costs of additional batteries should be similar to BAU as number of batteries does not change though quality may in some cases.
 - ✓ Additional administrative costs expected in OP 1 and OP 2

Measure 6 – Ensuring removability of batteries (XI)

Initial conclusions

- ✓ In relation to economic impacts:
 - ✓ Higher administrative costs expected for transposition and enforcement, but also for developing provisions for specific product groups which will involve not only regulators but also consultants (benefit) and stakeholders involved in the process.
- ✓ In relation to social impacts:
 - ✓ Safety risks to decrease (e.g., impacts on employees of waste management);
 - ✓ Increase in employment (device redesign, removal, enforcement, regulation development).

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (XII)

Alternative options – battery interoperability

Option B impacts regarded as additional to BAU, Option 1 or Option 2:

Option B: Provisions for interoperability for specific product groups

- Obligations to require interoperability between manufacturers are to be required from product groups, where this feature is expected to affect the number of batteries and or devices POM and thus to lead to environment and consumer benefit:
 - E-bikes and E-scooters to be investigated;
 - Power and garden tools – not investigated as interoperability exists and application between manufacturers not expected to affect number of batteries and/or devices in possession of users;
- Depending on the product group, it is assumed that provisions will affect the design of products within the group and shall either lead to a decrease in the number of batteries POM or to a decrease in the amount of products POM – this depends on consumers pattern of use.
- This is expected to impact manufacturers of products and devices, consumers of relevant products (and their batteries) and operators of the respective waste management.
- For power tools, stakeholders claim that interoperability between manufacturers would infringe intellectual property rights – this shall be investigated for other product groups.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (XIIIa)

Impacts of the options – initial results

Environmental impacts

Manufacture

- In OP B, E-bike and E-scooter manufacturers will need to redesign products to allow interoperability and this shall require the use of additional resources.
- Where interoperability is possible, this will either result in consumers purchasing a lower number of batteries per device (private consumers of E-bikes) or in consumers purchasing a lower number of devices but a higher number of batteries to support continuous operation (E-scooters – here number of batteries does not change, as scooters purchased in BAU also equipped with battery). In such cases, this affects use of materials for manufacture and is assumed to result in a benefit.
- Where the product group is used by sharing enterprises (E-scooters, E-bikes to a lesser degree), an environmental benefit is expected in relation to transport as batteries are smaller and will decrease the number of transportation cycles.

Collection and recycling

- Depending on the decrease in sales of batteries and devices, waste operators may have a decrease in waste to be treated, however batteries that are interoperable will also be removable, having a positive impact on related aspects (recovered materials, safety incidents)

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (XIII)

Impacts of the options – initial results

Economic impacts

Manufacturing

- In Option B manufacturers will have costs for redesign for interoperability. Revenue will decrease or increase depending on the product group and use pattern – in some cases more batteries will be sold and less devices and in some cases this will be the opposite.

Collection and recycling

- Revenues from removed batteries may increase where these come on the market and a decrease in safety incidents may also follow, but depending on the product group and use pattern, the total amount of waste to be treated may decrease (batteries or devices).

Consumers

- Consumers are expected to have benefits as they can accommodate purchases to their preferred use pattern and either have benefits in terms of continuous operation or in a decrease in number of batteries owned. In any case, a decrease in purchases of devices or batteries is expected and thus an economic benefit.

Administration

- Aside from transposition and enforcement costs, it shall probably be necessary to introduce standardization of batteries, chargers and their interface so as to ensure interoperability between manufacturers.

Measure 6 – Ensuring removability, replaceability and interoperability of batteries (XIII)

Impacts of the options – initial results

Social impacts

Employment

- Employment shall temporarily increase for redesign of devices but may be affected (positively or negatively) from changes in range of business activity (sales);
- An increase for waste management where more batteries are expected to be removed (more often manual) may be expected, but the decrease in battery and/or device POM will result in lowered waste to be treated and thus may decrease employment where processes not automated .
- As the development of provisions will require standardization and is product related, this will affect employment related to administration, both for regulators and consultants and for stakeholders involved in such processes.

Measure 6 – Ensuring removability of batteries (XIV)

Comparison of options

Impact	Baseline	Option B
Environmental impacts	/	+
	Resources for device redesign set-off by lower sales of devices	
	-	+
	Resources recovered from removed batteries, set-off by lower amounts of WEEE	
	- - -	-
Damages from explosions/fires		
Economic impacts	/	- -
	Costs for device redesign and losses for reduced sales	
	- - (- - -)	- (-)
	Total costs for battery removal (in brackets per unit)	
	- - -	-
	Safety risks: Damages from explosions/fires	
	/	++
	Consumer impacts – benefits from increased interoperability, lower transport costs	
	/	-
	Consumer costs for devices (shift of redesign)	
/	- -	
Administrative costs (transposition, enforcement, standardisation)		
Social impacts	- - -	-
	Safety risks	
	/	+
	Employment – device redesign, waste operators, regulators	
	/	+
Employment – standardisation		

Measure 6 – Ensuring removability of batteries (XV)

Initial conclusions

- ✓ In relation to environmental impacts:
 - ✓ Additional materials will be used for redesign, but material use will also be affected by lower sales of devices and batteries (the latter has a low affect as only relevant for some private users).
 - ✓ Benefits expected where sharing enterprises have lower transport costs; and
 - ✓ benefits also expected in the waste phase where removability is easier and more batteries provided directly after replacement, though less device waste may arrive at EoL where sales decrease.
- ✓ In relation to economic impacts:
 - ✓ Manufacturers expected to have redesign costs for devices and batteries but also lower sales of devices;
 - ✓ Waste operators should have lower removal costs than BAU also due to increase of batteries delivered separately (larger amounts recovered, less safety incidents) but WEEE operators will have lower amounts to treat where less devices are sold.

Measure 6 – Ensuring removability of batteries (XV)

Initial conclusions

- ✓ In relation to economic impacts:
 - ✓ In total, consumer benefit from interoperability assumed to off-set costs passed over for redesign.
 - ✓ Administrative costs expected not just for the legislation but also for standardisation it requires.
- ✓ In relation to social impacts:
 - ✓ Safety risks (e.g., employees of waste management) expected to decrease (benefit);
 - ✓ Increase in employment (device redesign, removal, enforcement. standardisation).