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IMPACT ASSESSMENT REPORT

Accompanying the document

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

amending Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment

{COM(2021) 547 final} - {SEC(2021) 318 final} - {SWD(2021) 244 final} - {SWD(2021) 246 final}

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1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1. Policy context

This Impact Assessment concerns an initiative in support of harmonised charging and unbundling for mobile phones and other similar devices. In particular, this initiative aims to establish a common level of interoperability for chargers of mobile phones and similar devices so to achieve consumer convenience and environmental benefits while further incentivising the unbundling of charger from the radio equipment. For the purposes of this Impact Assessment, a "charger" is intended as the combination of an External Power Supply (EPS[1]) and a cable. The combination of an EPS and a pad[2] is intended to be a "wireless charger" – see Annex 5 for a thorough explanation.

In 2009 there were different charging technologies that applied to mobile phones and the level of fragmentation resulted in consumer inconvenience and generation of unnecessary waste. In order to mitigate those problems, the European Commission facilitated a voluntary agreement on the "harmonisation of a charging capability for mobile phones", resulting in a first Memorandum of Understanding (MoU)[3] signed by major phone industries. The signatories agreed to develop a common connector[4] for charging, whose specifications were based on a specific standard[5], and would allow full compatibility with mobile phones to be placed on the market. For those phones that did not have a micro USB type B interface[6], an adaptor was allowed. At the international level, the initiative led to an alignment to the MoU almost globally. The implementation of the agreement led to an effective reduction in charging solutions for mobile phones from 30 to only 3.

However, the MoU also allowed for the use of proprietary charging interface, and one such solution continued to be used (and still is) by a major mobile phone manufacturer[7], who never aligned to the common connector mentioned above and therefore failing to allow full interoperability. At the same time, unbundling (i.e. the sale of device without a charger, or only with a cable) had not been achieved to a significant extent, with only a handful of companies offering such a possibility to consumers.

The MoU was renewed twice and finally expired in 2014. Since the expiration, the Commission has put much effort to find consensus on a new MoU that would complete the harmonisation of the charging interfaces. As a result, another MoU was proposed/signed in

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[1] Device converting alternating current (AC) power input from the mains into direct current (DC) to power a product as defined in Regulation (EU) 2019/1782 on eco-design
[2] a combination of circuitry and coil that allow wireless power transfer
[3] https://ec.europa.eu/docsroom/documents/2417/attachments/1/translations/en/renditions/native https://ec.europa.eu/docsroom/documents/2417/attachments/1/translations/en/renditions/native
[4] Electrical termination which is built according to a specific blueprint/technical drawing and interface
[5] USB 2.0 micro-B, see Annex 5 for the details of this technology
[6] For a complete explanation of micro USB type B, see Annex 5
[7] namely Apple's Lightning

March 2018[8], which covered only wired charging solutions, and considered (as therein written) "*the following cable assemblies to be compliant:*

- *a cable assembly that is terminated on both ends with a USB Type-C[9] plug;*
- *a cable assembly that is terminated on one end with a USB Type-C plug and has a vendor-specific connect means (hardwired/captive or custom detachable) on the opposite end; and*
- *a cable assembly that sources power to a USB Type-C connector from a USB Type-A[10] connector*".

Already the preliminary drafts of this MoU were deemed not satisfactory[11] in view of the policy objectives of the Union as they neither resolved the remaining interoperability issues, nor addressed future possible evolutions (wireless or fast charging), nor extended the original scope of the initiative to harmonise charging solutions for other devices similar to mobile phones that would further strengthen the consumer convenience. Also a number of Members of the European Parliament (MEPs) expressed their disappointment with the MoU[12], which in their view "*neither has a scope that extends beyond smartphones, nor solves the fragmentation in that sector, showing the limitations of voluntary approaches, where vetoes of strong market players influence the outcome and lead to an unsatisfactory approach also in terms of environmental policy objectives*". The European Parliament stressed in its Resolution in January 2020[13] the need to increase consumer convenience and reduce e-waste by means of actions to harmonise chargers. For the purposes of this Impact Assessment, e-waste is intended as waste from electronic and electrical equipment. Also consumers and their associations, have stressed the need to take action14 in order to address the remaining charging incompatibility issues (connector and charging communication protocol) and head towards a solution that returns benefits for the environment.

As a result, the Commission launched studies[15] [16] in 2019 and 2020 to assess impacts of possible options with the following objectives on the end-device side: (i) remove fragmentation, addressing the consumer convenience, (ii) reduce e-waste, and (iii) be forward looking, monitoring the state of play of future charging technologies (e.g. wireless), aiming to both preventing fragmentation yet without hampering innovation.

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[8] https://www.digitaleurope.org/resources/memorandum-of-understanding-on-the-future-common-charging-solution-for-smartphones/
[9] See Annex 5 for explanations on this technology
[10] See Annex 5 for explanations on this technology
[11] for instance see the reply to the last proposed draft in Ares(2018)242745
[12]https://www.eppgroup.eu/sites/default/files/pr_attachment/Letter%20to%20Commissioner%20Bienkowska%20PDF.pdf
[13] https://www.europarl.europa.eu/doceo/document/TA-9-2020-0024_EN.html
[14] https://www.anec.eu/images/Publications/position-papers/Digital/ANEC-DIGITAL-2019-G-008final.pdf
[15] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[16] https://data.europa.eu/doi/10.2873/788086 and https://data.europa.eu/doi/10.2873/537546

This initiative on the common charging and unbundling of mobile phones and similar radio equipment, hereinafter referred to as “this initiative”, was included in the Commission Work Programme 2020 for Q3 2020[17]. This initiative focuses on requirements on end-devices, for which the Radio Equipment Directive apply (see section 1.2). Possible future requirements on EPS would be based on a different complementing initiative, which has been planned (see Annex 6). These two complementary initiatives covering both sides of a cable would contribute to achieving interoperability between the devices and the chargers.

Unfortunately, the Covid-19 worldwide pandemic delayed the schedule of this initiative. It was then rescheduled for Q1 2021 in the adjusted Commission Work Programme 2020[18] and linked to the EU’s priority ‘*An economy that works for people*’, as it promotes interoperability in support of consumers’ convenience, and to achieving the EU goal of a more sustainable economy. It also aims to contribute to the implementation of the European Green Deal, which includes commitment to mobilise industry for a clean and circular economy, through a ‘*sustainable products policy*’ that support the circular design of products. It will prioritise reducing and reusing materials before recycling them and will foster new business models and set minimum requirements to prevent environmentally harmful products from being placed on the EU market. Finally, this initiative is also linked to the EU’s priority ‘*A Europe Fit for the Digital Age*’, under the objective of Digital for consumers. The EU’s digital strategy aims to make this transformation work for people and businesses by giving them more choice, lowering the prices, giving them less exposure to illegal content, and ensuring a better protection of fundamental rights, while helping to achieve its target of a climate-neutral Europe by 2050. The Commission is determined to make this Europe's “Digital Decade”. Europe must now strengthen its digital sovereignty and set standards, rather than following those of others – with a clear focus on data, technology, and infrastructure.

Finally it is noted that there is a parallel initiative also on Energy labelling of mobile phones and tablets[19]. This initiative aims to provide a clear and simple indication of the energy efficiency of products at the point of purchase so to make it easier for consumers to give consumers better information regarding product sustainability. It will therefore present additional information to the consumers on aspects that are not covered by this initiative, as for instance a labelling scheme on their energy efficiency.

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[17] https://ec.europa.eu/info/publications/2020-commission-work-programme-key-documents_en
[18] https://ec.europa.eu/info/publications/2020-commission-work-programme-key-documents_en https://ec.europa.eu/info/publications/2020-commission-work-programme-key-documents_en
[19] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12798-Energy-labelling-of-mobile-phones-and-tablets-informing-consumers-about-environmental-impact_en

1.2. Legal context

Mobile phones and other similar devices as well as chargers are subject to the EU product safety legislation which regulate conditions under which they can be lawfully placed on the EU market.

The Radio Equipment Directive 2014/53/EU[20] (RED) establishes a regulatory framework for placing radio equipment on the Single Market. It concerns mandatory market access conditions of products (e.g. safety, electromagnetic compatibility, efficient use of radio spectrum, access to emergency services, as well as other essential requirements which apply if related delegated are adopted) and Member States (MS) are required to take corrective measures on non-compliant equipment. The RED, subject to the exclusions specified in its Article 1 (2) and (3), covers electrical/electronic equipment that can use the radio spectrum for communication and/or radio determination purposes. All mobile phones and radio devices such as for example tablets or e-readers fall under the scope of the Directive. It is to be noted that in the current developing market trends, more and more electrical equipment are capable of wireless communications, therefore fall under the scope of the Directive and the pool of devices which can be potentially in scope of this initiative. Recital 12 of the Directive further states that interoperability between radio equipment and accessories such as chargers "*simplifies the use of radio equipment and reduces unnecessary waste and costs*", that a "*renewed effort to develop a common charger for particular categories or classes of radio equipment is necessary*", and that "*mobile phones that are made available on the market should be compatible with a common charger*". In 2014, when the Directive was adopted, the Commission was provided with an empowerment to adopt delegated acts to ensure interoperability of electronic devices with common chargers, Article 3(3)(a), and to ensure a common interface, Article 3(3)(c). That empowerment does not explicitly state that the Commission can impose one interface for ensuring the supply and use of a common charger.

The Low Voltage Directive[21] 2014/35/EU covers health and safety risks on electrical equipment operating with an input or output voltage of between 50 and 1000 V for alternating current and 75 and 1500 V for direct current, other than the equipment listed in Annex II to that Directive. It allows market access of a wide range of electrical equipment for both consumer and professional usage. Electric power supply (EPS) fall under this piece of legislation as regards safety. Chargers with radio functions, however, fall under the RED. The General Product Safety Directive[22] applies to products not covered by the

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[20] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC, *OJ L 153, 22.5.2014, p. 62–106*

[21] Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits, *OJ L 96, 29.3.2014, p. 357–374*

[22] Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety *OJ L 11, 15.1.2002, p. 4–17*

Union sectorial legislation on safety (e.g. the Low Voltage Directive and the Radio Equipment Directive), if they are intended for consumers or likely under reasonably foreseeable conditions, to be used by consumers – will be regulated by the General Product Safety Directive 2001/95/EC. If a product is covered by Union legislation on safety, the General Product Safety Directive applies any safety aspects and risks for consumers which are not covered by the Union sectorial legislation on safety. It obliges economic operators to make sure any dangerous products present on the market can be traced so they can be removed to avoid any risks to consumers. When cables are detachable from the EPS, they do not meet the provisions of Article 1 of the LVD and so they fall under the General Product Safety Directive. The relationship can be visualised as below.

Table 1 – Parts relationships with EU legislation

	Mobile phone	Cable	Electric power supply (EPS)
			
Applicable safety legislation	Radio Equipment Directive	General Product Safety Directive	Low Voltage Directive

As regards counterfeiting, the customs authorities of the EU Member States have been enforcing Intellectual Property Rights (IPR) on the basis of the Regulation concerning customs enforcement of intellectual property rights[23]. This regulation provides procedural rules for customs authorities to enforce intellectual property rights with regard to goods liable to customs supervision or customs control. It (i) specifies the range of IP Rights and infringements that are covered, (ii) contains provisions for right holders on how to ask protection to customs, (iii) determines procedures for customs to follow in case of identification of goods suspected of infringing an IPR, (iv) provides provisions for cooperation and exchange of information between customs and right holders, (v) includes measures to ensure that the interests of legitimate traders are protected.

This initiative is linked to the Circular Economy Action Plan[24] (CEAP) that the Commission adopted in March 2020. The plan presents a set of interrelated initiatives among which the Circular Electronics Initiative (CEI) that refers to regulatory measures on chargers for mobile phones and similar devices and calls for adoption of additional regulatory measures so that mobile phones, tablets and laptops are designed for energy

[23] Regulation (EU) No 608/2013 of the European Parliament and of the Council of 12 June 2013 concerning customs enforcement of intellectual property rights and repealing Council Regulation (EC) No 1383/2003 *OJ L 181, 29.6.2013, p. 15–34*
[24] https://ec.europa.eu/environment/circular-economy/

efficiency, durability, reparability, upgradability, maintenance, reuse and recycling. In this regard, the Commission is working on three concurrent initiatives.

The first one is the initiative on designing mobile phones and tablets to be sustainable – ecodesign[25] which is foreseen for adoption on Q2 2022. The second one is the initiative on review ecodesign requirements for computers[26] which is foreseen for adoption on Q4 2022. The third one is the initiative on energy labelling of mobile phones and tablets – informing consumers about environmental impact[27] which is foreseen for adoption on Q2 2022.

Table 2 – Eco-design and Energy labelling Initiatives

	Product scope	Timing
Eco-design for mobile phones and tablets (new regulation)	Smartphones and tablets	Q2 2022
Eco-design for computers (Regulation review)	Computers	Q4 2022
Energy labelling for mobile phones and tablets (new regulation)	Smartphones and tablets	Q2 2022

Another piece of legislation related to this Initiative is the Ecodesign and Energy Labelling Working Plan 2020-2024[28] (EELWP) as part of the implementation of the Ecodesign Directive[29] and Energy Labelling Regulation[30]. The Inception Impact Assessment has been published[31]. The EELWP contains a specific item being investigated, the "universal External Power Supply (EPS)", on which work has already started[32]. It therefore complements this Initiative which proposes actions only on the side of mobile phones and similar portable devices and which should be therefore considered when regulating on the EPS side. The supporting study on "universal EPS" follow the scope defined in the Regulation on ecodesign requirements for external power supplies[33] i.e., electric and

[25] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Designing-mobile-phones-and-tablets-to-be-sustainable-ecodesign
[26] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1581-Review-of-ecodesign-requirements-for-computers-and-computer-servers
[27] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12798-Environmental-impact-of-mobile-phones-and-tablets-Energy-Labelling
[28] https://www.ecodesignworkingplan20-24.eu/
[29] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, *OJ L 285, 31.10.2009, p. 10–35*
[30] Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU, *OJ L 198, 28.7.2017, p. 1–23*
[31] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12852-Ecodesign-and-energy-labelling-working-plan-2020-2024
[32] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1955-Energy-efficiency-ecodesign-requirements-for-external-power-supplies
[33] Commission Regulation (EU) 2019/1782 of 1 October 2019 laying down ecodesign requirements for external power supplies pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulation (EC) No 278/2009

electronic devices with power requirements up to 100 Watts having potential to be charged by one common power adapter with the industry specifications by USB-IF[34]. Examples of such products are: ear pods, rechargeable battery chargers, shavers, razors, alarm clocks, radio and loudspeakers, phones and tablets, LED stripes and luminaries, vacuum cleaners, cordless tools, computers (including desktop), monitors, televisions, and many more.

The "universal EPS" study investigated the environmental benefits of having one common EPS and touch up on possible environmental impacts of such requirement. The findings of this study will lead to a revision of the EPS regulation foreseen in 2022. In fact, the supporting study recommended "*to include the product group in the Working Plan for further assessments including refining the scope and developing implementing measures. There is a reasonable amount of energy savings related to resource efficiency and it is an area of interests for EU citizens who experience EPSs kept in stock but without any use*".[35] The revision of the EPS regulation will among others concentrate on promoting interoperability in terms of charging performance of charger with standardized charging protocol (USB PD) and ensure citizens have enough information as to make informed choices when they decide to buy a new charger which will give an intelligible and immediate tool to understand the performance of the charger used with a device when they use a universal external power supply. One of the preconditions to achieve a "universal charger" is a minimum ground on the performance that both the end-device and EPS guarantee. The combination of this initiative and the revision of the EPS regulation will ensure, in a complementary manner, that this minimum performance is met and that consistent information is given to the consumers. In particular:

In order to charge in an optimum manner, the device and the charger should be interoperable, e.g. preventing unjustified limitations of the maximum delivered power and supporting at least the same connector. The end-device maximum accepted power will be displayed and the charger's capacity/power will be included in the labelling under the EPSs initiative;

Fast charging needs to be supported at both the end device and the EPS side. For this reason, interoperability needs be ensured and a parallel strand of work on EPS will make it possible to inform users appropriately.

Therefore, this initiative, is fully complementary to the planned one on "universal EPS" by ensuring interoperability on both sides of the cable. The interoperability on the device end will be achieved by this initiative. In a complementary manner, the interoperability on the EPS will be achieved by the initiative on the universal power supply. Although adoption of these initiative has a different timetable in the Commission planning, the different procedures for adoption will make them applicable approximately at the same time, so to maximise the coherence and the effectiveness of the EU action.

[34] USB Implementers Forum, Inc. www.usb.org
[35] Point 6.2.7 of task 4 or the preparatory study.

Another objective of the CEI in close relation with the analysis of the environmental impacts of this initiative, is the call for improving the collection and treatment of waste electrical and electronic equipment[36]. The Commission is exploring options for an EU-wide take back scheme to return or sell back old mobile phones, tablets and chargers. The results of the study will be published in Q2 2021 (within the CEI communication), which will provide the hooks for any potential further action under the Directive on waste of electrical and electronic equipment (WEEE)[37].

Finally, there is an ongoing study for a possible introduction of a product passport to increase the information on product characteristics along the value chain and to consumers and facilitate product repair, upgrading, component recovery and reuse, and ultimately recycling as part of the Sustainable Product Initiative[38] (SPI) Impact Assessment. As of now, the SPI is planned in the CWP for adoption in Q4 2021.

2. PROBLEM DEFINITION

2.1. What are the problems?

A study carried out after the adoption of the RED in 2014[39] found that the MoU signed in 2009 was effective at harmonising charging solutions and improving consumer convenience. However, full harmonisation of the charging solutions had not been achieved. In addition, the study also recognised that unbundling had not been achieved to any significant extent, with only a handful of companies in Europe offering the possibility to consumers to buy a phone without the charger[40], hence limiting the expected benefits for the environment. In more general terms, two main problems drive this initiative: the first one is the consumer convenience, as repeatedly called by the European Parliament and the Consumers' associations (see section 1.1.1), the second is the environmental benefits, as outlined in two further commissioned studies of 2019 and 2021[41]. As regards an explanation of the terminology used in this Impact Assessment and a more detailed report on the state-of-play of the wired and wireless charging solutions for the equipment in scope of this initiative, we refer to Figure 1 and Annex 5. That Annex and the glossary also contains a technical description of certain terms which are used in the next Sections. The problems can be clustered as follows:

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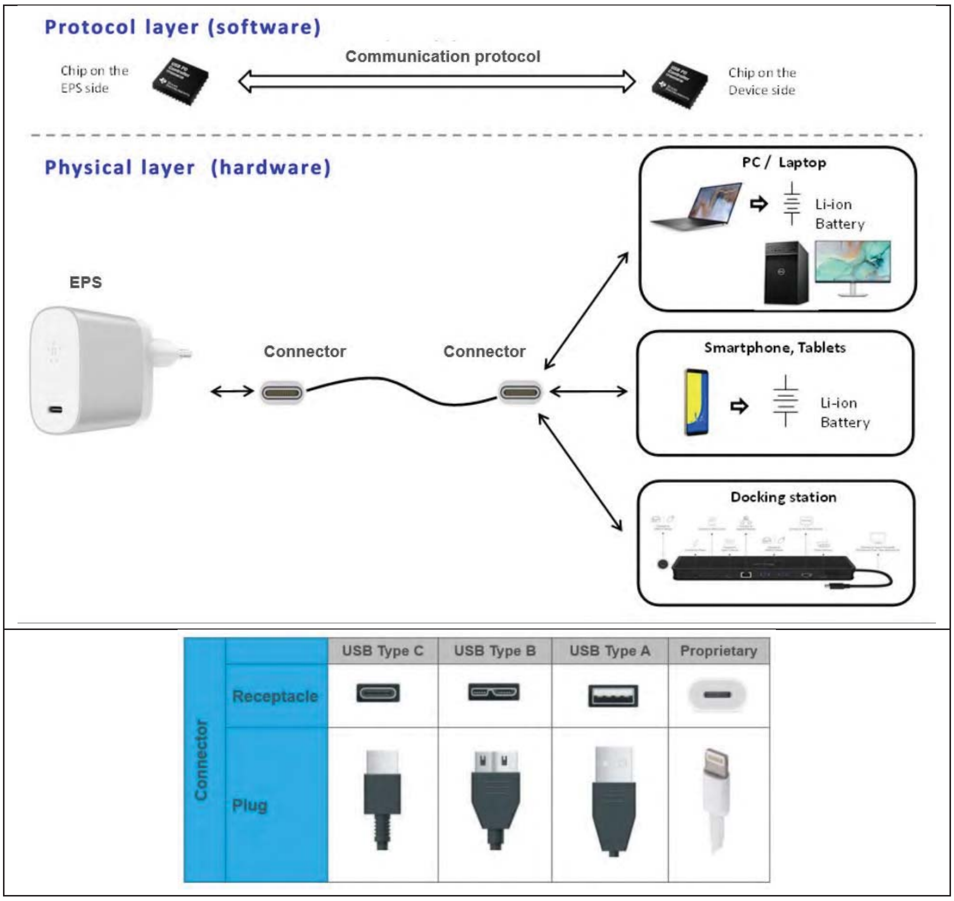
[36] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE), OJ L 197, 24.7.2012, p. 38.
[37] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02012L0019-20180704
[38] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative
[39] https://op.europa.eu/en/publication-detail/-/publication/4b3e4ea8-4f44-4687-96e4-cd3264407c5b/language-en
[40] Currently: Apple's Iphone 12 and Samsung's Galaxy s21.
[41] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1

Figure 1 – Description of elements for the charge



In a first instance, there is a consumer inconvenience. Some of the sold devices use proprietary connectors and/or charging protocols that are not always interoperable with other chargers, or that cannot charge at the same speed when using a charger from another brand. This is aggravated by the fragmentation in terms of connectors used, with devices using USB Type-C, USB micro-B and proprietary ones. And it is also aggravated by fragmentation of performance of the charging solutions as charger give different charging speed depending on the communication protocol used.

The second part of the problem is that there are more chargers in the market than what consumers realistically need or want. Most consumers already have one or more suitable chargers, so do not always need a new one with each phone. However, with some recent exceptions on new models[42], manufacturers continue selling chargers along with phones by default. This generates unnecessary use of raw materials, Green House Gasses (GHG) emissions and e-waste.

The following two sections explain the problems with more granularity.

[42] Apple, Samsung, Nokia and HMD, as of October 2020

2.1.1. Consumer matters

A number of issues around the current fragmentation of mobile phone chargers and, more broadly, of chargers for different electronic devices were raised by the consumers and their associations participating to the Public Consultation and in the consumer surveys (see Annex 2). The sources of consumer inconvenience identified via the surveys can be divided into four issues: (i) inability to charge certain devices (as fast) with certain chargers; (ii) too many chargers taking up place at home; (iii) no access to a compatible charger; and (iv) confusion about which charger works with what device. In more detail, participants in the consumer survey were asked whether they had experienced any problems when using a mobile phone charger in the 24 months prior to the survey. 84% of respondents reported having experienced at least one of the different types of problems. The most commonly cited problems can be clustered as: redundancy of chargers, lack of interoperability, lack of information, safety issues. These findings from the surveys of consumers[43] generally point to lack of interoperability as the main cause of consumers' inconvenience. This lack of interoperability consists of the following elements: absence of a common connector, inability to charge certain devices as fast with certain chargers and the lack of information provided to consumer as regard the charging performance of their device with certain chargers.

- **Interoperability at the device end**

The initial MoU partially resolved the issue of fragmentation of the interfaces (i.e. type of connectors used in a device to connect a charging cable), reducing the original number of charging solutions for phones from 30 to only 3[44]. However, both the European Parliament and the consumer associations stress that the incomplete harmonisation of the device interface is still inconvenient for consumers (see section 1 and annex 2). The estimates show that there are around 20% of smartphones, 27% of tablets, 11% of handheld videogame consoles, and 100% of wired smartwatches with proprietary connector[45] [46] [47] and de facto, this ratio is aligned with the percentages of cables ending with a proprietary connector (see section 2.3). Moreover, about 39% of mobile phones, particularly the cheapest ones, still use the micro USB type-B connector. Having different chargers for different electronic devices, in fact, was indicated as a source of confusion, especially for older people or people affected by disabilities[48]. 73% of EU citizens believed that users of different electronic devices need to have multiple chargers which occupy space and may lead to confusion to be a serious problem, while 26% of respondents described this as a minor problem. Only 1% of did not consider it a problem.

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[43] https://data.europa.eu/doi/10.2873/788086
[44] https://ec.europa.eu/docsroom/documents/2417/attachments/1/translations/en/renditions/native
[45] https://www.gartner.com/en/newsroom/press-releases/2021-02-22-4q20-smartphone-market-share-release
[46] https://www.statista.com/statistics/1168529/global-apple-market-share-2020/
[47] https://data.europa.eu/doi/10.2873/788086
[48] See also Annex 2

In addition, the charging interfaces that are currently found in mobile phones can be used not only for delivering power to the battery, but also to communicate with accessories and certain peripherals. When specific manufacturers do not include a common interface in their products, there is a risk of locking the consumer into ecosystems of accessories or peripherals, which may discourage the migration to different brands and may result in more e-waste when a consumer decides to do so. Additionally, market developments for tablets and laptops already head towards the use of USB type C connector, also for those manufacturers who used proprietary connectors. Considering that proprietary interfaces have higher retail prices than non-proprietary (USB types)[49], the lack of a common interface has an effect on the price paid by those consumers for accessories (and also incite consumer to buy counterfeit products).

The progressive introduction of the wireless charger can possibly be a source of additional fragmentation. As described in Annex 5, different pads already exist and the lack of interoperability can be the start of a new fragmentation of the market.

- **Interoperability in relation to charging performance**

There is quite a high degree of interoperability of chargers. It is also the case as regard to fast charging, since most manufacturers implement the USB Power Delivery (PD) technology[50] as a charging protocol (i.e. in simple terms the communication rules and signals for the device to communicate with a charger). However, some manufacturers (see Annex 5 for details) use proprietary charging protocols that are either not interoperable or when connected to non-proprietary chargers reduce the charging speed[51]. The survey conducted for the related study[52], found that most of consumers that bought a separate EPS did not encounter any problems, and similarly for those who bought a cable separately (71% and 70% respectively). However, those that experienced problems indicated issues such as reduced charging speed (16% for EPS and 15% for the cable), or that the new charger component cannot charge the mobile phone (8% for the EPS and 6% for the cable). It should be clarified that, at least for small products such as smartphones or tablets, cables do not have any impact on the charging performance if a cable with suitable connectors on both sides is used to charge a phone. The targeted interviews have also highlighted that the power may be limited on purpose in those cases where a phone using a proprietary charging protocol is charged with an EPS not implementing that specific fast charging protocol, in order to ensure safety. The result can be a reduction of the charging performance, e.g. the charging process will not deliver the theoretical peak power because either the EPS or the mobile phone limit it. It was also underlined how the absence of clear

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[49] https://data.europa.eu/doi/10.2873/788086
[50] IEC 62680-1-2:2018 or, more recently, IEC 62680-1-2:2021 – see Annex 5 for details
[51] Huawei SuperCharge and Oppo VOOC are proprietary charging protocols with 22% and 1%, respective market shares
[52] https://data.europa.eu/doi/10.2873/788086

labelling may make it hard to identify the differences among chargers, or to understand whether a charger is suitable for a given device. Clearer labelling was suggested.

- **Interoperability with other portable devices**

Mobile phones' peak charging power typically ranges between 5W and 18W if they include USB PD technology or other fast charging solutions. EPSs delivering power are becoming more and more available on the market[53] as the USB PD protocol can support, in the current version, up to 100W. Devices with similar charging power characteristics to mobile phones include, for instance, e-readers, tablets, wearables and cameras. They do not include laptops as laptops may require more power, which poses technical challenges when it comes to sharing the EPS with a mobile phone, i.e. these chargers can charge a laptop, but only very slowly (e.g. overnight) and may not provide sufficient power to fully compensate the energy depleting the battery.. However an EPS incorporating USB PD protocol and capable of delivering higher power than needed by the device, can safely power any device supporting the suitable fast-charging protocol, which is USB-PD.

Sales of those other small portable devices, having similar charging characteristics to phones, (i.e. tablets, e-readers, hearables, digital cameras, sport cameras, handheld videogame consoles) can be estimated at approximately 260 million devices in the EU27 annually[54]. Adoption of a standardised interface for these devices appears to be possible. However, certain devices which have to meet specific conditions (e.g. to be water proof or to fit a limited space in the product) would have to be excluded. As a result, the scope of this initiative and the issue of interoperability may concern approximately 390 million devices[55] sold annually in the EU27 (Annex 5 provides further details on the typology of other devices and their charging needs). Nearly all the consumer associations consulted stressed that the presence of different types of connectors and chargers and fast charging incompatibilities is inconvenient for portable device users[56].

- **Safety issues and counterfeit chargers**

Based on the consumer survey, it is assumed that 5-10% of all EPSs bought separately in the EU, and approximately 10-15% of cables, are counterfeit. As regards product safety issues, 1% of survey respondents who had bought a non-bundled EPS or cable in the last 24 months reported it had caused safety issues (e.g. electrical shock, fire…), while 3% reported it had damaged their mobile phone. 5% of those who had bought an EPS, and 7% of those who had bought a cable, reported that it broke / become unusable shortly after it was bought. Existence of such risks has been documented by an analysis of the number of

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[53] IEC 62680-1-2:2018 or, more recently, IEC 62680-1-2:2021 – see Annex 5 for details
[54] broken down as follows, tablets 20.7m, e-readers 16.2m, wearables 116m, digital cameras 54.2m, sport cameras 3.2m, videogame devices 52.1m, see https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[55] 160 million mobile phones and 230 million other portable devices.
[56] idem

risk alerts for mobile phone chargers in the RAPEX[57] and ICSMS[58] systems. Overall, the RAPEX and ICSMS data, supported by feedback from authorities, suggest that there are problems with chargers and that these are increasing, although data in 2017-2018 does not confirm a clear trend[59]. There appears to be a substantial market for counterfeit EPS and cables, which bring significant losses to intellectual property rights (IPR) holders, and could also constitute serious safety threats to users, and negatively impact the environment. According to data on the EU customs enforcement of IPR, the category 'parts and technical accessories for mobile phones' (including chargers) occupied the 8th place in the ranking of top categories of detained articles, with almost 1.1 million of articles in 2020[60], which is comparable to the previous years, for a total value of approximately 45 M €.

- **Bundling vs unbundling**

The number of chargers shipped/sold is higher than consumers need. Most of devices, including mobile phones, are sold bundled with a charger in the box. As of October 2020, two major manufacturers of mobile phones, accounting for roughly 50% of the market share[61], announced the removal of the EPS (and other accessories) from the retail box of certain (not all) new models, explaining that the aim is "*further reducing carbon emissions and avoiding the mining and use of precious materials, which enables smaller and lighter packaging, and allows for 70 percent more boxes to be shipped on a pallet*"[62] or "minimise the impact that products have on the environment" in order to support users in making "*sustainable choices in their daily lives to promote better recycling habits*"[63]. Other three manufacturers[64] have followed thereafter, on new models. However, certain manufacturers are likely not to introduce unbundling voluntary, as per the interviews. Therefore, the number of chargers on the market will continue to exceed the number of chargers that consumers would buy in a well-functioning market, thus leaving untapped the full potential to reduce environmental impacts (see section 2.1.2 below).

A mapping exercise[65] has shown that unbundling of the EPS from the device is already common in certain categories of products, such as low-power using hearables, e-readers, and portable speakers, whilst it is rare for devices such as digital cameras, portable videogame consoles and tablets requiring certain higher power levels. As regards the cable assembly, a suitable one is almost always provided in the box. In some cases,

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[57] RAPEX is the EU rapid alert system for dangerous non-food products
[58] The Information and Communication System on Market Surveillance
[59] https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[60] https://ec.europa.eu/taxation_customs/sites/taxation/files/ipr_report_2020.5464_en_04.pdf
[61] Apple and Samsung https://www.statista.com/statistics/1169503/regional-smartphone-market-share-in-europe/
[62] https://www.apple.com/newsroom/2020/10/apple-introduces-iphone-12-pro-and-iphone-12-pro-max-with-5g/,
[63] https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[64] Nokia, Xiaomy and HMD
[65] https://data.europa.eu/doi/10.2873/788086

manufacturers fear to lose market shares if they unbundle. In turn certain consumers, being unaware of the interoperability, may keep preferring bundled solutions, originating a vicious cycle.

In a consumer panel survey conducted for the related study[66] and focusing on unbundling of chargers, 82% of consumers indicated that they consider finding an EPS in the box with a new mobile phone very important or important, whilst an even larger share of consumers, 89%, considered that it was very important or important that a cable was supplied in the package with a new phone. The consumer preferences are clearly not homogenous in respect to unbundling. They are however partially consequence of still existing issues of interoperability, the lack of correct information on suitable chargers among the laypersons, and the relatively novelty of standards supporting possibly universal chargers. When provided with information on environmental impacts, interoperability, charging performance and product safety risks had been provided, these proportions decreased by around 10% points resulting in around three quarters of respondents still maintained it was very important or important for them that EPS and cable are provided with the phone. Additionally, the stakeholder survey showed that the majority of stakeholders request that all mobile phones are interoperable with any EPS (75% see figure 2.10 in Annex 2).

A specific matter concerning unbundling is the retail price of devices and chargers. In the interviews, manufacturers announced that they would offer EPS out of the box at a reduced price if unbundling becomes mandatory. This appears to be confirmed by the manufacturers who have started to unbundle, who commented that they have reduced the price of their stand-alone EPS[67].

2.1.2. Environmental aspects

It is estimated that in 2019, 266 million mobile phones were sold[68] in Europe[69]. As a conservative mere ratio of the population, in the EU27 approximately 160 million mobile phones were sold in that year. Adding more than 260 million portable devices described in the previous section, there were therefore approximately 420 million[70] portable electronic devices sold annually in the EU. When each of them are dispatched with a charger, the old ones either become unused or are disposed of. In the EU27 it can be estimated that

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[66] https://data.europa.eu/doi/10.2873/788086
[67] https://data.europa.eu/doi/10.2873/788086
[68] https://www.statista.com/outlook/cmo/consumer-electronics/telephony/mobile-phones/europe?currency=EUR#volume
[69] Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom
[70] see footnote 54, assuming no chargers sold at all for tablets, cameras, videogame devices as in the unbundling considerations in the previous section

approximately 20 Kg of e-waste per capita were produced in 2019[71], with a growing trend at global level[72]. Of these, it is estimated that chargers represent 0.3% of the total e-waste (11.000 tonnes of e-waste annually)[73]. As regards the standalone markets, EPS and cables for tablets, earbuds, headphones and cameras are estimated[74] to account for less than 20% of the stock of mobile phone EPS and cables (including those purchased on their own).

The consumer panel survey suggests that the average consumer owns around three mobile phone chargers, of which they use two on a regular basis. A little under half of consumers only use a single charger, while the remainder use two or more. Survey respondents also reported using an average of two chargers which implies that on average, one changer is left unused. There was significant variance in this data, with a few respondents reporting to own as many as 25 chargers. Not having the choice not to buy the charger implies that consumers have more chargers than they need. The results of the consumer survey show that chargers taking up space at home or at work was indicated as an issue by 44% of respondents[75]. Accumulating chargers at home was the single most common way of dealing with old chargers (49% of cases).

Certain manufacturers[76] [77] have already highlighted the positive impact on reducing emissions that unbundling has due to the use of fewer materials for the packaging and higher efficiency in the transport of the products. However, other stakeholders have argued that unbundling will lead to a higher amount of packaging material and associated emissions (as users will potentially buy separately an EPS and cable). Furthermore, a retail association during an interview indicated that while the packaging of phones is normally cardboard, when EPS are sold separately, they are packaged in plastic.

2.2. What are the problem drivers?

The drivers are different and can be clustered as showed below. At the end of the section, a problem tree is produced.

- **Lack of commitment to meet the policy objectives of the Union**

The MoU 2009 resulted in convergence towards a common external power supply (EPS) and USB micro-B connectors at the device end of mobile phones. The most notable exception was one single manufacturer, continuing to use proprietary connectors (from 2012). Since the expiry of the MoU in 2014, several technological innovations in relation

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[71] http://ewastemonitor.info/wp-content/uploads/2020/12/GEM_2020_def_dec_2020-1.pdf , page 76
[72] https://www.statista.com/statistics/499891/projection-ewaste-generation-worldwide/
[73] https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[74] https://data.europa.eu/doi/10.2873/788086
[75] The problem occurred once or twice for 17% of consumers, on a few occasions for 20%, on numerous occasions for 12%, and for 5% almost on a daily basis.
[76] Apple (2020) Product Environmental Report. iPhone 12 Pro.
[77] Nokia (2019) People and Planet Report 2019.

to charging technologies, EPS, and connectors have occurred[78]. The new MoU on wired chargers for smartphones proposed by the industry in March 2018 was found not to align with the EU's harmonisation objectives[79]. A comparison of the MoU 2009 and the MoU 2018 shows that little has been done to promote the use of a "universal charger", so to maximise consumer convenience and environmental benefits. On the contrary, the MoU 2018 does not provide sufficient reassurance that work is ongoing to resolve the observed fragmentation[80]. As a result, not only the target of having one single connector has not been achieved, but also progressive fragmentation has been observed in time, by means of proprietary features and solutions concerning the technical protocols and performance. The general and political "perception" is therefore that this convergence to a "universal charger" and its wide adoption has been a missed opportunity.

- **Proprietary charging solutions for commercial benefits**

In some cases, interoperability of chargers is prevented by proprietary protocols in the EPS, which are not compatible with the most common standard. Those protocols do not allow a correct communication between the source (the EPS) and the device being charged. In other cases, interoperability is prevented by specific proprietary connectors on the end-device. There are different economic aspects linked to these choices. For instance, the selling prices of specific accessories of brands using proprietary connectors is higher than the average[81].

Some industry representatives interviewed claim that their proprietary fast charging solutions are more energy-efficient than USB PD[82]. Interviewees also claim that proprietary solutions are safe (apply several levels of control to ensure the temperature stays low), charge phones quickly, and the production cost is lower than if they used USB PD. These manufacturers generally include in the box EPS and cables that provide high power to allow the fast charge advertised[83].

- **Some consumers do not know most chargers are interoperable**

Chargers and mobile phones can support different power levels and hence allow for a degree of interoperability, if programmed according to existing standards, without proprietary changes[84]. In the consumer survey[85], less than half of respondents (45%) were

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[78] e.g. the USB Type C has been developed and its use has progressed, see Annex 5 or https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1, pages 6-8
[79] , page 7
[80] See also section 5.1
[81] This assessment is based on information provided by interviewees of the supporting studies
[82] It has been reported that Huawei SuperCharge achieves up to 96% of energy efficiency during the charge, whereas USB PD reaches up to 80% of energy efficiency.
[83] For instance, the Huawei Mate 40 Pro includes the Huawei Supercharge EPS (66W). With this charger, it can be fully charged in 49 minutes
[84] https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[85] https://data.europa.eu/doi/10.2873/788086

fully aware that the vast majority of chargers from all major mobile phone manufacturers are interoperable, i.e. can be used to charge all modern phones irrespective of the brand. The current level of interoperability however don't guarantee the same fast charging performance as there are proprietary charging communication protocol that do not allow interoperability. The rest of respondents were either partly aware (36%) or did not know it (19%). Similarly, in the consumer survey conducted for another study[86], confusion over which charger to use for different mobile phones was a problem that had been experienced by 30% of respondents. For 1% it happened almost every day, for 5% on numerous occasions, for 12% a few times, and for 13% once or twice. When needing to charge their phone, 19% of respondents reported having experienced problems once or twice because all other chargers were incompatible, 15% had this problem on a few occasions, 3% on numerous occasions and less than 1% almost daily. 63% did not face problems relative to interoperability with other chargers than the one from the same brand as the phones. Actually consumers, even those willing to reuse their chargers in the assumption that the interface is the same, struggle to understand the performance of already-owned chargers in charging new mobile phones[87].

The consumers' perception is therefore that no sufficient information is provided on the charging capabilities of the equipment. In turn, this makes it very difficult to ascertain the extent to which an old charger can meet the charging needs of new devices. The presence in the retail box of chargers is therefore perceived as the sole "best-match" to charge the device, making old chargers redundant and therefore disposed or dismissed. Clearer labelling was suggested by consumer associations as a measure to distinguish chargers with different charging features (e.g. by defining a limited number of types of chargers based on their power output and/or specifications, and labelling them accordingly).

- **Some consumers find it convenient to get a charger with each phone**

In the consumer survey conducted for this study, 82% of consumers indicated that they consider finding an EPS in the box with a new mobile phone very important or important, whilst an even larger share of consumers, 89%, considered that it was very important or important that a cable was supplied along with a new phone. Although these proportions decreased by around 10 percentage points after information on environmental impacts, interoperability, charging performance and product safety risks had been provided, around three quarters of respondents still maintained it was very important or important for them that EPS and cable are provided with the phone. Among the consumers who found it important to have either an EPS and/or cable in the box, almost half (46%) indicated that it is because of habit, i.e. they are used to finding a complete product in the box. Other relevant factors are: safety (50%), performance (48%), and convenience (38%). However, the survey also shows that a majority of respondents (61%) were supportive of the idea that

[86] https://op.europa.eu/en/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[87] https://data.europa.eu/doi/10.2873/788086

all mobile phone manufacturers / distributors should give customers the option of purchasing (or not) a new EPS and/or cable with new phones.

- **Lack of awareness of the environmental impact**

As explained above, until last year, nearly all mobile phones sold in the EU market were bundled with an EPS and cable[88] and the scenario changed as of October 2020. As per the interviews, other manufacturers are considering the unbundling at the moment, but those with proprietary charging technologies appear less keen, as they consider their high charging performance an added value. As regards the cable, this is almost always provided in the box.

Consumers appear to be less aware of the environmental impacts of chargers. In the consumer survey, less than a third of respondents (29%) knew that chargers' production requires raw materials and generates CO2 emissions, and when chargers are no longer used, they generate electronic waste. 38% of respondents partly knew this, and 33% did not know it. Knowing this information changed slightly the extent to which they think having a charger in the box is important. The number of respondents who thought it is important to have an EPS decreased from 82% to 71%, and those who thought it is important to have a cable decreased from 89% to 78% of respondents. A minority of consumers (6%), however, indicated that it is not important for them to have an EPS in the box, and that this is because of sustainability reasons.

- **Concerns on consumers' reactions**

In interviews[89], manufacturers have expressed their concern about consumers' reactions if they stop selling chargers with their devices. Two manufacturers informed that they had previously tried unbundling schemes in the past. One camera manufacturer noted that they started selling their cameras without the EPS and received very negative feedback from consumers. A phone manufacturer also noted that they piloted an unbundling scheme in Russia (in this case, the phones were sold without EPS or cable), but most consumers chose to buy the charger when acquiring a new phone. The lack of effectiveness in the scheme also meant that the environmental benefits they were expecting to achieve were not realised.

Figure 2 shows the problem tree.

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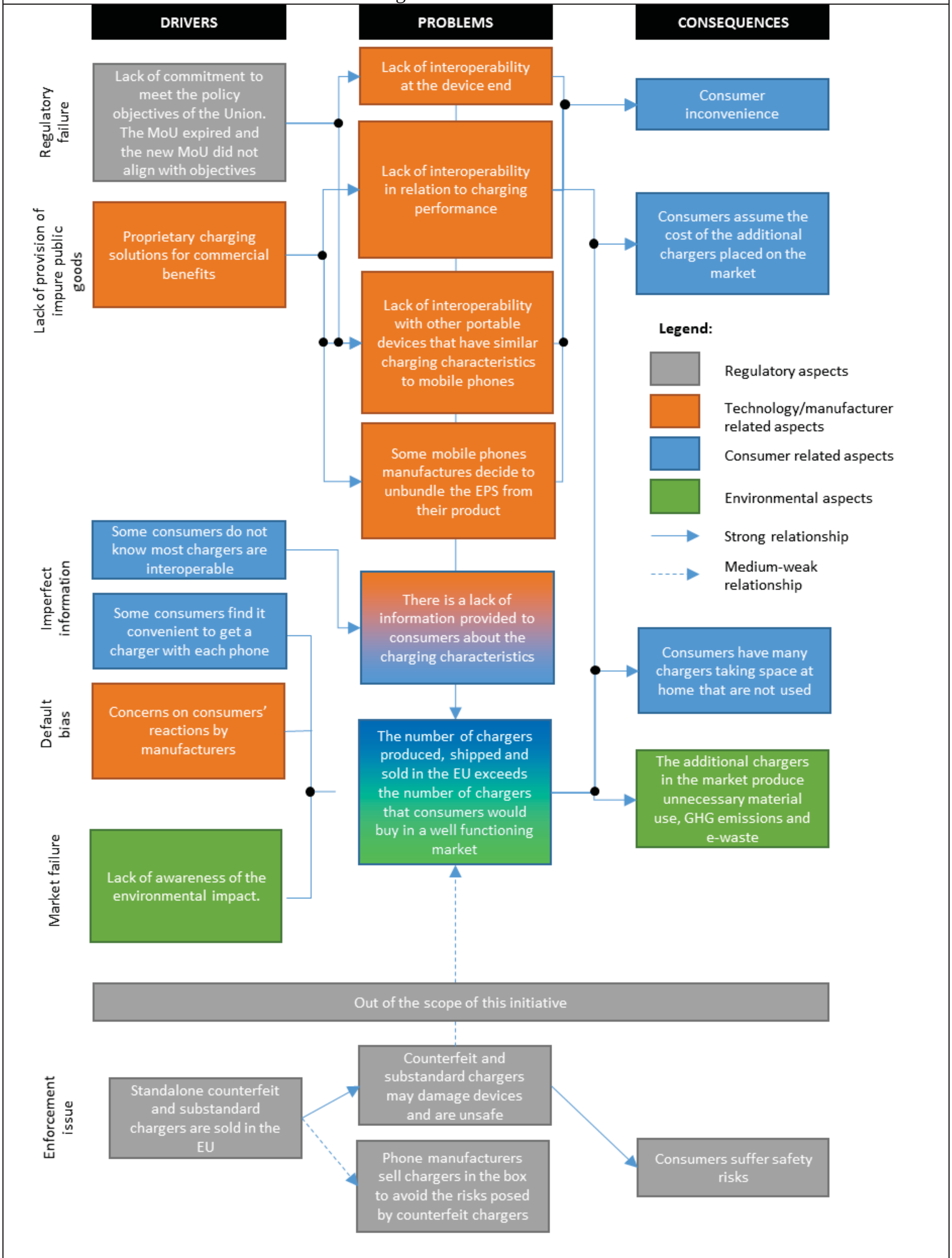
[88] Only one small manufacturer (Fairphone) offered consumers the option of buying phones without chargers

[89] Annex 2 and more extensively https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1

Figure 2 - Problem tree



Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

2.3. How will the problem evolve?

In the absence of action to promote a common charging solution, fragmentation is expected to continue for the foreseeable future.

As regards the wired chargers, following the MoU of 2018, the manufacturers will not eventually converge to a common solution for connectors and would not phase out existing proprietary connectors, as that MoU also allowed to keep the micro USB type-B interface and proprietary interfaces. As regards the old common connectors (micro USB type-B), Figure 5.4 of Annex 5 and a projection of an industry study[90], identify that as of 2024 their phase-out will be de facto completed. However the remaining proprietary solution on phone (on other products) will stay. In addition, other manufacturers may wish to introduce in the future new proprietary solutions (both for phones and other devices), if this is not addressed. The fact that, despite the voluntary approach didn't lead to one single solution, the regulators didn't act, may be even an incentive for other manufacturers to switch to proprietary solutions. Whilst fragmentation is being observed also in the uptake of the wireless charger, with different protocols, coils, interfaces and technologies being developed[91], there are efforts to converge to a common solution or interoperability. Since wireless charging enabled phones were first introduced, they have seen widespread adoption. Between 2016 and 2018, their overall sales increased six fold, rising to around 44 million, or around 28% of overall sales in 2018[92]. The largest share of wireless enabled phones sold throughout 2016-2018 were from one manufacturer only. More recent observations of the market were in line with this effort to limit the fragmentation[93]. In view of the recently launched voluntary unbundling initiatives by certain manufacturers, the specific study[94] estimates that 25% of phones will be sold without an EPS in the box, and that this proportion will increase to 48% by 2023, and more slowly thereafter, to 54% by 2030. But, in light of the experience with the implementation of the MoU, voluntary initiatives on the matter may not be followed by all active manufacturers in the field.

Based on the results of the consumer survey, it is estimated that 57% of consumers who purchase an unbundled new phone will choose to purchase one EPS along with the phone. However, since these consumers will be able to choose which kind of EPS they acquire, demand for stand-alone EPS bought at other times (not along with a new phone) will decrease, by an estimated 31%. The net effect of these two trends is that, for every phone sold without an EPS, it is assumed that an additional 0.39 stand-alone EPS will be bought.

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[90] Figures 3-8 and 3-9 of the study in https://www.digitaleurope.org/wp/wp-content/uploads/2019/12/RPA-Study-Common-Charger-2.0-final.pdf
[91] https://data.europa.eu/doi/10.2873/537546
[92] note that these numbers refer to wireless *enabled* phones, i.e. not to phones that come with a wireless charger, but those that *can be* charged with a wireless charger that needs to be purchased separately
[93] https://data.europa.eu/doi/10.2873/537546 - see also Annex 5 for further details
[94] https://data.europa.eu/doi/10.2873/788086

In other words, every 100 phones sold without an EPS the total number of bought EPS is reduced by 61 units. In 2021, on the EPS side, there were two main non-proprietary technologies on the market, with respectively 70% (USB Type A) and 30% (USB Type C) of the share[95]. As a transition is in place, this situation is expected to reverse by 2030. However, proprietary connectors will remain 22% of the total. With respect to EPS, the trend towards more powerful (and faster) EPS is expected to increase in future, with EPS providing less than 7.5W reducing to 7% by 2030.

As regards environmental impacts, high-power quality chargers (both cables and EPS) are typically designed to last longer than cheap and low-power chargers[96]. In the short-medium term, the consumption of materials for the production of chargers will increase, as the fast chargers are heavier (see Annex 5). In this timeframe, an unnecessary proliferation of chargers will lead to consuming more resources. In the medium-long term, new technologies (such as GaN, Gallium Nitride) will reduce part of the weight and are expected to increase the durability of the chargers available in the market, as indicated during the interviews[97]. In this scenario, the absence of a common interface and minimum charging performance and the progress of fragmentation risk to reduce the reuse of these devices within their lifetime.

The material use is estimated[98] to increase from 14 584 tonnes in 2017 to 20 969 tonnes in 2030. From 2017-2024 there is a steady increase in the material used. This is driven by the switch to heavier EPS and more robust and durable cables. The increase in material used slows in 2023 and 2024 (4% and 2% increase, respectively). This is then followed by an overall stabilisation of the material used until 2026, after which there is an annual decline of 1-2% driven by increased adoption of lighter and smaller EPS introducing new components (such as GaN).

For context, the baseline annual average material use (based on 2024-2030) of 21 829 tonnes represents a negligible proportion (0.0005%) of the 4.5 million ktonnes (kt) of total material used in the EU in 2018. It also equates to around 2.6% of the weight of small household appliances put on the market in the EU in 2018, and so within this category is a small but non-negligible contributor. Without action, the e-waste is expected to increase from 12 574 tonnes in 2018 to 20 177 tonnes in 2030 despite the decline in the number of EPS and cables added to the stock of chargers each year as mobile phone sales decline and unbundling increases. From 2024 onwards, the annual increase in e-waste slows but overall, the amount of e-waste generated increases gradually every year, as changes in material use translate to changes in e-waste. The baseline annual e-waste generated in 2023

[95] USB Type-A and USB Type C – see Annex 5 for details
[96] https://data.europa.eu/doi/10.2873/788086
[97] https://data.europa.eu/doi/10.2873/788086
[98] https://data.europa.eu/doi/10.2873/788086

of 16 616 tonnes represents approximately 5.4% of the 353 172 tonnes of total small household appliances collected from households equipment in 2017. The model assumes an increase in the recycling rates of plastics and metals. These recycling rates result in an average increase of 31% of the e-waste collected, and 43% of the e-waste recovered for recycling between 2024 and 2030 compared to 2024.

Table 3 - Modelled recycling rates for EPS and cables (2015-2030)

Disposal method	2015	2020	2025	2030
Disposed to recycling	56%	69%	76%	84%
Incorrectly disposed (untreated waste)	44%	31%	24%	16%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

The GHG emissions increase from 2017-2023 despite the trend for e-waste. This is driven by the switch to faster, more powerful EPS (7.5W and above) and the move to USB Type-C cables, both of which are heavier than the previously more common low (<7.5W) power EPS and USB Micro-B cables. The average weight of an EPS + cable combination is modelled to increase by 70% from 57g to 97g between 2017 and 2023. The trend in weight increase per charger combination stabilises from 2024 onwards and even declines a little as lighter EPS, e.g. using GaN, become more common. These effects lead to the observed decline in baseline GHG emissions of 7% between 2023 and 2030. Baseline annual GHG emissions in 2023 of 1 142 ktCO2e represent approximately 0.03% of EU GHG emissions in 2018. With respect to other electronic devices, the trend is as in the following table[99]. This confirms that the environmental problem is present also in different devices than mobile phones.

Overall, other devices are smaller markets than for smartphones. The market of mobile phone chargers is much larger than any other market of portable devices (see the Table below). However, there is already quite some inconvenience coming from the fragmentation of performances and interfaces for these devices. Together with the high rate of unbundling, the consumer inconvenience for these devices can be significant.

Table 4 – Trends for other devices

Device	Sales trend (thousand units)	Fragmentation (interfaces and performance)	Unbundling impact	Considerations
Tablets	Decreasing 22 350 (in 2019)	High	High	Closest device to smartphones in terms of battery and charging

[99] https://data.europa.eu/doi/10.2873/788086

				characteristics
Cameras	Decreasing 5 428 (in 2019)	High	High	High potential to reduce fragmentation and likely high impact of unbundling
Earbuds and headphones	Increasing 23 612 (in 2019)	High	Medium	Very fragmented market (type of connector) and growing market. All products analysed include a cable and half of them include also an EPS. Some earbuds are charged via wireless in their box, and the box connects to an EPS via a cable (common or proprietary).
Hand-held video game consoles	Constant 18 598 (in 2018)	Low	High	Consoles share cable and EPS with smartphones. All devices analysed in the mapping are sold with cable and EPS.
Portable speakers	Increasing 1 639 (in 2020)	Medium	Low	Most of the devices use USB technologies and approximately 20% are sold with an EPS. The trend towards USB-C and towards de-coupling has been confirmed in interviews with manufacturers.
E-readers	Constant 11 838 (in 2020)	Low	Low	EPS typically included in the box and connectors already standardised
Smartwatches and fitness trackers	Constant 7 658 (in 2020)	High	Low	Most devices are charged via wireless. These wearables are often designed to be water resistant and support hard conditions, therefore USB connectors may not offer the best solution.
Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)				

2.4. Impact of COVID-19

Different statistics for 2020[100] [101] [102] show that the COVID situation has impacted by 5%-10% on the sales of mobile phones and other electrical equipment. However, the estimates[103] foresee a full recovery in 2021 or 2022 the latest, with a growing trend as in the years pre-crisis. For the purposes of the environmental benefits, is therefore assumed that the COVID-19 situation will not impact the overall findings and policy options.

On the contrary, as regards the consumer convenience, the Economic and Budgetary Outlook for the European Union 2021[104] notes that "*despite being protected by government measures, aggregate labour income is set to decrease in 2020 as many companies defer decisions about employing new staff, or reduce working hours or staff numbers. Some segments of the workforce are likely to be affected more than others, with the incomes of lower-wage earners and younger cohorts showing greater vulnerability to downturns*". This is confirmed also by Eurostat[105], which also registered a rise to the unemployment rate[106]. All this makes consumers more vulnerable and therefore the effects of COVID-19 require to pay specific attention to the consumer convenience (e.g. costs, interoperability or reusability) which has been described in section 2.1.1.

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

The legal basis for this initiative is the RED, which is based on Article 114 of the TFEU. The way in which the RED will be used in support of the current initiative is described in section 8.1, with respect to the preferred policy option. As the RED does not cover EPS, this initiative focuses on the end-device, not their chargers or chargers' components.

3.2. Subsidiarity: Necessity of EU action

EU intervention in this area is a common interest for consumers and the environment. As outlined above, the EU needs to make sure that products placed on the EU market support the consumer convenience and are rationalised so to allow the reduction of e-waste, promoting the objectives of a circular economy.

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[100] https://ec.europa.eu/eurostat data code STS_TRTU_A
[101] https://www.gartner.com/en/newsroom/press-releases/2021-02-03-gartner-says-worldwide-smartphone-sales-to-grow-11-percent-in-2021
[102] https://www.statista.com/outlook/cmo/consumer-electronics/telephony/mobile-phones/europe?currency=EUR#revenue
[103] as in the previous 2 footnotes
[104] https://www.europarl.europa.eu/RegData/etudes/STUD/2021/679062/EPRS_STU(2021)679062_EN.pdf
[105] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Impact_of_COVID-19_on_employment_income_-_advanced_estimates&stable=1
[106] https://ec.europa.eu/eurostat/web/covid-19/society-work

The technology for chargers is available and sufficiently flexible for charging multiple categories of equipment. Harmonisation of charging solutions has to be developed in a manner that supports the policy objectives of the Union in terms of circular economy and consumers’ convenience. The lack of interoperability, unjustified difference in performance and the related consumers’ inconvenience affect an effective and efficient functioning of the internal market, where the absence of harmonisation may lead to substantial differences between the Member States' laws, regulations, administrative provisions or practices. Without EU action, the trend (see section 2.3) is that fragmentation of connectors, EPS and performance will persist. The size of the internal market in recharging mobile phones and similar devices and the fragmentation of different chargers on the Union market call for stronger action at Union rather than national level to achieve the smooth functioning of the internal market.

It is therefore necessary to ensure that citizens do not suffer an unjustified level of fragmentation when charging certain categories of radio equipment and that no waste is produced by unnecessary sales. A basis for adapting harmonisation in this area with any new technology, relating to wired or wireless charging, shall also be provided.

3.3. Subsidiarity: Added value of EU action

An EU action will guarantee that the objectives of consumer convenience and WEEE reduction apply at the Union level. It will also prevent manufacturers to be subject to different possible national initiatives that aim to achieve the same objectives in a non-harmonised manner and would lead to obstacles to the free movement of goods within the EU. It would ensure that sufficient information is provided to consumers. Such measures must, therefore, have the same content throughout the EU. In line with the principle of subsidiarity, it is thus appropriate for the measure in question to be adopted at EU level.

EU action will also allow enforcing measures when products are placed on the market according to the principles laid down in the Internal Market legislation of the Union. MS do not have a legislative tool to recall or to impose corrective measures to the equipment that does not facilitate the consumer convenience or creates excessive e-waste. The status quo has likewise implicit quantifiable and non-quantifiable impacts which are expected to persist, as a minimum, despite the long-standing request to reduce the fragmentation in the sector. A response is therefore needed.

A regulatory action at the EU level will consequently fit a coherent implementation of the EU law, supporting the development of the Internal and Digital Single Markets and providing legal certainty for both manufacturers and consumers.

An EU regulatory action will also apply to all manufacturers in a non-discriminatory way, thus establishing a level-playing field on the EU market for the equipment in scope, harmonising the requirements that are to be demonstrated in the Union for market access.

Setting specific requirements for interoperability, i.e. charging performance and interfaces, will make it easier to assess the quality of chargers on the market, and hence. In turn, this will provide Market Surveillance Authorities with precise benchmarks to ascertain the correct functioning of chargers and therefore contribute to a better implementation of the internal market.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives

The general objectives is to increase consumer convenience and achieve environmental benefits through an initiative concerning a common charging and unbundling for mobile phones and other portable devices which have similar charging needs.

4.2. Specific objectives

The general objectives in the previous section will be achieved through the following specific objectives which aim to reduce the impact of the problems described in section 2:

1. In a first instance the aim is to promote interoperability reducing the fragmentation in terms of end-device connector of mobile phones and other portable devices;
2. In a second instance, the aim is to promote interoperability in terms of charging performance of devices, including fast charging;
3. In a third instance, ensure citizens have enough information as to make informed choices when they decide to buy a new device. Consumers shall be given clear, intelligible and immediate tool to understand the performance of the electronic devices and which charging accessories shall be used to achieve the optimal performance. This point will be complemented by a parallel initiative on common EPS (see section 1.1.2) under a different legal basis[107];
4. Furthermore, provide consumers with a choice as to whether they want to acquire a new charger when they purchase electronic devices;
5. Finally, the pool of devices in scope of the initiative is to be extended to the maximum possible, in the respect of the charging requirements, technologies and uses. The devices analysed for a possible inclusion are radio devices with similar charging characteristics than mobile phones, as in section 5.

The use of a common interface, supported by interoperability as to the charging performance, adequate information to the users and offer of unbundled solutions will allow consumers to be in a position to assess on a more solid ground whether they need a new charger. This in turn will allow to reduce unnecessary purchases and reduce the environmental impact of chargers, which will even be more effective by extending the pool of devices in scope of this initiative. Therefore the attainment of the specific objectives on consumer convenience are linked to the environmental specific objective of reducing e-

[107] Directive 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

waste. Finally, the complementary of the present initiative with the up-next initiative under eco-design towards a universal external power supply will allow to achieve the ultimate goal of the "common charger".

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

The different policy options include a status quo option, non-regulatory and regulatory options. The latter ones have been built on the hypothesis of an ad-hoc amendment of the RED and taking into account parallel initiatives on EPS, which are planned for next year (see section 1 and Annex 5). The assessment of policy options has taken into consideration the extent to which the different policy options could achieve the policy and regulatory objectives set out above and in the Commission's inception impact assessment[108]. Different consultations of the Expert Group on Radio Equipment took place to verify the extent to which the policy options could respond to the stakeholders' and the Member States expectations. The policy options have been built as a function of the different possible measures presented in the following points, each of them tackling different specific objectives. They have been packaged according to the level of ambition of the EU action:

1. Harmonisation of the end-device interface: this has been the objective of the MoUs of 2009 and 2018. The aim of this measure is to ensure a degree of interoperability requiring mobile phones and/or other devices to have a common interface. The aim is to have the most common solution used on the market (USB Type C – see Annex 5) harmonised across all devices in scope.

2. Interoperability in terms of charging performance: supporting interoperability with USB PD communication protocol by the device: this can be left to the market (no action) or to a mandatory measure, ensuring that appropriate protocol and performance (see Annex 5) are implemented in all devices, in a proportionate manner;

3. Making unbundled solutions available on the market: this measure aims to minimise the sale of EPS together with the devices, favouring the re-use of existing chargers, and minimising the need to buy new chargers. It can be implemented in two ways, i.e. either placing on the market only unbundled solutions or placing on the market at least unbundled solutions (a manufacturer could offer both). It can be mandated or left to a market approach (no action);

4. Informing consumers about charging performance: this measure aims to inform consumers on the charging capabilities of the devices they intend to buy, so that they can understand whether they can re-use their old charger and to which extent. It will

[108] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/2020-Common-chargers-for-mobile-phones-and-similar-devices

allow consumers to compare the charging performance of the device with the EPS and match them as appropriate. To do so, the following information should be displayed:

- The maximum power that the device can take will be indicated on the device. The standard allows for downward compatibility, i.e. devices supporting higher power can also operate at lower powers.
- The support of the common fast charging communication protocol.

The same requirements will have to be displayed on the EPS (which for numerous of them it's already the case), this will be implemented through the revision of the EPS regulation. This is considered to be a flanking measure to the second measure and are merged because closely linked to each other (see also section 5.3);

5. An additional dimension is the scope of the initiative: the equipment in scope of the options can be narrow (mobile phones only) or broad (certain devices with charging characteristics which are comparable to a mobile phone). The issue of scope could be considered as a sub-option of all the possible policy options.

How these measures are combined into policy options is reported in Section 5.2.

The safety of chargers, the reduction of counterfeit products and the promotion of quality and durable products will not be directly supported by this initiative. The planned initiatives on Eco-designs and common EPS (see section 1.1.1) will complement to achieve quality and durable products. In terms of safety, the pending evaluation of the Low Voltage Directive showed that the rules concerning safety of EPS are fit for purpose. There are a number of recent and upcoming initiatives related to market surveillance and improved enforcement of IPR rules that should have a positive impact on the safety of chargers and reduction of counterfeit chargers on the market. In particular, the Regulation (EU) 2019/1020 on market surveillance and compliance of products supports fairer internal market for goods, through fostering more cooperation among national market surveillance authorities. This includes sharing information about illegal products and ongoing investigations so that authorities can take effective action against non-compliant products.

As a consequence, before taking further action on the safety of chargers and the reduction of counterfeit, it is appropriate to assess the effectiveness of the implemented measures mentioned above. Those aspects will therefore not fall under a specific policy option or action. The harmonisation of the interface on the end device will be based on international and European standards which are developed by industry. Those standards will represent a basis to strengthen the enforcement in the field, as it will provide a benchmark against which enforcement can take place. In order to keep track of the technological developments, any regulatory option descried in section 5.2 will be accompanied by an empowerment to issue delegated acts to keep the pace of possible future standards/revision of existing standards with common solutions. Those delegated acts, as common practice, will include a transitional period to allow industry and consumers to smoothly migrate to the new common solutions.

5.1. What is the baseline from which options are assessed?

Policy Option 0 is the current baseline scenario of the revision, against which the potential impacts of the policy options are measured. This policy option consists in no EU action, meaning the preservation of the "*status quo*", as described in section 2. Under this option, the MoU of 2018[109] – a voluntary action from the manufacturers – will remain the only voluntary tool through which signatories "*declare their commitment to continue to enable smartphones to be charged through a common charging interface in fulfilment of the requirement of interworking between the power source and the smartphone while leveraging the ability of USB Type-C™ to be the common charging interface for other types of portable electronic equipment as mentioned in the Radio Equipment Directive 2014/53/EU (article 3.3a). In furtherance of this end, signatories agree to gradually transition to the new common charging solution for Smartphones based on USB Type-C*". However, this MoU:

- *"is limited to wired charging solutions for Smartphones"*;
- allows the following to *"be considered compliant with this MoU:*
    - o *a cable assembly that is terminated on both ends with a USB Type-C plug;*
    - o *a cable assembly that is terminated on one end with a USB Type-C plug and has a vendor-specific connect means (hardwired/captive or custom detachable) on the opposite end;*
    - o *a cable assembly that sources power to a USB Type-C connector from a USB Type-A connector".*
- allows that "*Smartphone models compliant with the technical requirements as laid out in the first MoU (5 June 2009) may still be sold*"[110];
- "*shall not preclude innovation (for example in Smartphone and External Power Supply designs, battery and charging technologies, interfaces, adaptors, cables, or improved charging performance)"*.

The MoU will only cover, in a voluntary manner, the end-device connector described at the beginning of this chapter. The MoU does not include any of the other four specific objectives and currently there is no consideration to launch a new MoU. Therefore, its implementation will not lead to full interoperability. Additionally, manufacturers will be able to sell their mobile phones, or other similar devices, bundled or unbundled from a charger.

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[109] https://www.digitaleurope.org/wp/wp-content/uploads/2019/01/2018.03.20-MoU%20on%20the%20future%20of%20Common%20Charging%20Solutions%20(1)%20(1)%202.pdf

[110] "*http://ec.europa.eu/DocsRoom/documents/2417/attachments/1/translations. Smartphones compliant with the first MoU include, but are not necessarily limited to, those chargeable through a cable assembly that sources power to a USB Micro-B connector (with an adaptor made available if needed) as set forth therein"*

5.2. Description of the policy options

The following packages have been considered as viable alternatives that will be subject to detailed assessment.

Table 5 - Description of policy options

Policy Option	Harmonisation of the end-device connector	Support of the relevant charging protocol on the end-device and informing consumers about charging performance	Making available on the market at least unbundled solutions
Option 0	No action	No action	No action
Option 1	**Mandatory**	No action	No action
Option 2	No action	**Mandatory**	No action
Option 3	No action	**Mandatory**	**Mandatory**
Option 4	**Mandatory**	**Mandatory**	No action
Option 5	**Mandatory**	**Mandatory**	**Mandatory**

For all options, there would be then an additional consideration to either a narrow scope (mobile phones only) or a broad scope (mobile phones, tablets, cameras, earbuds and headphones, headsets, handheld videogames consoles, portable speakers, e-readers, smartwatches and fitness trackers). It is recalled that when no action is foreseen under "Harmonisation of the end-device connector", the MoU 2018 keeps applying.

Policy Option 0 – No action: This policy option entails no change to the current regulatory framework and to the ways of work.

Policy Option 1: This option builds on the baseline and adds the measure to mandate a harmonised interface USB type C at the end-device's side.

Policy Option 2: This option builds on the baseline and adds the measure to mandate interoperability with suitable USB communication protocol at radio equipment side. It also adds as a flanking measure the measure to mandate manufacturers to inform consumers about the charging performance of the device.

Policy Option 3: This option builds on the policy option 2 and adds the measure to mandate manufacturers to make available on the market at least unbundled solutions. Manufacturers will be left with the opportunity to supply also a bundled version.

Policy Option 4: This is a combination of the measures in policy options 1 and 2.

Policy Option 5: This is a combination of the measures in policy options 1 and 3.

5.3. Discarded options and measures

Different measures discussed at the beginning of this section were either discarded at an early stage, or during the development of this initiative, for the considerations below. These were:

- **A new MoU or a voluntary approach**

Under this option, industry would have improved the MoU of 2018, through a revamped request of the Commission, consumers and European Parliament, possibly expanding its scope or applicability (e.g. to uniformity of performance or information to users). It is recognised that the voluntary approach of 2009 has initially been successful in reducing significantly the number of charging solutions. However, to reach a new MoU took 9 years and the outcome has been deemed unsatisfactory to meet the policy objectives as a result of the opposition of major market players. Actually, the MoU of 2018 has been identified to allow even more solutions that the one of 2009, with a reduced commitment. Amongst others, the issue of performance was explicitly not addressed, despite the problem being already present at the time of adoption of the MoU. It is therefore highly unlikely that a new satisfactory MoU can be agreed and effectively implemented.

- **Non-action on the charging protocol or unbundling whilst mandating information to consumers**

Interoperability with a shared communication protocol is a pre-requisite to achieve a coherent unbundling of the charger as well as to provide pertinent charging performance information to the consumers.

- **Considering "the support of the relevant charging protocol on the end-device" and "informing consumers about charging performance" as two separate measures**

It would not be coherent to mandate equipment to be interoperable with chargers (up to the maximum power the device supports) without providing the related information to consumers, who would have to match devices and chargers.

- **Considering "unbundling" without "the support of the relevant charging protocol on the end-device and informing consumers about charging performance"**

It would not be coherent to mandate unbundling of EPS leaving the consumers uninformed on the charging requirements and performance of the devices they plan to buy.

- ***Ad-hoc* solutions (e.g. adaptors) for devices with proprietary interfaces**

This option would consist in obliging manufacturers of devices with proprietary interfaces to include in the box (i) exclusively a cable with a common connector with an adaptor from common to proprietary interface or (ii) an adaptor from the proprietary interface to a common interface. Both these suboptions was discarded as they would not solve the problem of full interoperability of chargers with devices and would not reduce the inconvenience to some users at the expense of inconvenience to other users. In addition, negative environmental impacts would have resulted from the need to supply adaptors which would not be used or easily lost. This was confirmed through the results of Public

Consultation suggesting that consumers are not keen on adaptors[111], with only 25% stating they would be satisfied with this option.

- **Harmonisation of EPS**

Full harmonisation of the EPS (e.g. in terms of interfaces and performance) was discarded after the report of the study on Common Chargers of Portable Devices[112]: all cables are detachable, and only two interfaces, both non-proprietary, are present on the EPS (USB type A and type C) due to an ongoing transition. The benefits of attempting to accelerate this transition risks to make obsolete a significant amount of existing EPS and charging infrastructure (e.g. at the airports, on trains, in vehicles, etc), with potential negative consequences and costs in terms of both consumers and e-waste. In addition, chargers are not in the scope of the RED. However, it is acknowledged that measures on the EPS side would usefully complement this initiative and the need of further action on the EPS side is being addressed in parallel (see Section 1 and Annex 6).

- **Unbundling cables**

Under this option, the unbundling would not concern the EPS only but also the cable. Amongst all equipment for charging, cables are the product that consumers purchase most, counting for approximately 50% of the sales[113]. This is due to different reasons, as cables (i) break more frequently than EPS, (ii) can be used for other purposes than charging (e.g. for transferring data to a laptop), (iii) can connect to existing dedicated charging ports (e.g. in airports, on trains, in hotels, etc)). As, in addition to the fact unbundling of cables will results in a higher consumer inconvenience, cables have a reduced impact on e-waste with respect to EPS (see table 4.4 and 4.5 of annex 4), this option was not retained.

- **Making available on the market only unbundled solutions**

This option aimed to have on the Union market exclusively mobile phones sold without chargers. Surveys of consumers showed that around 80% of consumers still think it is important to find a charger (EPS and cable) in the box of the device they buy, which is also the result of the reduced information passed to consumers (see section 2.2). In addition, according to the stakeholders' feedback, manufacturers are also most likely to offer only one packaging solution (unbundled) on the market if unbundling is mandated. Therefore, this option has been disregarded.

- **Regulatory options on wireless charging**

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[111] idem and https://data.europa.eu/doi/10.2873/788086
[112] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1
[113] Figure 6-2 of the study in https://www.digitaleurope.org/wp/wp-content/uploads/2019/12/RPA-Study-Common-Charger-2.0-final.pdf

Wireless charging is a new technology. The technology is not at a mature stage and it is too early to assess if and to what extent it could become a source of consumer inconvenience in the future. Nevertheless, there is no indication of an obvious problem, or a strong demand from consumers or stakeholders for a common wireless charger. A separate technical study confirmed a low fragmentation at the moment and a good level of interoperability among the different solutions for each product. Furthermore, wireless charging can be affected by the shape of the device to charge (charging pads for earbuds and other small devices have very specific shapes that have to match the product to ‘connect’ with embodied batteries). Manufacturers are currently working to a level of harmonisation and interoperability of this technology. The Commission will keep monitoring the situation, leaving the need to act to a future assessment. This initiative, however, will refine the empowerments to act on this type of charging.

- **A scheme for labelling the equipment**

Finally, it would not be appropriate to pursue the option to set in place environmental information. Consideration of elements related to the chargers is being explored in ongoing Ecodesign/Energy Labelling studies (on mobile phones, tablets and laptops); pending the results of those, taking action at this stage appears unrealistic but to consider it in the future, specifically in the context of ecodesign developments[114].

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

This section describes the impact of different options as regards the wired charging solutions. As for the wireless charger the status quo will be preserved, there is no further analysis that will be run in this section. Legal and policy considerations, however, will be put forward in section 8.1.

Economic, social and environmental impacts were considered in assessing the policy options. In more detail, it was sought to have a quantitative analysis, wherever possible, of the following aspects: environmental impacts, consumers’ perspective and convenience, effects on the industry in particular as concerns costs and employment. Other significant impacts such as impact on SMEs, innovation, competitiveness were also analysed.

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[114] See the EC inception impact assessments on Ecodesign requirements (URL: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Environmental-impact-of-mobile-phones-and-tablets-Ecodesign) and Energy labelling of mobile phones and tablets (URL: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12798-Environmental-impact-of-mobile-phones-and-tablets-Energy-Labelling). The preparatory study on potential Ecodesign and Energy Labellling requirements for mobile phones and tablets confirmed the relevanvce of the aspects related to environmental information, in particular related to the manufacturing phase. However, this appears of complex feasibility within the Ecodesign framework, with the aim to have reliable, comparable and verifiable information.

There are various uncertainties when projecting forward and assuming market and technological developments into the future, and also for the other assumptions that underpin the market model. Whilst some assumptions such as charger profiles, e.g. weight, price, etc, will see scaling effects proportional to the changes made, others can have more complex effects. The model was examined for variables for which sensitivity checks would be possible and where variance in the variable/assumption could have an important impact on the results. Also it was considered triangulation of data to validate model results, for example in terms of quantities of charger units, it provides good confidence that the model overall settings are robust as the number of EPS and cables in the stock, compared to the survey reported EPS and cables owned by consumers correspond closely. Feedback received from stakeholders were complemented through desk research, where possible. Efforts were spent to get reliable quantitative data. In many cases stakeholders could not provide precise costs or data, as reported in the different sections. Where possible, in order to remedy to this uncertainty, a sensitivity analysis was performed. For a full description of the limitation of the analysis and details concerning the methodology, we refer to Annex 4.

It is specifically noted that limited EU industries are present in the sector, hence the related impacts lacked robust data. Further in this report, when referring to the industry, it is meant to refer to manufacturers of mobile phones and/or other portable devices, manufacturers of chargers, manufacturers of accessories, and wholesalers all together. For all mandatory options a transitional period will be observed, providing manufacturers sufficient time to adapt to the new requirements. It is noted that the selected common interface[115] and communication protocols[116] have been standardised at the international level, are widely available and also manufacturers of mobile phones with proprietary interfaces are using them on different products.

It is noted that most of the companies in the supply chain of mobile phones and other portable devices and their chargers are located outside of the EU. There are few manufacturers of mobile phones headquartered in the EU (notably, HMD, Nokia, BQ, Wiko, and Fairphone). None of them use proprietary interfaces in their phones. Fairphone is the only SME, whose products come already without chargers. As regards manufacturers of chargers, in the EU there are around 10,000 companies manufacturing “other electrical equipment” in the EU (NACE 2790), of which it is estimated that around 1% (100 firms) manufacture power supply units for telecommunication apparatus[117]. As in the next options the impacts on the EU industry is marginal, it is considered that there is no impact on European employment and it will not be repeated further.

Regulations that affect the overall number of sales of EPS and cables in the EU would mainly affect the firms’ turnover and, therefore, may have wider implications on

[115] USB type C
[116] USB Battery Charging and Power Delivery
[117] It is estimated that their turnover in 2020 was 154 million EUR (including only turnover from sales of chargers).

production. These effects have been modelled (see Annex 4) and differences in revenues between the policy options and the baseline have been reported.

Specifically for certain technical aspects of the measures described in section 5.2, namely the harmonisation of the end-device connector and the support of the relevant charging protocol on the end-device, doubts that were occasionally put forward concerned the creation of a non-tariff barrier, with specific respect to the Agreement on Technical Barriers to Trade[118]. In that respect, it has to be noted that any regulatory option will ensure that (i) imported products will not be subject to a stricter regulation than products which are EU-manufactured, (ii) the requested interoperability aspects will be based on specific clauses of international and manufacturers' drafted standards, (iii) those clauses will be necessary to fulfil the policy objectives. This is of the utmost importance, recalling that the reference to international and manufacturers' driven standards is presumed not to create an unnecessary obstacle to international trade as per the Agreement itself.

6.1. Policy Option 0 – baseline scenario

As described in section 2 and Annex 5, the current situation is characterised by the co-existence of different interfaces and proprietary charging solutions as regards both the connectors and the communication protocols. Unbundling of EPS is taking place for certain models of mobile phones, whilst no information is given to the consumers on the charging requirements of the equipment. The situation for small electronic devices other than mobile phones is also fragmented.

Stakeholders' views on the policy option: Manufacturers support this option. EU MS have different views, with a majority not in favour. The European Parliament and the consumers' associations do not support this option.

6.2. Policy Option 1 – Harmonisation of the end-device connector

This option builds on the baseline and adds the measure to mandate a harmonised interface USB type C at the end-device's side. This option requires that manufacturers of mobile phones with a proprietary connector would change them to a common one. The transition from the old common connector (USB type B) to the new one (USB type C) will be accelerated. The effect of this elimination is observed after 2024, which is a timeline consistent with the legislative one.

Economic impacts:

Impact on economic operators: The manufacturers of mobile phones using a proprietary connector will need to ensure that charging via USB Type C is possible for all new products from the date of implementation of the changes in the Directive. This might entail

[118] https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm

some one-off adjustment costs. There is only one manufacturer who will have to change the mobile phones to adapt them to the common interface. Other manufacturers typically use the common interface in devices in the middle-top end of the segment and they are progressively adopting it in devices in the lower end of the segment (Micro USB type B to be phased out by USB C at 95-99% by 2024 under the baseline).

As regards the related costs, it was not possible to retrieve the following one-off costs: (i) whether the changes would concern the connector only as assembled on the board or they would concern other changes and which would they be, and (ii) to which extent the related costs have not been yet sustained (e.g. other products from those manufacturers already have a common interface). As regards administrative burden on businesses, there is already a standard in place and manufacturers with a common interface run tests on it as a matter of internal quality control. The compliance costs are consequently already part of the BaU. As discussed at the beginning of Section 6, there are a few EU manufacturers in the sector, some of which, SME *in primis*, already use a common interface in their products. Even taking into account the supply chain[119] of major international manufacturers, impact on SMEs is negligible. As consumers will buy less cables (4.8% reduction in sales compared to the baseline), the profits for manufacturers of mobile phones and accessories with proprietary interfaces are expected to decrease by 8.4% after 2023. The overall impact for the worldwide industry with this option is a reduced turnover by 139 million EUR[120] yearly (-8.2%) while the impact on EU industry will be limited to a loss of 18 million EUR yearly (-8.5%). The consequences on distributors and retailers until the point of sale will cause for them a reduction of turnover of 271 million EUR yearly (-9%). In this losses are also expected incomes from royalties[121]. These ones are difficult to assess due to the lack of data from the manufacturers and therefore difficult to highlight. If not appropriately mitigated[122], this option could potentially have a negative effect in terms of reducing possible future innovation in phone connectors (see section 8.1).

Impact on competitiveness and innovation: one of the arguments in the interviews from manufacturers using proprietary connectors is that their connectors allow certain advantages (e.g. they are lighter or thinner) and this may be reflected on the technical characteristics of their products. Hence, they argue that harmonising the connector would hamper innovation and it would likely damage their competitive position. In any case, recent developments show that mobile phones with the common interface can be actually thinner[123] than those with a proprietary interface[124]. It is also to be considered that those

[119] The most affected manufacturers will be Apple and their supply chain. Most of their supply chain is comprised of multinational organisations with a few basis in the EU.
[120] see table 29 of https://data.europa.eu/doi/10.2873/788086
[121] https://data.europa.eu/doi/10.2873/788086
[122] See section 8.1 on the mitigation of this risk
[123] e.g. 6.81 mm as in the Xiaomi Mi 11 Lite https://www.mi.com/global/product/mi-11-lite/specs
[124] e.g. 7.3 mm as in the Apple iPhone SE (2020) https://www.apple.com/iphone-se/specs/

manufacturers are already migrating for certain products to the USB type C connector in their new tablets.

Impact on Public Authorities: Public authorities have not, so far, enforced the presence of a common connector. The costs of checking its presence are believed to be negligible and the costs for checking its safety are already currently performed, so the costs are expected to be negligible. There will be no additional impact compared to the baseline for public authorities. In general, as also the other options can be verified by the Authorities either via inspection or via conventional tests on the equipment, the impact on the public Authorities is considered to be included already in the BaU, and hence negligible.

Social impacts:

Consumers convenience: The elimination of the need for proprietary connectors and cables will give a substantive economic gain to consumers. In fact, market share show that these type of cables represents 17% of the stock in the baseline, and can be up to 1.8 times more expensive than USB Type C to USB type C cables and 2.6 times more expensive than USB Type A to USB Type C cables. Consumer survey also reveals that a broken cable is the main reason for buying a new mobile phone charger (36% of cases). On average users of proprietary cables bought per capita 0.73 cables in the last 24 months, whereas the overall average for all brands is 0.51 cables. Consumers will buy less cables and the average price that consumers pay for the cable will decrease because of the harmonisation, resulting in a increase of the average money saved yearly by consumer of 549 million EUR (8.4%)[125]. This is the result of two effects, i.e. the removal of the necessity for proprietary connectors, which are more expensive than the common ones, and the reduction in the number of sold EPS and cables. Two significant sources of consumers inconvenience (see section 2.1) i.e. no access to a compatible charger and confusion about which electronic devices work with which charger works will be eliminated through the possibility to use common chargers with all devices within scope.

Under this option, users of equipment with proprietary connectors will benefit from a reduction of price of chargers, cables and accessories, thanks to the absence ofroyalties which are passed on to the consumers. At the same time however, existing accessories can be connected to devices through proprietary connectors only. EPS are not in this category of accessories, as they are already interoperable through appropriate cables, which are distributed in the retail boxes almost in all cases. As regards those accessories, it is noted that (i) when those manufacturers switched to the USB type C connector on newer devices (e.g. tablets), consumers did not report major inconvenience and (ii) those accessories became wireless in the last years, therefore the market itself has already limited the inconvenience due to a change of the physical connectors. In the absence of precise data it is therefore not possible to quantify at which moment in time the consumers will have a

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[125] see table 12 of https://data.europa.eu/doi/10.2873/788086

break even between the (temporary) costs incurring from the change of interface and the (permanent) reduction of prices.

Product Safety and Illicit Markets: this option could lead to a small reduction of the sale of substandard cables. According to the consumer panel survey, users of phones with proprietary connectors[126] purchase slightly (approx. 27%) more stand-alone chargers than users of phones with USB connectors. As regards the safety of in-the-box chargers, a common universal USB Type-C connector at the phone end would have no impact on product safety. Safety risks from in-the-box cables are negligible to begin with, and there is nothing to suggest this option would make any difference in this respect.

Environmental impacts:

The environmental impacts from the fact that USB Type C cables and connectors are heavier (by 21.6% to Lightning and 237% to USB micro-B) are bigger than the reduction of standalones sales of cables will have the following net overall effects:

- A marginal increase in the materials used, this represents a 1.5% yearly increase compared to the baseline (329 tonnes). For this policy option, only minimal changes between 2024-2030 per material type are observed compared to the baseline (2% additional decrease of both the amount of the copper and stainless steel used);
- A nearly negligible effect in e-waste generated and represents a 0.8% yearly increase compared to the baseline (155 tonnes). The same trend is observed in the amount of untreated and recycled e-waste (0.8% and 0.9% increase to the baseline, respectively);
- A small increase in GHG emissions that represents a 1.6% yearly increase compared to the baseline (18 tonnes).

The environmental impacts of disposing all accessories with proprietary interfaces, and their replacement by USB-C is unfortunately difficult to estimate because, as highlighted by the surveys, consumers tend to hold to the out-of-use accessories quite a long time before disposing them.

Suboption: broad scope of the initiative

As regards to the extension of the scope, the study shows that tablets, headphones, headsets, handheld videogame consoles, portable speakers and cameras are suitable devices to be incorporated in the scope as they share a similar situation as mobile phones with regards to the connector. As they mostly use the USB type C, the accelerated transition would have minor negative effects on the environment but would increase further the savings for consumers, while also decreasing the profit for the industry.

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[126] e.g. Lightning

Therefore, extending the scope to other devices was deemed not to provide any additional positive impact either because it is not the best technical option and/or the negative impacts would clearly overweight the positive impacts. The impacts, when looking at the data available for tablets, cameras, and headphones, evolve to the following figures when comparing to the baseline (refer to Annex 4 for more details):

- The turnover of worldwide industries decreases of 180 million EUR yearly, 18 million for the EU industries, and decrease of 261 million EUR yearly for distributors and retailers.
- The saving to consumers will be in the order of 620 million EUR yearly;
- The material use increases by 524 tonnes more yearly, the e-waste by 280 tonnes yearly and GHG emissions by 25 ktCO_2 yearly.

Stakeholders' views on the policy option: Manufacturers do not support this option, nor the suboption. EU MS have different views, with an overall majority in favour, although they would prefer it in combination with other measures. The European Parliament and consumers' associations would welcome this Option but would prefer it in combination with other measures.

6.3. Policy Option 2 – Support of the relevant charging protocol on the end-device and informing consumers about charging performance

Under this option, the radio equipment will be mandated to be interoperable with suitable USB communication protocol and manufacturers will be required to inform consumers appropriately. Equipment which only requires reduced power inputs (5W or less) will not be mandated to support more expensive solutions, in line with the content of the standard. In more detail,

- As regards the information to consumers, there are two data that would allow consumers to understand the charging needs of new devices. These are (i) the maximum power that the device can take and (ii) the support to fast charging. Under this option, these data would be requested to appear in in a clear, intelligible and visual manner on the retail box -so to allow consumers to make informed decisions. This information will be complemented on the EPS side through the related eco-design initiative and will allow consumers to match them as appropriate.
- As regards the charging protocol, more and more EPS are supporting USB PD charging protocols, with increased versatility. On the one hand, consequently, devices will be requested to support (up to the maximum power), the USB PD charging protocol. On the other hand, however, manufacturers will not be prevented to develop on top of this common protocol, proprietary technologies for a competitive advantage. In other words, manufacturers will have to include at least the standardised fast charging protocol (USB PD) but will be allowed to include other technologies provided that minimum interoperability requirements (as in the

USB PD standard) are guaranteed. This will allow to achieve the policy objectives on interoperability of the charging performance, whilst not preventing innovation.

Economic impacts:

Impact on economic operators: According to information provided by interviews, the cost for manufacturers of including USB PD at the device end would be a minor increase (0.6 EUR per phone). It would concern manufactures currently using proprietary fast charging protocols not compatible with USB PD or not supporting fast charging at all, around 20% of the volumes of the total market. Recalling that 260 million phones are sold in the EU yearly, this would account for 30 million EUR. Interviewed stakeholders foresee that phones currently using Quickcharge 3 will have naturally transitioned to later versions of Quickcharge compatible with USB PD, with costs therefore falling under the Business as Usual (BaU). This option will ultimately result in a reduction of standalone sales of EPS (4% reduction by 2030 compared to the baseline) and cables (3.1% reduction by 2030 compared to the baseline). This turns into a loss of revenues for worldwide industries estimated at 32 million EUR yearly between 2024 and 2030 which correspond to a decrease of 1.9% compared to the baseline. The negative impact on the turnover of EU industries is estimated at 7 million EUR yearly (corresponding to a decrease of 3.1%). See also annex 4 for details. The consequences on distributors and retailers until the point of sale will cause for them a reduction of turnover of 105 million EUR yearly (-3% compared to the baseline).

Adding the measure on providing information to consumer about the charging performance as a flanking measure is expect to have negligible costs. In fact, under the RED, manufacturers are already obliged to provide information (Article 10(8)). Only the costs to make it more visible are to be accounted, but – if sufficient time is provided – this will fall under the business as usual, as new packaging and new instructions are always designed by the industry.

Impact on competitiveness and innovation: The impact on competition will be limited, in fact, most of the phones and chargers already ensure interoperability, so this option will only affect manufacturers that do not provide interoperable devices with the USB PD (see fgiure 5.2 in Annex 5). However, some smaller cost may occur for manufacturers of system on a chip[127] (SoC), but the battery charging protocol is only a small component of the chip. It is not expected that the option would produce changes in the distribution of revenue among competitors. For manufacturers of mobile phones, the option is not expected to generate major changes in the competitive landscape. Manufacturers who want to continue offering proprietary fast charging solutions along with USB PD could continue to do so, and consumers who value this as a competitive advantage. This option might affect negatively small firms that produce low-end phones and that would have otherwise

[127] See annex 5

continued using USB micro-B connectors and/or USB BC protocol. The size of this market is small (9% in the baseline in 2024). There will be no impact on the competition for manufacturers of chargers nor for retailers and distributors. As under this option, manufacturers can maintain their charging solutions in the mobile phone, as long as the common protocol is implemented, no negative impacts on innovation are expected.

Impact on public authorities: costs for public authorities would be the same as for option 1.

Social impacts:

Consumer Convenience: The increased consumer convenience under this policy option originates from (i) the switch from slightly more expensive accessories and charger (due to charging protocol) to cheaper ones and to the long term reduction of standalone chargers purchased (3.1% less cables and 4% less EPS) induced by the harmonisation of the charging protocol, and (ii) the information provided to customer about charging. It would enhance the guaranteed interoperability of fast charging, plus ability to charge all phones with the same cables, it would also add a minor benefit in regard to the compatibility of charger due to faster elimination of USB micro-B connectors, and the measure on providing information to consumer would reduce the confusion about which charger works with which devices.

The improved information will allow consumers to reuse existing chargers, at least to some extent. The expected reduced purchases would allow consumers to save 168 million EUR[128] yearly, which is 2.6% less compared to the baseline. See annex 4 for detailed calculations.

Product Safety and Illicit Market: This option would lead to a very small decrease in stand-alone charger sales. This would results in a negligible impact on the sales of counterfeit and illicit chargers.

Environmental impacts:

Also, as discussed in section 2, the switch to more powerful EPS, leads to an increase in average cable and EPS weight and consequent increase in materials used. In this option, the offsetting impact of the option in reducing standalone sales is slightly lower than the weight increase effect. The overall reduction of standalones sales of cables (-3.1%) and EPS (-4%) slightly overweighs the fact that USB Type C cables and connectors are heavier, this results in the following net overall effects on the environmental impact:

- A decrease in the materials used, 173 less tonnes yearly compared to the baseline between 2024-2030. This represents a 0.8% decrease compared to the baseline.
- A decrease in e-waste generated, with 50 less tonnes yearly of e-waste generated compared to the baseline total between 2024-2030. This represents a 0.3% decrease

[128] see table 12 of https://data.europa.eu/doi/10.2873/788086

compared to the baseline. The same trend is observed in the amount of untreated and recycled e-waste.

- A decrease in GHG emissions, with emissions 10 ktCO2e yearly lower than the baseline between 2024-2030. This represents a decrease of 0.9 % compared to the baseline.

Suboption: broad scope of the initiative

The direct impact induced by mandating the interoperability of the device with USB PD would only be appropriate to apply to devices which can support the power levels therein described.

Because of this proportional application and because the USB PD has already a wide degree of support, the impacts of this option 2 are expected to be very minor.

An extended scope to tablets, headphones, and cameras, change the different impacts to the following figures when comparing to the baseline (refer to Annex 4 for more details):

- The turnover of worldwide industries decreases to 31 million EUR yearly and stays at 7 million EUR yearly for EU industries, and decrease of 105 million EUR yearly for distributors and retailers.
- The consumers will save approximately 166 million EUR yearly;
- The material use decreases by 130 tonnes less yearly, the e-waste increases by 12 tonnes yearly and GHG emissions decreases by 8 ktCO_2 yearly.

As for option 1, handheld videogame consoles and portable speakers, for which data was not possible to gather, are assumed to provide a proportional similar impact depending on the number of units that are currently sold on the market (see Table 5).

Stakeholders' views on the policy option: Mobile phone manufacturers support this option and suboption as a fall-back of Option 0. EU MS would welcome additional provided information, but the majority of them would prefer this option in combination with a common connector. The consumers and the European Parliament do not appreciate this option as standalone, but would like to see it in combination with at least option 1.

6.4. Policy Option 3 – Unbundled solutions in addition to Option 2

This option builds on the policy option 2 and adds the measure to mandate manufacturers to make available on the market at least an unbundled solution. Manufacturers will be left with the opportunity to supply also a bundled version. In all cases, cables could still be provided.

Economic impacts:

Impact on economic operators: For those devices that are not already unbundled, this requires changing the packaging, adapting the shipment and distribution of phones to the new packaging dimensions, and potentially re-negotiating their contracts or changing their relationships with their EPS suppliers. The most affected by this option would be EPS manufacturers that currently provide the EPS to be sold in the box. For them, it will be a one-off cost to sell the charger separately and to arrange the related aspects (e.g. logistics, supply chain, etc). The EPS manufacturers would need to steer their their business models from supplying both the device manufacturer and the general public to supplying to a greater extent the general public. In that respect, it was not possible to retrieve the following data, which concern one-off costs: to which extent (i) manufacturers are planning to unbundle their products and (ii) the related costs (e.g. in designing packages) are currently being sustained and hence fall under the BaU. However, the related costs to apply these changes can be absorbed in the BaU –as it is reasonable to assume–, given the relatively short average lifetime of mobile phone models and as new models are continuously developed. Retailers and distributors would benefit from the increased sales of stand-alone chargers, from which they would obtain higher margins than when sold along with mobile phones. This option has no further administrative or compliance burden or costs than the ones exposed in previous option 2. Furthermore, in terms of innovation, unbundling has no impact.

It is estimated that the combination of the measures on harmonizing the charging protocol and providing consumer with information about charging performances of the devices with unbundling will further incentivise the latter and will lead to a overall decrease of turnover for the worldwide industry of 168 million EUR yearly (-9.9% compared to the base line), while it is expected that the impact on EU indsutry will be an increase of 18 million EUR yearly[129] (+8.1% compared to the baseline). The consequences on distributors and retailers until the point of sale will produce for them an increase of turnover of 334 million EUR yearly (+10.5%). This is the result of 60 million EUR less of turnover each year from EPS sold in the box, combined with increase of standalones sales of EPS and cables (respectively +3% and +12.9%).

On top of the impact generated by the measure on interoperability of communication protocol (option 2), the measure on mandatory unbundling can have an impact for those manufacturers investing and advertising proprietary fast charging technologies, as they could not offer the complete solution in the box. However, the degree of unbundling happening in the baseline scenario shows that this measures will not affect the entire market, but only a fraction of the manufacturers. In addition, it is worth recalling that this option will not mandate all manufacturers to provide unbundled solutions, but at least unbundled solutions, leaving the freedom to provide both. This will mitigate the impact of this option for those manufacturers that may want to keep providing bundled solutions, whilst allowing consumers' choice.

[129] see table 30 of https://data.europa.eu/doi/10.2873/788086

Also in light of the above, no impact on innovation and competitiveness is expected as companies will be able to continue offering bundled phones if they consider it as competitive advantage, but as long as unbundled solutions can be found on the EU market.

Impact on public authorities: Costs for public authorities would be the same as for option 2.

Social impacts

Consumer convenience: Under this option, it is expected that producers would decide to market all their phones unbundled from chargers (as they are obliged to offer at least this option to consumers). As per the interviews of those manufacturers that are already providing unbundling, the cost of the phone is expected to be discounted by the cost of the EPS. As EPS would not come by default anymore with mobile phones, there would be a rebound effect in the sales of standalone EPS[130]. When bought standalone, consumers pay the retail price, which is 2.2 times the wholesale price. (see annex 4) The costs generated by unbundling are practically equivalent to the amount saved by the reduction of standalone sales of EPS and cables from the harmonization of the charging protocol. As a result, this will bring no savings for consumers (0% compared to the baseline which is -2 million EUR yearly[131] for the period 2024-2030). See annex 4 for details. This option will progressively reduce the stock of chargers in each household but will affect consumers, at least in the short term, as the majority of them surveyed expressed a preference for being provided with a charger along with a new phone.

Product Safety and Illicit Market: The unbundling measure would also lead to a very small decrease in stand-alone charger sales. Combining the unbundling measure with harmonizing the charging protocol would overall result in a negligible impact on the sales of counterfeit and illicit chargers.

Environmental impacts:

The elimination of the EPS supplied in the box (60 million EPS less each year) surpasses the increase in the sales of standalone EPS and cables due to the unbundling of the EPS, and the negative effect of heavier interface due from harmonisation. The net effect of this policy option, as regard to the environmental impact, is:

Building on that, the overall net effect (see annex 4 for details) of this policy option is:

- A decrease in the total materials required, with yearly 1908 tonnes fewer materials used compared to the baseline total between 2024 and 2030. This represents a 8.7% decrease compared to the baseline.

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[130] It is estimated that for each phone sold unbundled, 0.39 standalone EPS are bought.

[131] see table 30 of https://data.europa.eu/doi/10.2873/788086

- A decrease in the e-waste generated, with yearly 729 less tonnes of e-waste generated than the baseline total between 2024 and 2030. This represents a 3.8% decrease compared to the baseline. The same trend is observed in the amount of untreated and recycled e-waste.
- A significant decrease in GHG emissions, with yearly emissions 136 $ktCO_2e$ lower than the baseline total between 2024 and 2030. This represents a 12.1% decrease compared to the baseline.

Suboption: broad scope of the initiative

On top of the effects described in option 2, the main environmental and economic direct effects of unbundling the different devices would mirror those for mobile phones – though the scale would obviously be adjusted to account for the size of the different markets, and the already existing unbundling rates (for EPS only). The smaller the market, and the higher the current unbundling rates, the more limited the environmental benefits as well as other impacts. This includes different effects on consumer convenience, as the inconvenience would be higher for users of tablets (all of which currently come with an EPS), but much less so for portable speakers (most of which are already unbundled).

Given that unbundling of EPS already exists to some extent in all devices, no operating costs, costs of doing business, costs for public authorities, or impacts on SMEs would be experienced beyond those explained in for mobile phones. Unbundling would reduce the number of chargers that are sold bundled, hence reducing the profits for manufacturers of chargers.

An extended scope to tablets, headphones, and cameras, change the different impacts to the following figures when comparing to the baseline (refer to Annex 4 for more details):

- The impact on turnover of the worldwide industries decreases further to reach approximately 238 million EUR yearly while this option is expected to have a positive impact on EU industries of 27 million EUR yearly, and a positive impact on distributors and retailers turnover of 511 million EUR yearly;
- The costs to consumers will be increase roughly by 35 million EUR yearly;
- The material use decreases by 2 566 tonnes less yearly, the e-waste decreases by 1 048 tonnes yearly and GHG emissions decreases by 179 $ktCO_2$ yearly.

As for option 1 and 2, handheld videogame consoles and portable speakers, for which data was not possible to gather, are assumed to provide a proportional similar impact depending on the number of units that are currently sold on the market (see Table 5).

Stakeholders' views on the policy option: Manufacturers would support this option, or the suboption, as a fallback of options 0 and 2. The majority of EU MS would support it, although many would require to adopt a common connector as well. The consumers do not appreciate this option, (i) as it does not deliver a common connector and (ii) being unbundling not preferred by their majority. The European Parliament would not welcome this option without a common connector.

6.5. Policy Option 4 – Charging interoperability in addition to Option 1

This option combines the mandatory measures of options 1 and 2. We refer to those sections for a description of the standalone impacts and below only the combined effects of these two measures are described. The overall impacts of this package would be slightly smaller than the sum of the impacts of options 1 and 2 individually. This is because both of these options entail the replacement of all remaining USB micro-B connectors in phones with USB Type-C connectors (and the corresponding connectors at the device end of cables), speeding up the transition process that is already ongoing, but will not be fully completed under the baseline scenario by 2024.

Economic impacts:

Impact on economic operators: As discussed in option 1, certain manufacturers of mobile phones using a proprietary connector will need to ensure that charging via USB Type C is possible for all new products from the date of implementation of the changes in the Directive. As discussed in option 2, the cost for manufacturers of including USB PD at the device end would be a minor increase (0.6 EUR per phone). It would concern around 20% of the volumes of the total market. Recalling that 260 million phones are sold in the EU yearly, this would account for 30 million EUR. The reduction of standalone sales of EPS is also as for Option 2, but the combined loss of revenues is estimated at 173 million EUR yearly[132] between 2024 and 2030 which correspond to a decrease of 10.2% compared to the baseline. The negative impact on the turnover of EU industries is estimated at 25 million EUR yearly (corresponding to a decrease of 11.6%). See also annex 4 for details. The consequences on distributors and retailers until the point of sale will cause for them a reduction of turnover of 374 million EUR yearly (-11.8%).

Impact on public authorities: costs for public authorities would be the same as for option 1.

Social impacts:

Consumer convenience: The elimination of the need for proprietary connectors and cables will give a substantive economic gain to consumers, as discussed in option 1. Further gain will come from the savings and the information as in option 2. The consequent combination of effects will therefore allow consumers to save 720 million EUR[133] yearly, which is 11% less compared to the baseline. This effect overweighs by far the higher cost of upgrading the connector to USB Type-C and the charging protocol to USB PD.

Product Safety and Illicit Market: The combined effect is estimated to produce a 4% reduction in stand-alone EPS sales, and 7.9% reduction in stand-alone cable sales. This would result in a reduction of substandard and/or counterfeit sales on a similar scale, and thus to a very small reduction in product safety risks.

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[132] see table 30 of https://data.europa.eu/doi/10.2873/788086
[133] see table 30 of https://data.europa.eu/doi/10.2873/788086

Environmental impacts:

As for Option 1, the fact that USB Type C cables and connectors are heavier than others compensates the gain from the reduction of standalones sales of cables and EPS, results in net overall effects on the environmental impact:

- A small decrease in materials used from 2023 onwards: around 140 less tonnes yearly compared than the baseline. This represents a 0.6% decrease. As for option 1, only minimal changes per material type are observed compared to the baseline (Section 2 and Annex 4).
- A small decrease in the e-waste generated from 2023 onwards: 27 tonnes yearly lower than the baseline. This represents a 0.1% decrease. The same trend is observed in the amount of untreated and recycled e-waste.
- A small decrease in GHG emissions from 2023 onwards: 8 ktCO2e lower than the baseline per year. This represents a 0.7% increase compared to the baseline.

See annex 4 for detailed calculations.

Suboption: broad scope of the initiative

The impacts, from the inclusion of tablets, headphones, headsets, cameras, portable speakers, and handheld videogame consoles, are the impacts exposed in option 1 and option 2.

An extended scope to tablets, headphones, and cameras, change the different impacts to the following figures when comparing to the baseline (refer to Annex 4 for more details):

- The turnover of the worldwide industries decreases of around 215 million EUR yearly and 25 million EUR yearly for EU industries, and decrease of 364 million EUR yearly for distributors and retailers.
- The consumers will save approximately 790 million EUR yearly;
- The material use increases by 55 tonnes more yearly, the e-waste increases by around 100 tonnes yearly and GHG emissions decreases by 1 ktCO_2 yearly.

As for option 1, and 2, handheld videogame consoles and portable speakers, for which data was not possible to gather, are assumed to provide a proportional similar impact depending on the number of units that are currently sold on the market (see Table 5).

Stakeholders' views on the policy option: Manufacturers do not support this option, nor the suboption. EU MS have different views, with an overall majority in favour. The European Parliament and consumers' associations would welcome this Option, even if the European Parliament may question the absence of unbundling.

6.6. Policy Option 5 – A common connector in addition to Option 3

This option is built on the policy option 3 and adds the measure to mandate solution common connector (policy option 1), i.e. it is a combination of the mandatory measures in options 1 and 3, to which we refer for a description of the option. Only the combined effects of these two options are described below.

Some of the impacts of this package would be slightly greater or smaller than the sum of those of options/measures individually, due to the synergy effect, notably because the elimination of USB micro-B in the different measures does not stack-up, and because the impacts are increased thanks to the synergy between harmonised communication protocols, informing consumer about charging and unbundling of EPS.

Economic impacts:

Impact on economic operators: Under this option, the impacts of policy option 1 and 3 will be combined. The manufacturers of mobile phones using a proprietary connector will need to ensure that charging via USB Type C is possible for all new products from the date of implementation of the changes in the Directive. This might entail some one-off adjustment costs. Other costs would concern the devices that are not already unbundled, as in option 3. The most affected by this option would be EPS manufacturers that currently provide the EPS to be sold in the box. For them, it will be a one-off cost to sell the charger separately and to arrange the related aspects (e.g. logistics, supply chain, etc). The EPS manufacturers would need to steer their their business models from supplying both the device manufacturer and the general public to supplying to a greater extent the general public. Retailers and distributors will gain as discussed in option 3. It is therefore estimated that the combination the regulatory measures will lead to an overall decrease of turnover for the worldwide industry of 240 million EUR yearly (-14.20% compared to the base line), while it is expected that the impact on EU indsutry will be an increase of 13 million EUR yearly[134] (+5.9% compared to the baseline). The consequences on distributors and retailers until the point of sale will generate for them an increase of turnover of 271 million EUR yearly (+8.5%). This is the result of 60 million EUR less of turnover each year from EPS sold in the box, combined with increase of standalones sales of EPS and cables (respectively +3% and +8.1%).

Impact on public authorities: Costs for public authorities would be the same as for options 1 and 3 (i.e. negligible).

Social impacts:

Impact on consumers: The elimination of the need for proprietary connectors and cables will give a substantive economic gain to consumers, as discussed in option 1. Further gain will come from the savings and the information as in option 2. However, the measure of unbundling will decrease the benefits, as described under policy option 3. As a

[134] see table 30 of https://data.europa.eu/doi/10.2873/788086

consequence, this option will bring the overall gain for consumers to 3.2% compared to the baseline (210 million EUR yearly[135] for the period 2024-2030). See annex 4 for details.

Environmental impacts:

The elimination of the EPS supplied in the box (60 million EPS less each year) surpasses the increase in the sales of standalone sales of EPS and cables due to the unbundling of the EPS, and the negative effect of heavier interface due from harmonisation. The net effect of this policy option, as regard to the environmental impact, is (see Annex 4 for details):

- A decrease in the total materials required, with 14 944 tonnes fewer materials used compared to the baseline total between 2024-2030, or around 2 135 tonnes per year. This represents a 9.8% decrease compared to the baseline. The most substantial changes are observed in 'plastics', 'alumnium' and 'others (EPS)'.
- A decrease in the e-waste generated, with 5 647 less tonnes of e-waste generated than the baseline total between 2024-2030, or around 807 tonnes per year. This represents a 4.2% decrease compared to the baseline. The same trend is observed in the amount of untreated and recycled e-waste.
- A significant decrease in GHG emissions, with emissions 1 028 ktCO2e lower than the baseline total between 2024-2030, or around 147 ktCO2e per year. This represents an 13.1% decrease compared to the baseline.

Suboption: broad scope of the initiative

The impacts, from the inclusion of tablets, headphones, headsets, cameras, portable speakers, and handheld videogame consoles, are the combination of the impacts from options 1 and 3.

An extended scope to tablets, headphones, and cameras, change the different impacts to the following figures when comparing to the baseline (refer to Annex 4 for more details):

- The turnover of worldwide industries decreases of 350 million EUR yearly while this option is expected to have a positive impact on EU industries turnover of 22 million EUR yearly and a positive impact on distributors and retailers turnover of 457 million EUR yearly;
- The gain to consumers will be 246 million EUR yearly;
- The material use decreases by 2 606 tonnes less yearly, the e-waste decreases by 980 tonnes yearly and GHG emissions decreases by 184 ktCO_2 yearly.

As for option 1, and 3, handheld videogame consoles and portable speakers, for which data was not possible to gather, are assumed to provide a proportional similar impact depending on the number of units that are currently sold on the market (see Table 5).

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[135] see table 30 of https://data.europa.eu/doi/10.2873/788086

Stakeholders' views on the policy option: Manufacturers do not support this option, nor the sub-option. EU MS have different views, with a majority in favour. As per option 3, the majority of consumers would prefer to receive a charger in the retail box of the phone. The European Parliament would welcome this Option.

7. HOW DO THE OPTIONS COMPARE?

A synoptic of the yearly impacts are reported in the table 6 below.

Table 6 - synoptic of the yearly impacts for the period 2024-2030

Policy Option	Required material	e-waste	GHG emissions	Consumers' savings	Difference in turnover for economic operators[136]	Total consumers + economic operators
0 – baseline	No change	No change	No change	No change	No change	
1 – narrow scope	+1.5%	+0.8%	+1.6%	549 m€	-410 m€	139 m€
1 – broad scope	+2.1%	+1.3%	+1.9%	620 m€	-440 m€	180 m€
2 – narrow scope	-0.8%	-0.3%	-0.9%	168 m€	-137 m€	31 m€
2 – broad scope	-0.5%	-0.1%	-0.6%	166 m€	-136 m€	30 m€
3 – narrow scope	-8.7%	-3.8%	-12.1%	2 m€	166 m€	168 m€
3 – broad scope	-10.0%	-4.7%	-13.8%	-35 m€	273 m€	238 m€
4 – narrow scope	-0.6%	-0.1%	-0.7%	720 m€	-547 m€	173 m€
4 – broad scope	+0.2%	+0.4%	-0.1%	791 m€	-578 m€	213 m€
5 – narrow scope	-9.8%	-4.2%	-13.1%	211 m€	30 m€	241 m€
5 – broad scope	-10.2%	-4.4%	-14.2%	246 m€	105 m€	351 m€

Table 7 provides information comparing the policy options in terms the two objectives that triggered the initiative.

Table 7 - policy objectives and policy options

Options	Environmental benefits	Consumer convenience
Policy option 0	*No change*	*No change*
Policy option 1	+-	+++
Policy option 2	+-	++
Policy option 3	++	+-
Policy option 4	+-	+++
Policy option 5	++	++

Legend: +- almost no impact; + reduced positive impact; ++ positive impact; ++ very positive impact

Table 8 provides information comparing the policy options in terms of effectiveness (how each option achieves the specific objectives) and efficiency (cost-benefits analysis) and coherence with other pieces of EU law. Administrative costs and impacts on EU

[136] namely worldwide manufacturers, retailers, distributors

manufacturers and Authorities are negligible or already falling under the BaU under all options and will not be reported anymore.

Table 8 - comparison of policy options

	Effectiveness	**Efficiency**	**Coherence**
Policy option 0	In terms of consumer convenience and environmental impacts, the *status quo* described in section 2 will be preserved.		There is no conflict of coherence with the existing EU legislation
Policy option 1	This option resolves one of the major drivers of problems (the absence of a common connector) but it does not addresses minimum performance concerning fast charging, information to consumers and e-waste. As a consequence not all drivers are addressed. It contributes indirectly to safety and counterfeit issues.	This policy option introduce costs only on those manufacturers that are using proprietary interfaces. Consumers' convenience will be improved, but not to the maximum. Compliance costs are expected to be one-off and applicable only to a minor part of the market. In any case they can be reduced through an appropriate delay in the applicability of the option.	Other pieces of EU law, see Annex 6, do not cover this aspect, hence these options are coherent with the EU acquis.
Policy option 2	This option resolves another driver of the problems (the unjustified limitation of the performance by the device), but it does not reduce the fragmentation on the connectors and e-waste. As a consequence not all drivers are addressed. It contributes indirectly to safety and counterfeit issues.	This policy option introduce costs only on those manufacturers that are limiting the charging performance of their devices. Consumers' convenience will be improved, but not to the maximum.	Other pieces of EU law, see Annex 6, do not cover this aspect, hence this option is coherent with the EU acquis. Information to users is already a provision in the RED. This option will complement it.
Policy option 3	This option builds on option 2, addressing environmental matters through unbundling but leaving unresolved the interoperability on the connectors.	In addition to impact of policy option 2, this policy option introduce further costs only on those manufacturers that are not moving towards unbundling of their products. Compliance costs are expected to be one-off. In any case they can be reduced through an appropriate delay in the applicability of the option.	This measure would be coherent with the policy of the Union to reduce waste and promote a circular economy. It will not have overlaps with the environmental legislation described in section 1 and Annex 6.
Policy option 4	This option combines the impacts of policy options 1	This policy option introduce costs on those manufacturers that are using proprietary	Other pieces of EU law, see Annex 6, do not

	and 2, but does not resolve nor mitigates environmental matters through unbundling.	interfaces and that are limiting the charging performance of their devices. Compliance costs are expected to be one-off. In any case they can be reduced through an appropriate delay in the applicability of the option. Consumers' convenience will be improved to the maximum.	cover this aspect, hence this option is coherent with the EU acquis. Information to users is already a provision in the RED. This option will complement it.
Policy option 5	This option builds on option 4, addressing environmental matters, hence it has the highest mitigation of the identified problems.	This policy option introduce costs on those manufacturers that (i) are using proprietary interfaces, (ii) are limiting the charging performance of their devices and (iii) are not moving towards unbundling of their products. Compliance costs are expected to be one-off. In any case they can be reduced through an appropriate delay in the applicability of the option. Consumers' convenience will be improved, but not to the maximum.	This measure would be coherent with the policy of the Union to reduce waste and promote a circular economy. It will not have overlaps with the environmental legislation described in section 1 and Annex 6.

The assessment of the impacts can be visualised as follow:

Table 9 - Impacts of policy options

Options/impacts relative to the baseline	Economic impacts	Social impacts	Environmental impacts
Policy option 0	*no change*	*no change*	*no change*
Policy option 1	--	+++	+-
Policy option 2	-	++	+-
Policy option 3	++	+-	++
Policy option 4	--	+++	+-
Policy option 5	++	++	++

Legend: +- almost no impact; + reduced positive impact; ++ positive impact; - minor negative impact; -- negative impact; --- significant negative impact

The overall support to the initiative can be visualised as in the following tables.

Table 10 – Support to the Initiative

Options	Member States	European Parliament	Consumers Associations	Equipment manufacturers

Policy option 0	-	---	---	+++
Policy option 1	+	+	++	--
Policy option 2	+	-	+	-
Policy option 3	+	+-	+-	--
Policy option 4	+	++	+++	---
Policy option 5	+	+++	++	---

Legend: --- completely adverse; -- not in favour; - not so in favour; +- neutral; + marginally in favour; ++ in favour; +++ significantly in favour – for a more detailed explanation, see Section 6

Table 11 – Support to the Scope

Options	Member States	European Parliament	Consumers Associations	Equipment manufacturers
Narrow	-	---	---	+++
Broad	+	+++	+++	--

Legend: --- completely adverse; -- not in favour; - not so in favour; +- neutral; + marginally in favour; ++ in favour; +++ significantly in favour

8. Preferred option

8.1. Preferred policy option: option 5 with a broad scope

Analysing the summary table 5 in section 7, it can be noted that

- Options 1 and 4 mostly maintain the status quo as regards environmental matters, but provide the most benefits to consumers, at the expense of the economic operators;
- Also option 2 mostly maintain the status quo as regards environmental matters, but provide the reduced benefits to consumers, which are also *de facto* offset by the turnover of the economic operators;
- The policy options 3 and 5, mandating unbundling, maximise the environmental benefit but in the case of consumers' convenience option 3 scores much worse than option 5. In fact, option 3 maximises the gain for the economic operators, at the expense of the consumers.

It is therefore clear that there is no solution that allows to reach the maximum for both intended policy objectives. This is because maximising consumers' convenience (e.g. providing a charger in each retail box) would in turn maximise e-waste and, vice versa, minimising e-waste has an impact on consumers' convenience. In this multifunction maximisation, option 5 allows to achieve the fairest trade-off between all the needed achievements. Under this option, the consumer convenience will not be the maximum possible, but it will be increased. At the same time this option – on aggregate – will maximise the benefits for consumers and economic operators and the environment. The decrease of consumer convenience with respect to option 3 is due to unbundling, which has been identified in the surveys a source of inconvenience. At the same time, however, unbundling makes it in turn possible to reach the highest environmental benefits from the initiative and to mitigate the losses for the economic operators. As a result, it allows to achieve a win-win situation for all the represented categories and the environment and it is therefore the preferred policy option. With respect to the scope, the analysis shows that the cost-benefit improves when more devices are in scope.

With respect to the selected connector and technology, this will be USB Type C and for the fast charging communication protocol, it will be USB PD, as detailed in Annex 5.

However, there may be certain risk with the mandatory measures of this option, which would require mitigation.

A first identified risk is hindering innovation when mandating the harmonisation of the end-device interface. Article 3(3) of the RED empowers already the Commission to adopt delegated acts to specify the categories or classes that are concerned by each of the essential requirements enumerated in paragraph 3, including that "*radio equipment shall be so constructed so that they interwork with accessories, in particular with common chargers*" (subparagraph a). However, in the absence of an empowerment to define one or more "*common chargers*", an amendment of the RED is needed to ensure legal certainty in the selection of the needed interface. The changes in the technical specifications will be defined by the progress in the standardisation exercise. As a result of the above considerations, the Commission will propose an amendment to the RED, where (i) specific clauses of the standard concerning the USB type C[137] will be mandated, (ii) manufacturers will be obliged to place at least unbundled products on the EU market and (iii) the information to the consumers will be improved (for all those aspects, see Sections 6.1 and 6.2). This initiative will not include other legal basis then the RED, even if coherent and complementary actions will be taken under the legislation described in Annex 6.

The possibility to update in a timely manner the specific clauses of the standard concerning the common solution is key to ensure that the technology is not outdated. For this purpose, the Commission will propose to the co-legislators to grant an empowerment to make updates through delegated acts. Industry has already joined forces to standardise interfaces (e.g. in USB-IF in 1995, where Apple is a founder) and this work will not be impeded as long as interoperable solutions are produced. Industry is therefore expected to keep up with the efforts of the past and produce interoperable, open and non-controversial solutions to be adopted through delegated acts. This will minimise the risks to innovation, whilst maintain the consumers' and the environmental convenience.

[137] At the time of drafting this impact assessment it is noted that CENELEC released

- EN IEC 62680-1-3:2021 'Universal serial bus interfaces for data and power - Part 1-3: Common components - USB Type-C Cable and Connector Specification' and
- EN IEC 62680-1-2:2021, 'Universal serial bus interfaces for data and power - Part 1-2: Common components - USB Power Delivery specification'

which will be the basis for the provisions therein described

Linked to innovation, there is the risk to include in scope equipment which cannot accommodate the common interface for physical dimension. For this reason, earbuds will not be in scope.

A second identified risk concerns disproportionality in mandating the support of the relevant charging protocol on the end-device. As explained in section 6.3, devices will be requested to support the appropriate USB charging protocols, up to their maximum charging power. This will allow the chargers and the devices to negotiate the power level to what is achievable by both and hence will allow the best (and safe) charging performance. Devices will not be requested to support power levels above the maximum they can support, as this would not be proportionate.

A third category of risks concern the compliance costs. In section 6, these are considered negligible or reasonably negligible in the absence of specific data and under the assumption of a transition period for the new provisions in line with the average lifetime of products. On the one hand, the USB type-C specifications, which are already described in an international and European standards, will be mandated. The legal draft will suggest a minor amendment to the conformity assessment procedures concerning the essential requirement in Article 3(3)(a), so to allow the manufacturers' self-assessment and avoid a mandatory involvement of Notified Bodies in the conformity assessment procedures. On the other hand, there is the risk that a short transition period would require certain manufacturers to redesign their products. However, the time needed for the co-legislation procedure, together with an appropriate deadline to MS to transpose the new provisions, will provide a sufficiently long transition period[138] to manufacturers to plan and adapt in advance to the new provisions, so that any related cost (e.g. to redesign the product or to provide additional information on the package) can be absorbed under the Business as Usual for new models.

A fourth risk may concern consumers' costs related to dismissing certain accessories. As regards those accessories, other than the considerations in section 6.2, it is noted that the transition period will further mitigate the inconvenience.

A fifth risk concerns the possible creation of a non-tariff barrier, with specific respect to the Agreement on Technical Barriers to Trade[139]. In that respect, Section 6 explains why this is presumed not to create an unnecessary obstacle to international trade, as per the Agreement itself.

A further argument can be the proportionality of the measure to mandate unbundling, under the assumption that the market appears to move in that direction. In that regard, it has to be noted that specific manufacturers, as per their interviews during the stakeholders' consultations, would decide not to unbundle, so to keep up with the consumers' preference.

[138] as a function of the average lifetime of the equipment
[139] https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm

There are therefore, for the time being, only specific manufacturers who decided to unbundle. In turn, in the long term this can create an uneven ground for manufacturers, some of which may decide to re-bundle the chargers with the mobile phones aiming to restore a level playing field. This would significantly affect the benefits of this initiative as regards the environment. In any case, it is acknowledged that the effects of this initiative will be tangible after the date of applicability. In that timeframe, certain consumers may still find convenient to find chargers in the box of new devices. For this reason, manufacturers will be given the option to place on the market bundled solutions as long as unbundled solutions are also available. This will mitigate further the consumers' inconvenience, should they not have a suitable charger at home.

Finally, this initiative will be adopted through co-decision as regard to a revision of the Radio Equipment Directive 2014/53/EU. The date of applicability is currently assumed to be a couple of years after the Commission adoption. As regards interwork with the complementary initiative on EPS, the "universal power supply" will take form of a revision of the EPS Regulation which is under the Eco-Design and does not require lengthy co-decision process. The proposal is expected in 2022. Given these different legislative procedures, it is expected that both initiatives will enter into force in the similar period of time.

8.2. REFIT (simplification and improved efficiency)

This initiative is an *ad-hoc* revision of Directive 2014/53/EU aiming to replace the empowerment in Article 3(3)(a) and on the presentation of information. Information and instructions are already foreseen under Article 10(8) of the Directive and manufacturers address it each time they place radio equipment on the market. The obligation to add and present certain information in a more legible manner to consumers is not expected to create additional administrative burden once sufficient time in line with the average lifetime of models is provided to manufacturers to adapt. The other measures which comprise Option 5 are not expected to create additional burden. As regard simplification, the reduced proposed revision of the Directive is not expected to alter the current framework.

9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

After the entry into force of the revised Directive, the Commission will monitor the implementation, the application and the compliance to the new provision with a view to assessing its effectiveness. The Commission is under the obligation to monitor and report the implementation of the Directive to the Council and the European Parliament. A report is due by 12 June 2023, as per Article 47 of the RED. However, the time for co-legislation and the delayed transposition date will allow to examine implementation aspects only in the report of 2028, or in earlier evaluations of the Directive. The monitoring framework would account for the information reported under the related pieces of EU law in Annex 6. This collective source of information will create an evidence base for a future evaluation of the functioning of the intervention.

- On the implementation, the Commission will spend significant efforts to ensure that the common interface is fit for the purpose and will monitor technological advancements. In accordance with Article 47(2) of the Directive, the Commission will report the state-of-play of the implementation of the Directive, including the aspects herein discussed, to the Council and European Parliament by 2028;
- On the application, by means of the reports of Member States in Article 47(1), the Commission will verify that no conflicting national initiatives would have been taken;
- The general effectiveness will be monitored in conjunction with the other relevant pieces of EU law, and the Commission will monitor the reports of Market Surveillance Authorities, which are regularly submitted to the Expert Group on Radio Equipment.

In more detail the above can be described as follows:

Table 13: monitoring strategy

Indicator	Definition	Unit of measurement	Baseline	Data source
Reduction of e-waste	As in the WEEE	Absolute volumes of sold and disposed chargers	Previous volumes and related trend	Market and environmental statistics
Harmonisation of the interface	As in the relevant standard	Percentage of compliant and non-compliant products	Estimates of the previous years	Annual reports/statistics of Market Surveillance Authorities Reports under Article 47(1) of the RED
Harmonisation of the protocols for fast charging	As in the relevant standard	Percentage of compliant and non-compliant products	Estimates of the previous years	Annual reports/statistics of Market Surveillance Authorities Reports under Article 47(1) of the RED
Presence of information to consumers	As in the modified articles	Percentage of compliant and non-compliant products	N/A	Annual reports/statistics of Market Surveillance Authorities Reports under Article 47(1) of the RED
Unbundling	As in the modified articles	Percentage of compliant and non-compliant products	Estimates of the previous years	Annual reports/statistics of Market Surveillance Authorities Reports under Article 47(1) of the RED
Safety	As in Article 3(1)(a) of the RED	Percentage of compliant and non-compliant products	Estimates of the previous years	Annual reports/statistics of Market Surveillance Authorities and Consumers' reports

ANNEX 1: PROCEDURAL INFORMATION

1. LEAD DG, DECIDE PLANNING/CWP REFERENCES

The lead DG is the DG for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW). The Directorate in charge was Directorate H – Ecosystems III: Construction & machinery. The internal Planning entry was PLAN/2018/3079.

2. ORGANISATION AND TIMING

An Inter- Service Group was set up with the participation of DG GROW, DG CNECT, DG COMP, DIGIT, EEAS, DG ENER, DG ENV, DG JUST, LS, DG RTD, SG, DG TRADE, JRC, DG SANTE.

Meetings took place on 5 February 2021, 1 March 2021 and 5 May 2021.

3. CONSULTATION OF THE RSB

This impact assessment was discussed at a meeting with the RSB on the 16th June 2021. The RSB issued its opinion on the 18th June 2021, following which this impact assessment has been revised as follows:

Summary of findings	
RSB Recommendations	Changes made in the IA Report
The report does not sufficiently explain the links and coherence with other closely related policy initiatives, in particular the upcoming eco-design initiative on the universal external power supply. It is not sufficiently clear that its scope does not include regulating chargers.	Section 1 now includes a more specific description of the complementing initiative under the eco-design framework. Sections 1 and 3 have also been modified so to explain in a better manner that this initiative concerns end-devices, not chargers, for which the EPS legislation will apply.
The rationale for some elements of this initiative is not sufficiently convincing.	Sections 2, 6 and 8 have been complemented with additional explanations and rationales.
The report does not sufficiently analyse some of the impacts. It does not demonstrate the proportionality of the options, given their sometimes limited or negative impacts.	Section 8.1 has been deeply revised enhancing the analysis on the impacts and the proportionality
The options do not specify clearly how they would improve consumer information. They also remain vague on the way to ensure that imposed standards stay in line with technological developments and do not prevent innovation.	Section 6 now reports more granular details on innovation (6.1), consumers' information (6.2). Timely updates of technological developments are discussed in section 8.

What to improve	
(1) The report needs to clarify the relationship and coherence between this initiative and other upcoming initiatives. In addition to the eco-design initiative on the universal external power supply, this also concerns the upcoming eco-design and energy labelling initiative on smartphone and tablets. The report should explain and justify the scope of this initiative in relation to the others. For this initiative, it should particularly clarify that it does not regulate chargers and that it does not introduce a common charger.	(i) Section 1 has been revised with additional information on the complementing initiative under the eco-design framework; (ii) The end of section 1.1 concerns specifically the initiative on smartphone and tablets; (iii) Sections 1 and 3.1 have also been modified so to explain in a better manner that this initiative concerns end-devices, whilst other EU legislation will apply to EPS as these devices are not radio equipment; (iv) In section 3 the relevance of the initiative for the efficiency and effectiveness of the internal market has been strengthen.
(2) The report should present a more convincing and coherent rationale for the harmonisation of the charging connector in devices and for unbundling. It should not use consumer preferences as the main argument for the harmonisation of the connector and ignore them when it comes to their preference for bundling. It is not clear why the report considers the ongoing market evolutions towards unbundling insufficient. The report should take into account that consumer preferences are not homogeneous, which is reflected in their buying behaviour. It should justify why it considers some of these revealed consumer preferences as problematic. It should also provide evidence on the problems related to current business models that privilege proprietary solutions over interoperability.	(i) Section 8.1 has been revised explaining why option 5 allows to achieve the best cost-benefit analysis; (ii) The same section also explains better the risks not to take action on unbundling with respect to the policy objectives of this initiative. (iii) It also explains how there would be a measure to take into account non homogeneous consumer preferences in light of the policy objectives; (iv) It finally explains how specific problems can be mitigated; (v) Sections 2 and 6.2 includes considerations on problems related to current business models that privilege proprietary solutions over interoperability;
(3) The options should indicate more precisely how they would improve consumer information on interoperability and charging performance. The report needs to explain how new information requirements will be aligned with existing and potentially new information requirements of the related initiatives (see above). The report also needs to discuss possible options on transition periods and analyse their merits.	(i) Sections 5 and 6.2 has been made more precise on the ways which would allow to improve consumer information on interoperability and charging performance; (ii) Section 8.1 has been redrafted accordingly; (iii) The same section now also explains that the transition period is expected to be overall in line with the average lifetime of the equipment.
(4) The report should better explain how the	(i) Section 8.1 better explains how the

options are future proof. It should be more specific on how the imposed standards will be kept up to date. It should be specific on what USB power delivery standard it will include, as the newest standard supports higher power use than described in the report.	options are future proof and the imposed standards will be kept up to date; (ii) References to specific recent standards, which will serve as the basis for certain provisions, have been included in the same section.
(5) The report should analyse the impacts on competition and innovation in more detail. It should justify why it considers the risk for creating non-tariff barriers to be limited. The analysis of the social impacts needs to include the cost for consumers of replacing adapters (e.g. to HDMI or for headphones) when the charging connector for their preferred brand is changed.	(i) Sections 6.2, 6.3 and 6.4 have been revised including considerations on competition and innovation; (ii) The text before section 6.1 explains the extent to which the risk for creating non-tariff barriers to are limited; (iii) Section 6.2 includes also the considerations on social costs. The analysis therein presented is complemented by appropriate mitigating measures in section 8.1.
(6) The comparison of options should better analyse the proportionality of the options. It should better justify why the preferred option contains measures with limited or negative impacts. In particular, the harmonisation of the charging connector in the devices would have limited benefits for consumers, combined with negative economic and environmental impacts.	(i) A new column has been added to the synoptic table in section 7 to better assess the benefits for the entire society (consumers and economic operators) in a quantitative manner; (ii) The first part of Section 8.1 has also been modified to explain that the preferred option has a holistic approach in dealing with the presented problems where a common maximum cannot be achieved.
(7) The key limitations and the potential risks of the methodology used should not only be covered in the methodological annex but should also be taken into account when the results of the analysis are presented in the main report. Sensitivity analysis should be used to deal with key uncertainties, such as the proportion of consumers who choose to purchase a charger when they buy an 'unbundled' phone.	(i) The report was made more transparent on the methodology explaining in section 6 the main issues with obtaining quantitative data in certain cases; (ii) It was also explained that the analysis of each suboption would be more precise on the key missing data; (iii) The methodology to remedy to these issues was also explained.

4. EVIDENCE, SOURCES AND QUALITY

Three studies[140] [141] [142] supporting this impact assessment have been carried out by consultants. The Commission's consultants carried out a number of interviews, analysed the data from the public and the targeted consultations, complementing them through desk research and other case studies. The first study identified a positive cost-benefit analysis in

[140] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1.
[141] https://data.europa.eu/doi/10.2873/788086
[142] https://data.europa.eu/doi/10.2873/537546

the adoption of a common connector, but noted that unbundling would have magnified it. A second study, consequently, extended the analysis to unbundling and identified Option 5 of this Impact Assessment as the best trade-off option amongst the different needs and objectives at stake. A third technical study concerned the state-of-play of the wireless charging to understand to which extent (i) fragmentation is ongoing, (ii) a common solution is being sought by manufacturers and (iii) there are commonalities in the existing strands of work which may eventually converge to a common solution. The consultant's research was based on data including from Eurostat (2019), Statista (2019), Comtrade (2019), eMarketer (2017), Strategy analytics (2019), IDC Quarterly Mobile Phone Tracker, Q1 2019, RAPEX (2019) and own sample-based research.

Complementary information was taken from Study on the Impact of the MoU on Harmonisation of Chargers for Mobile Telephones and to Assess Possible Future Options, RPA (2014)

Evidence was also gathered in the Expert Group on Radio Equipment, interview with stakeholders and through public or targeted consultations.

Whenever quantitative information has been sought, EU sources were preferred (e.g. reports or statements from ECB, EU Court of Auditors, Eurostat, EU Agencies, other EU Bodies, etc). Other sources were also considered (e.g. studies or reports of international organisations or firms, of associations of stakeholders, etc). The sources have been chosen, consequently, as reliable as possible. Similar data, when possible, were cross-checked. It is acknowledged that some data are estimates. In order to compensate for possible inaccuracies, throughout this document benefits were repeatedly estimated in a conservative manner.

The stock model of the consultant relies on a number of assumptions, but the most influential of these are the assumptions related to the number and type of chargers added to the model each year. Sales of new phones are held constant across all options, as are the proportion of proprietary phones and by extension chargers.

The situation is more complex for the options, when variations in the charger types are higher, and where the policy typically mandates changes that are more beneficial for interoperability and other impacts, but that have negative impacts on material use and e-waste. This impact is offset by the effect of any reduction in standalone sales. It is important to note that whilst the assumptions for the reductions in standalone sales are based on evidence from the consumer survey or a logical rationale, these are only best estimates of what may occur.

The stakeholder consultation consisted of (i) online public consultation, (ii) targeted consultation and (iii) consumer panel.

Details on the calculations and assumptions are given in Annex 4.

ANNEX 2: STAKEHOLDERS' CONSULTATION

1. INTRODUCTION

In the context of the impact assessment on an initiative in support of harmonised charging solutions for mobile phones and other similar devices, various consultation activities were conducted between May 2019 and April 2021. The aim was to assess the potential areas of revision and the impacts of the suggested policy options on different targets. Here below is a summary table of all the consultations activities.

Table 2.1 – Summary of consultation activities against type of stakeholder

Consultation Activity	Citizens	Consumers Associations	Environmental Associations	Member States	Market Surveillance Auth.	Non Gov. Organisations	Manufacturers Associations	Manufacturers
Inception IA (2018-2019)	X	X				X	X	X
Public Consultation 2019	X	X		X		X	X	X
Consumer Survey 2019	X							
Consumer Survey 2021	X							
Stakeholders Survey 2020-2021	X	X		X				X
Targeted Interviews 2021		X	X		X	X	X	X
Expert Groups Meetings		X		X	X	X	X	X

2. INCEPTION IMPACT ASSESSMENT (2018-2019)

In December 2018, the Commission published an inception impact assessment announcing its plans as regard to the common charging solution. All interested stakeholders could provide feedback on the inception impact assessment for a six week period. 18 answers were provided[143].

3. PUBLIC CONSULTATION (2019)

A Public Consultation on chargers for mobile phones was launched by the European Commission on 14 May 2019 and closed on 6 August 2019. The Public Consultation achieved a total of 2,850 respondents. An overwhelming majority were **EU citizens** (2,743, or 96%). **Non-EU citizens accounted** for 34 entries, resulting in a total of 2,777 responses from private individuals (97%). There were responses from citizens from all EU countries. Among the countries with the highest number of respondents were Italy (13%), followed by Romania (12%), and Portugal (8%). The

143 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/2020-Common-chargers-for-mobile-phones-and-similar-devices

majority of 34 **companies, business organisations, and business associations**[144] that participated in the Public Consultation were mainly based in EU countries. 7 (21%) were from the UK, 5 (15%) from Germany, and 4 (12%) from Belgium. Responses were received also from companies based in Korea (1) and in the United States (3). Of the companies, 42% were from sectors that clearly have a direct stake in the initiative, whilst 13% were telecommunications companies, two testing bodies, and one a certification body. 19 individuals representing **public authorities** submitted their views. Fewer responses were received from **NGOs, consumer organisations, and academic institutions** – overall reaching 14 contributions. The three consumer organisations were from Belgium, Iceland, and Italy, whilst two NGOs were from Belgium, one from Bulgaria, and one from Switzerland. Among the NGOs that took part in the Public Consultation, only one had a clear environmental focus.

A clear majority of EU citizens indicated that the present situation was a source of inconvenience. Respectively, 42% and 34% respectively agreed or strongly agreed with this statement. Only 10% disagreed and 5% strongly disagreed with the statement. 8% held neutral views.

EU citizens' views are aligned with those expressed by NGOs and consumer organisations. Public authorities had more nuanced views, although generally aligned with consumers in indicating financial costs and environmental reasons as the two single-largest problems. Businesses' and business organisations' opinions sometimes showed notable differences from consumers' views in terms of environmental impact (30% held that there was no environmental impact) and inconvenience (47% indicating that no inconvenience was caused by having multiple types of chargers). In addition to this, variety was seen by 56% of businesses and business organisations as a positive factor.

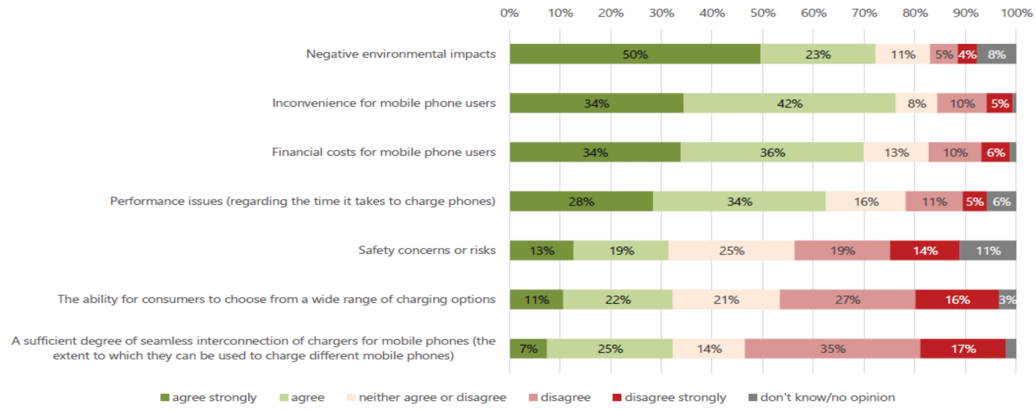
Inconvenience: Among those who indicated that the situation resulted in inconvenience (76%), the following were the main sources of inconvenience reported by respondents:

- 73% of EU citizens believed that users of different electronic devices need to have multiple chargers which occupy space and may lead to confusion to be a serious problem, while 26% of respondents described this as a minor problem. Only 1% of did not consider it a problem.
- EU citizens also indicated that it can be difficult to find a suitable charger when away from home, with 64% considering this a serious problem and 35% a minor issue.
- Having multiple chargers taking up space or generating confusion in the household was considered a serious problem by 58% of respondents, while 39% considered this a minor problem. This was not deemed an issue by only 2% of respondents.

Figure 2.1 – Current situation with charger for mobile phones

[144] Companies, business organisations and business associations are often referred to as 'businesses and business organisations', 'the business sector' or 'the business sector' throughout the report. 'The industry' are instead those directly involved in the production or trading of mobile phones or chargers.

Figure 35: Do you agree that the current situation regarding chargers for mobile phones results in:



Source: *Public Consultation (2019). N=2,743.* ***Note:*** *Only EU citizens.*

The views of those businesses and business organisation that reported inconvenience were aligned with those of consumers, although not having a suitable charger when travelling was indicated as a serious problem only by 54% of the business stakeholders in the subsample.

Performance: Longer charging time for a fast-charging enabled phone charged with a different charger were a serious problem for 57% of EU citizens, a minor problem for 37%, and for 3% it was not a problem. Although performance issues are perceived as a problem also by the business sector, less than half of businesses and business organisations consider that having multiple chargers has serious consequences.

Financial costs: When restricting the sample to consider the views of those reporting that having multiple types of chargers generates financial costs (N=1476, or 52%), the following results were found:

- Needing to buy a replacement charger when one breaks rather than re-using one was a serious problem for 75% of the EU citizens in the subsample, and for 22% it was a minor issue. For 3% it was not a problem.
- 39% of the EU citizens indicated as a serious problem the fact that new phones are sold with a new charger, resulting in a price increase. However, 45% considered that this was a minor problem, while for 15% this did not present any problems.

Business stakeholders were divided on whether the current situation increases the costs for consumers.

Safety: A clear majority of EU citizens who judged that the situation posed a safety hazard (N=899, or 32%), indicated that unbranded chargers (80%) or chargers not specifically designed for the mobile phone in use (72%) may be potentially unsafe. Similar views were expressed by public authorities, concerned with limitations to interoperability. However, business stakeholders appeared more likely to indicate the presence of counterfeit chargers as a serious problem compared to EU citizens (90% vs 80%).

Environment: EU citizens are concerned that old chargers may not be properly recycled or reused (91%), while 8% only considered this a minor issue. The amount of e-waste generated by old chargers was a serious concern for 93% of respondents and a minor problem for 6%. The depleting of natural resources and increasing gas emissions linked to the production of chargers is highlighted as a serious problem by 86% of respondents, whilst it is considered a minor issue by 12% of respondents. When considering businesses' opinions, percentages are generally lower. 56% considered accumulating chargers at home or not recycling them as a serious issue (33% as a minor issue). 67% was seriously concerned by the consumption of scarce resources and CO2 emissions resulting from the manufacturing process (28% indicated this as a minor problem). e-waste was instead a serious concern for 67% of businesses and business organisations, and a minor problem for 28% of them.

Should the EU take further action for mobile phones chargers? There seems to be strong consensus among EU citizens on the need for a universal charger model. A 63% majority was in favour of the EU exercising its regulatory power to mandate a charger standard, whilst 31% considered that the EU should promote an industry-wide agreement. Support was also expressed by public authorities, non-governmental organisations, and consumer organisations in similar proportions. Among the industry sector, 35% deemed regulatory action necessary, while 29% would opt for an industry-led agreement. Yet, 32% opposed further action.

Other devices that could be standardised: 88% of EU citizens indicate a preference that tablets could also be standardised. A high share of European citizens also supports the standardisation of chargers for cameras (73%), laptops (74%), e-readers (76%), and smartwatches (70%). Public authorities hold stronger views compared to consumers on the need for standardisation of other devices. For businesses only tablets seem to aggregate broad consensus (68%), with all other items being below 50% of support.

4. CONSUMER SURVEY (2019)

A Consumer Survey (CS) was carried out in June 2019. A total of 5,002 respondents distributed equally among 10 countries participated in the survey. In order to achieve a representative sample across the 10 EU MS covered, responses were weighted by participating countries' age and gender distribution, in addition to total population size of individual countries.

Number of phone chargers owned: On average, respondents reported that they own three chargers.

Chargers supplied with mobile phones: 80% of respondents indicated that the charger they use had been provided with their mobile phone, whilst 32% reported that they were using a secondary charger and 25% as an additional charger. Chargers provided with an older mobile phone were used as main charger by 7% of respondents, whilst 27% indicated that they were using them as secondary chargers, and 20% as a third, additional charger. Chargers of other electronic devices were used as main mobile phone chargers by only 4% of respondents, whilst 12% used them as secondary chargers, and 17% as additional chargers.

Types of connectors on the device (phone) end: 100% of respondents with an iPhone indicated that their chargers were based on Lighting technology (only 3.4% among non-iPhone users). USB micro B is the most common connector type (95%) among respondents that do not own an iPhone, followed by USB Type C connectivity (51%).

Preferences for a standard charging solution: The standardisation of fast-charging solutions found broad consensus among EU citizens (80% would support). Neutral views were expressed by 14% of EU citizens, while 3% would be dissatisfied.

Charging time: 51% of the sample indicated a charging time of less than 90 minutes, whilst 59% reported charging times were between 90 minutes and 2 hours. 30% of respondents cited that their phone took between 2 and 3 hours to complete a charge cycle, whereas only 13% more than 3 hours.

Interoperability of chargers: Most respondents (63%) indicated that they only charged their primary mobile phone with their primary charger. However, people aged 65 and over were more likely to use only their primary charger with their mobile phone (71%) compared to those aged 18 to 25-years old (59%). 15% of respondents indicated that they used their mobile phone chargers to charge other mobile phones. A minority of respondents (14%) used their mobile phone chargers with other electronic devices.

Cable and EPS interoperability: Most respondents who used their phone chargers for other mobile phones and/or other devices used both the cable and the EPS (58% for mobile phones and 53% for other devices). Differences are clear between iPhone and non-iPhone users; while approximately 48% of iPhone users indicated that they used both the cable and EPS for other mobile phones, 60% of non-iPhone users did this. 16% did not use their mobile phone charger (cable and EPS) to charge other chargers, but only for other electronic devices (15% among non-iPhone users, 22% among iPhone users). When considering interoperability with other electronic devices. iPhone users were more likely to use only the EPS to charge other devices compared to non-iPhone users (28% and 15% respectively).

Charging speed with other mobile phones: 26% reported performance issues when using their primary charger to charge other mobile phones. iPhone users were more likely (32%) to indicate absence of problems if they used another Apple charger, compared to others (19%).

Reasons for purchasing a new charger: A broken charger cable was the main reason for buying a charger (36% of cases). The second most cited cause was the convenience of having a spare charger (28%). Travelling with an extra charger was the third most important reason (15%), followed by losing the original charger (14%), damage to the EPS (10%), wanting a faster charger (8%) or a wanting wireless charger (3%). 6% mentioned other reasons. Only 3% reported that their phone did not come with a charger as a reason.

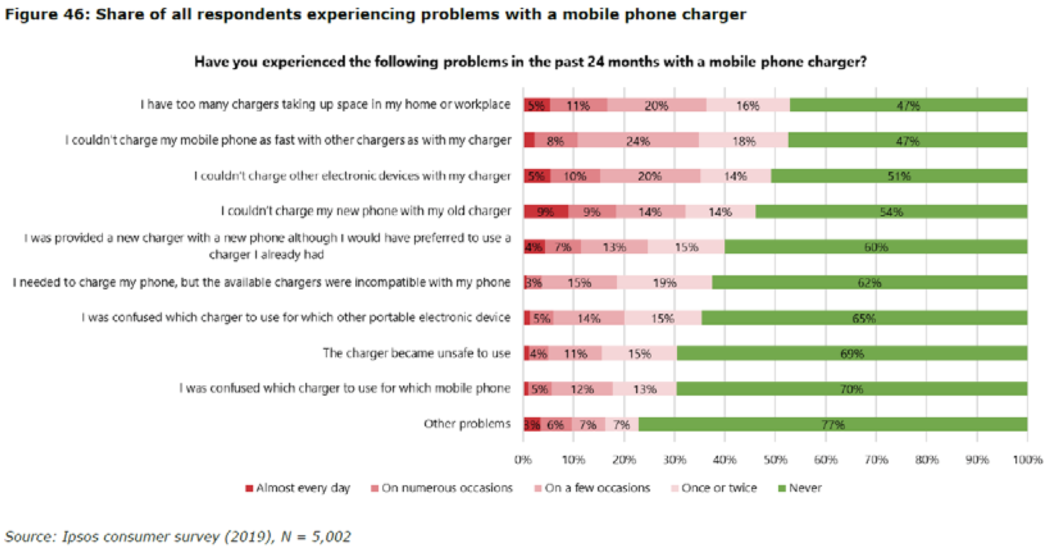
Characteristics of the new charger purchased: 31% bought an unbranded charger, whereas 25% purchased one from an unknown brand. A charger of a known brand, but not matching that of their mobile phone, was the choice of 21% of respondents. 13% of respondents were unable to provide information on the brand of their chargers. 11% bought a charger that was the same brand as the mobile phone. When buying a new charger, 47% did not buy a fast charging-enabled charger or a wireless charger. 39% opted for a fast-charging model, 8% were wireless and only 6% were both fast-charging and wireless. The factors underpinning the choice of charger where compatibility with the mobile phone in use (56%), price (41%), speed of charge (18%) and safety (18).

Disposal of used chargers: Accumulating chargers at home was the single most common way of dealing with old chargers (49% of cases). 23% of respondents declared that they disposed of old chargers by using recycling facilities, whilst 7% considered them generic waste. 17% re-used old chargers, and 14% passed them on to family or friends. Selling used chargers online was common only among 5% of respondents.

Willingness to buy a phone without an EPS: Respondents were also asked whether they would consider buying a phone with only a cable, and without an EPS. 36% would not support this option, 18% had no opinion, and 46% would be willing to buy a phone with only a cable included in the box. 12% would accept this without any price reduction. 8% would expect a price reduction of 5 Euros in order to buy a phone without an EPS but only with a charging cable included in the box; 11% expected a 10-Euro reduction, and 15% a 15-Euro discount. When considering those that would be willing to purchase a mobile phone with only a charging cable included, 52.9% would do so to save resources and reduce e-waste, 46% for reasons of convenience, as they already had too many EPSs, and 37% to save money.

Frequency of problems with chargers: Overall, 84% of respondents had experienced at least one of the following problems at least once or twice in the 24-month period prior to the survey. As regards the different types of problems, the results are given in the figure below.

Figure 2.2 – Share of respondents experiencing problems



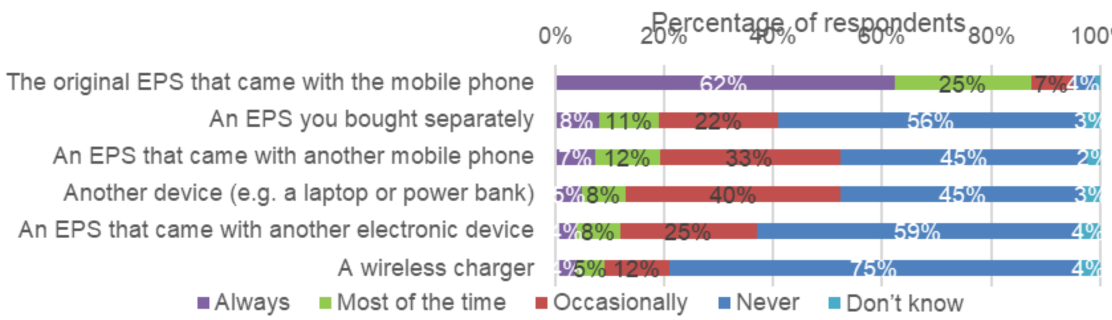
Costs: Within the same 24-month reference period, only 15% of respondents who experienced problems reported incurring any financial costs as a result of a problem with their chargers. The share of respondents that had to bear costs as a result of problems with their chargers was higher among those aged 18 to 24 (27%) than among the older groups of the population (for those aged 65+, only 6% reported financial costs).

5. CONSUMER SURVEY (2021)

The consumer survey (CS) was carried out by Ipsos in January 2021 and collected responses from a representative sample of 5,010 respondents split evenly across the six largest EU Member States: France, Germany, Italy, Poland, Romania, Spain. The survey collected information about the type of mobile phones and chargers in use, as well as their experiences with and preferences towards unbundling. It also investigated consumers' awareness by providing information about environmental impacts, interoperability, charging speed, and counterfeit and explored the effect of this type of information on consumer preferences.

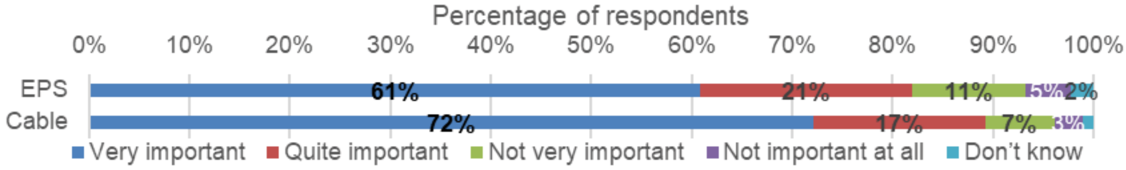
How frequently do consumers use different types of chargers to charge their mobile phones? The Figure below illustrates the types of EPS used by the respondents. A similar question was asked about the cable of the charger, and responses were broadly similar. A majority of respondents (64%) reported to use the cable provided with their mobile phones to charge their phones, and one quarter used it most of the time.

Figure 2.3 – Use of different type of chargers - Source: Ipsos (2021)



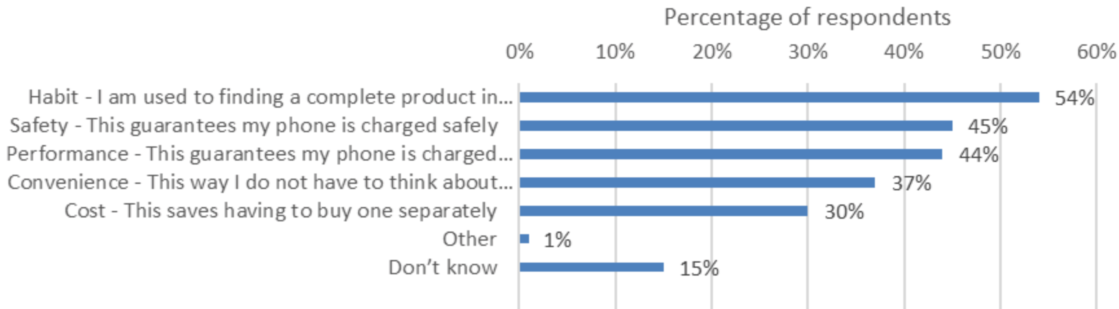
How important is it to find a charger in the box?: Consumers appear to believe that it is important to have a charger in the box when purchasing a new mobile phone (see Figure 2.4 below, N=5,010).

Figure 2.4 – Importance to find the charger in the box - Source: Ipsos (2021)



The survey also sought to understand why respondents considered important (or not) that charging accessories were provided in the sale box. Among the respondents who were of the opinion that finding an EPS in the box with a new phone was *not very* important or not important *at all*, over half (56%) indicated considerations around convenience (e.g. having enough EPS at home). 35% of respondents preferred not to pay for the EPS, whilst 33% mentioned environmental concerns. 14% indicated that they would prefer continuing using the EPS they have, and 11% did not feel the need of a new EPS. A very similar question was also asked about the cable assembly. The figure below reports their responses.

Figure 2.5 – Why is it important to find a charger

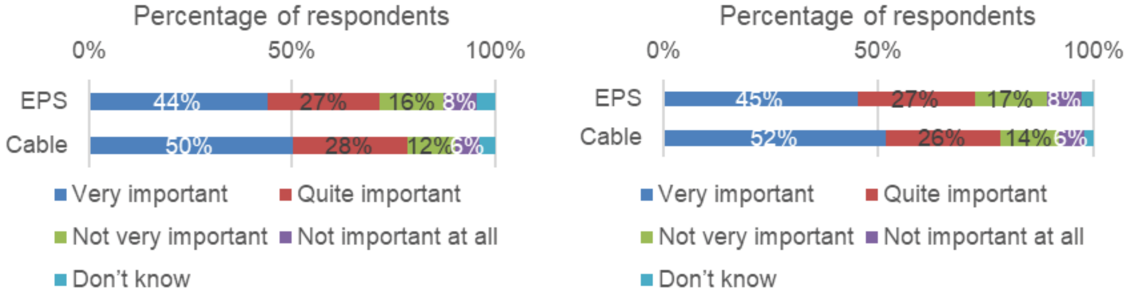


Source: Ipsos (2021), consumer survey. N=4,469.

Does the provision of information affect consumer preferences? Respondents were then provided with information on four different aspects related to chargers, namely: (i) Environment (raw materials, CO_2 emissions, and electronic waste), (ii) Interoperability, (iii) speed of charge, and (iv) counterfeit. The two Figures below show that information on the negative environmental consequences and interoperability of chargers results in a fall of the share of those who find important having EPS and cable in the box.

Figure 2.6 – Importance to find a charger in the box after having received information about

Environment impacts | Interoperability aspects

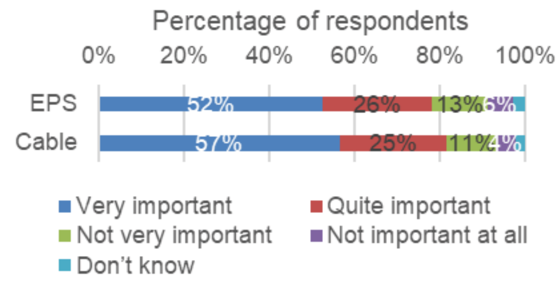


Source: Ipsos (2021), | **Source:** Ipsos (2021), consumer survey. N=5,010. consumer survey. N=5,010.

Consumer reaction to information about charging speed and the presence of counterfeit chargers does not appear to cause marked shifts in preferences compared to when the question was asked before any complementary information was provided. Results are shown the Figure 2.7.

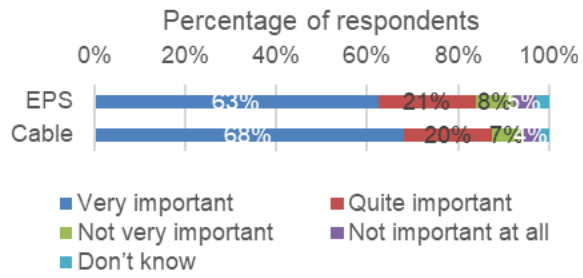
Figure 2.7 – Importance to find a charger in the box after having received information about

Information about Speed



Source: Ipsos (2021), consumer survey. N=5,010.

Information on Counterfeit chargers

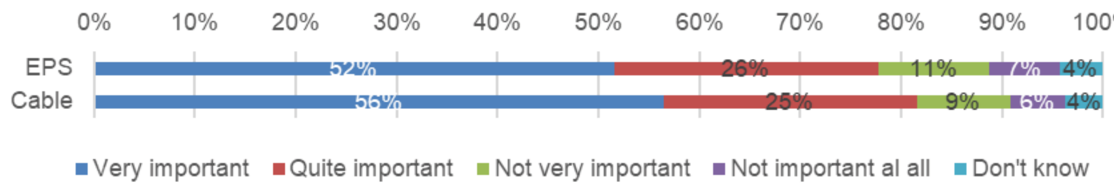


Source: Ipsos (2021), consumer survey. N=5,010.

After providing relevant information, 78% of respondents stated that the inclusion of an EPS was (very or quite) important for them. This is only 4% lower than before providing information, although it should be noted that the proportion of those for whom the inclusion of an EPS was very important fell more (by 9%). The proportion of respondents who considered the inclusion of a cable (very or quite) important fell by 8% (to 81%), including a 16% drop of those who responded very important. This is shown in the figure below.

What choices would consumers make if phones were sold unbundled from their chargers? The survey also tested consumers' reactions to two potential scenarios, one in which only the EPS is removed from the bundle, and one where devices are sold without both EPS and cable. One half of the respondents were presented with the former scenario, and the other half with the latter.

Figure 2.8 - Importance of finding a charger in the box after information had been provided

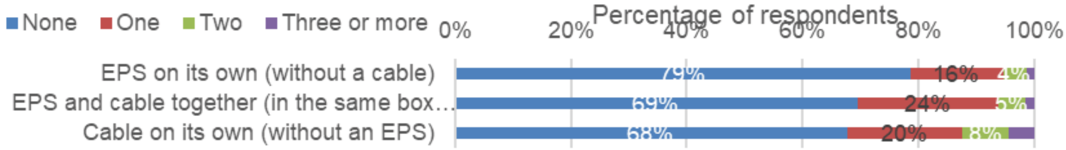


Source: Ipsos (2021), consumer survey. N=5,010.

Despite previous indications, 43% of consumers would re-use their EPS. Around a third (31%) would opt for the fast (and more expensive) EPS. The regular EPS would be preferred by 15% of consumers. A cheaper charger or one from a different manufacturer would be chosen by 6% of respondents each.

Stand-alone charger purchases: All respondents were asked how many standalone chargers (EPS and/or cables, not in the retail box of a phone) they had bought in the previous 24 months. Results are as below.

Figure 2.9 - Charging accessories bought separately in the past 24 months



Source: Ipsos (2021), consumer survey. N=5,010.

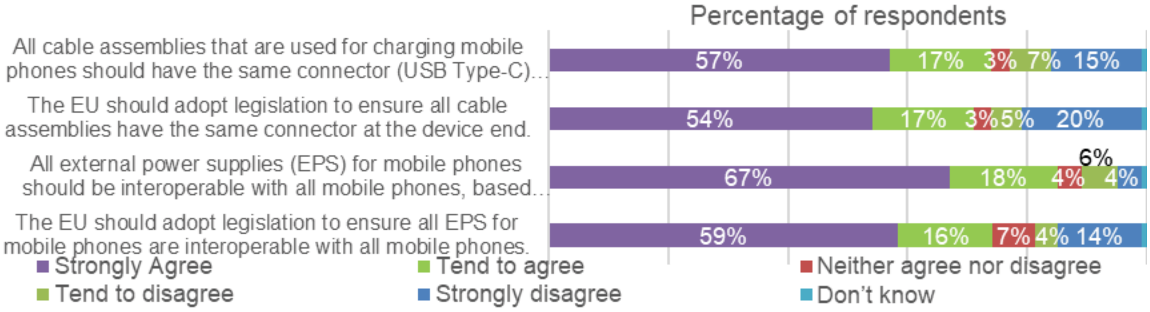
Do consumers re-use or dispose of old chargers? The survey also explored consumers' behaviours when it comes to having multiple (old) chargers at home. Responses do not vary considerably between EPS and cable. When responders have spare chargers, they tend to keep them in storage (39% for EPS, 35% for cables). Some have started re-using old charging accessories, especially cables (18%), but also EPS (15%). Respondents also gave their old chargers to relatives or friends for free (13% for the EPS, 14% for the cable). When disposing of them, 11% correctly recycled both EPS and cable and 4% sent them to an online recycler (both cable and EPS), whilst a slightly smaller share threw them in the general waste bin (6% for the EPS, 7% for the cable component). Selling old chargers was not overly common (5% sold their EPS, 6% their cables). However, around 40% did not do any of these.

6. STAKEHOLDER CONSULTATION (2020-2021)

The following section presents the findings from the stakeholder survey conducted via EU Survey to explore stakeholders' views on the common charging and unbundling initiatives. A total 121 stakeholders responded the survey from the 9 December 2020 until the 25 January of 2021. Out of all stakeholders who contributed to the survey, 84% of these were based in the EU, with the remainder based in Asia (8%), North America (4%) or elsewhere in Europe (4%). Respondents included private citizens (31%), private companies (23%), public authorities (23%), and civil society organisations (18%). The private company respondents were approximately split evenly between representatives of manufacturers of mobile phones and similar devices on the one hand, and representatives of other sectors (including manufacturers of other products, retailers and wholesalers) on the other.

Stakeholders' views on the Common Charging Initiative: Survey results reveal stakeholders' support towards the implementation of a common charging solution legislation for mobile phones, as below

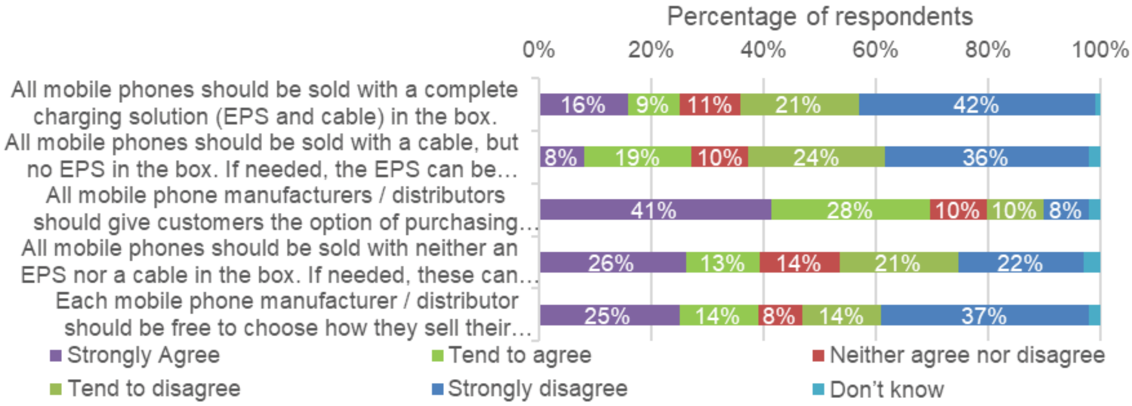
Figure 2.10 - Stakeholders' views on the Common Charger Initiative



Source: Ipsos (2021), stakeholder survey. N=121, all respondents

Stakeholders' attitudes towards unbundling: The survey responses reveal stakeholders' support towards decoupling initiatives, as below.

Figure 2.11 - Stakeholders' views on mobile phone unbundling

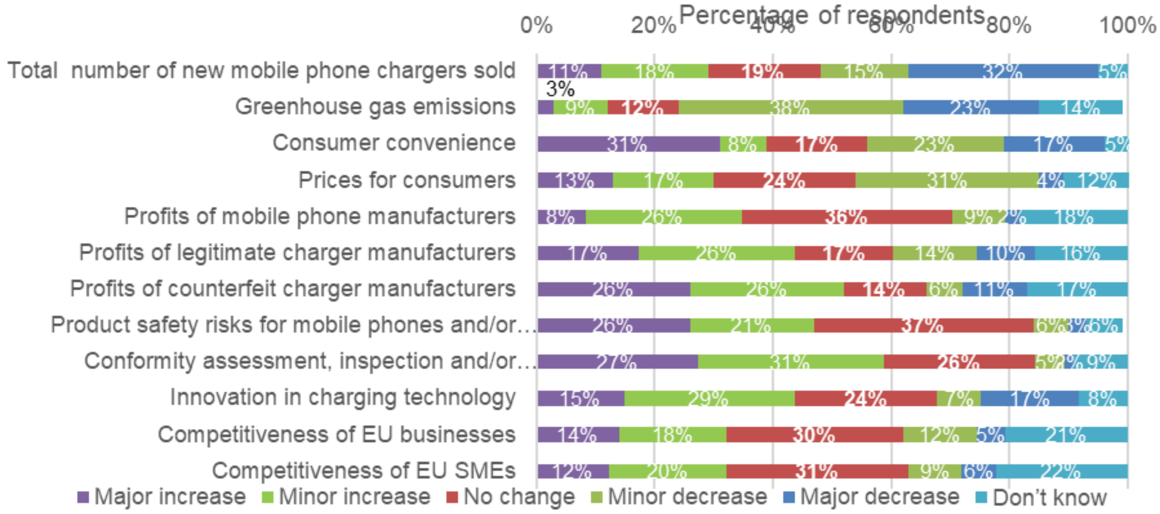


Source: Ipsos (2021), stakeholder survey. N=121, all respondents

Perceived benefits and risks of unbundling: Respondents anticipated different benefits and risks from the widespread unbundling of chargers from phones in the EU. The most common are in the next figure.

Anticipated market reactions to unbundling: Finally, private companies were asked to provide their views on the likelihood of different market reactions to making the unbundling of EPS from phones mandatory. Over half of respondents stated that, if unbundling is made mandatory in the EU it is unlikely that (i) manufacturers will offer a greater variety of EPS for purchase than would have been the case without unbundling (65% of respondents thought it is quite/very unlikely), (ii) the retail price of mobile phones will be reduced (64% of respondents thought it is quite/very unlikely for this to happen in the short term; 57% of respondents thought it is quite/very unlikely to happen in the long term) or that that EPS are offered at a discount to customers purchasing a new mobile phone (54% of respondents thought it is quite/very unlikely); (iii) most mobile phone manufacturers or distributors will have to make significant changes to their business models and/or processes (53% of respondents thought it is quite/very unlikely that phone distributors will change their business models; 50% thought it is quite/very unlikely that this applies to phone manufacturers).

Figure 2.12 - Anticipated changes of widespread unbundling of chargers from mobile phones



Source: Ipsos (2021), stakeholder survey. N=121, all respondents

7. TARGETED INTERVIEWS

Targeted interviews were also conducted in 2021, they concerned: one Market Surveillance Authority, one European Standardisation Organisation, one international organisation, 7 manufacturers associations, 17 manufacturers, 2 consumers' associations, 4 environmental and recycling organisations.

The wireless study was a technical study and interviews were limited to technical aspects. 10 manufactures were interviewed on technical aspects.

8. EXPERT GROUP MEETING CONSULTATION (2020-2021)

Consultations of the stakeholders in the Expert Group on Radio Equipment took place in the meetings of 2 March 2020, 25-26 February 2021 and 28 April 2021.

- In favour of option 5: Cyprus, France, Germany, The Netherlands, Slovakia, and Spain.
- Not in favour of option 5: Denmark, Greece, Italy, and Sweden arguing that intervention on the matter at hand would hamper innovation and that unbundling is already happening.

Annex 3: Who is affected and how?

1. Practical implications of the initiative

The initiative will concern a significant share of EU population[145], manufacturers of smartphones and other electronic devices.

Consumers: the initiative will directly affect approximately 20% of users who, without this initiative, would continue using mobile phones with a proprietary or legacy types of connectors. In the short term, they may suffer inconvenience. However, considering the average lifetime of the devices in scope and the sufficient time that will be provided to the manufacturers to adapt, the

Manufacturers of mobile phones: The preferred option would entail adaptation costs and foregone revenues for a major manufacturer that currently use proprietary connectors. The main impact is associated with necessity to adapt production lines to include USB type C connector for those manufacturers who have so far preferred proprietary solutions. Using a common connector will allow to establish a level-playing field also across the supply chain.

Public authorities: The impact would be associated with surveillance and enforcement of additional requirements. Given that control and surveillance systems are already in place, the marginal cost is expected to be negligible.

SMEs: No major impacts are to be expected on SMEs as the mobile phone manufacturers are large companies. There could be however, adaptation costs in the supply chain of manufacturers currently using the proprietary solutions such as for designers of tailor-made charging solutions and distributors. In interviews, these companies clarified that the initiative would only affect them if the initiative is strict and imposes very specific charging characteristics (current and voltage)[146]. An SME interviewed for the impact assessment study welcomed the standardisation of charging solutions, as it would create a level playing field for companies.

Specific sectors or regions: Few mobile phone manufacturers are based in the EU and they have only very small market share. In light of the fact that the vast majority of economic operators that would be potentially affected are not based in the EU, this initiative would not affect specific sectors or regions in the EU.

[145] approximately 160 million smartphones, 20% of which with a proprietary interface, and other 260 million electronic devices concerned electronic devices are annually sold on the EU market
[146] which is not the case, as discussed in section 8

2. SUMMARY OF COSTS AND BENEFITS

A synopsis of the cost-benefit of the different policy options based on the considerations and the data in Annex 4 is reported below. In particular, tables 4.15-18 in Annex 4 can be summarised as follows, in absolute and relative values, with respect to the baseline.

Table 3.1 – Overview of Benefits

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
Environmental benefits	GHG emissions: 184 ktCO_2e yearly Material use: 2606 tonnes yearly e-waste: 980 tonnes yearly	Incentivising the unbundling of EPS (specific objective 4) brings the biggest influence as regard to the reduction of the extraction of resources, manufacture, transport, use and disposal of the chargers.
Consumer benefits	EUR 246 million yearly	The harmonisation of the connector at the device (specific objective 1) end and interoperability of fast charging communication protocol (specific objective 2) will bring a reduction of the purchases of standalone EPS and cables.
Economic benefits	EU Manufacturers: EUR 22 million yearly Retailers and Distributors: EUR 457 million yearly.	Worldwide industries are affected negatively
Indirect benefits		
Safety of products on the market	Not quantifiable	Reduction of purchases of standalone cables and EPS will indirectly reduce the quantity of dangerous products on the market.

Notes:

- *As in section 2.4, the COVID crisis may have magnified the costs for manufacturers and the benefits for the society, although a quantitative estimate is not possible at the point of preparing this IA (September 2020)*
- *Estimates are relative to the baseline for the preferred option as a whole*

II. Overview of costs – Policy Option 5								
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
Policy Option 5	Direct costs	N/A	N/A	For manufactures who already use USB Type C in the products in scope: N/A For manufactures who do not use USB Type C in the products in scope: Costs to redesign the charging circuitry of the equipment (mitigated by a transition period)	N/A	N/A	N/A

				For manufactures who currently use proprietary fast charging protocols not compatible with USB PD or not supporting fast charging at all, around 20% of the volumes of the total market: 30 million EUR (0.6 EUR per device)			
	Indirect costs	N/A	N/A	For manufactures who do not use USB Type C in the products in scope: Loss of royalties for which, unfortunately, data could not be gathered. By the combination of the measures, there will be a loss of turnover by worldwide industries of 367 million EUR yearly compared to the baseline	N/A	N/A	N/A

Notes:

- *As in section 2.4, the COVID crisis may have magnified the costs for manufacturers and the benefits for the society, although a quantitative estimate is not possible at the point of preparing this IA (February 2021)*
- *Estimates are relative to the baseline for the preferred option as a whole*

ANNEX 4: ANALYTICAL METHODS

1. ENVIRONMENTAL ASSUMPTIONS AND CALCULATIONS

Environmental impacts are assessed for each option using a model developed by the contractor, see Annexes F and G of the unbundling study[147], to which we refer for all the details. The essential element is that charger (EPS and cable) additions and disposals are modelled each year, and that these flows, when combined with impact assumptions are used to calculate the impacts. In this section we present the approach to assessing the environmental impacts, including elaborating the assumptions used in the stock model. Following a screening of main environmental impacts, the study focuses on the 3 key environmental impacts of EPS and cables, namely: (1) use of raw materials, as the production of chargers consumes metals, plastics, and other materials; (2) e-waste, generated as chargers are discarded; and (3) greenhouse gas (GHG) emissions over the life-cycle of the chargers (e.g. manufacturing, transport, and disposal and materials recovery). The following indicators are assessed:

- Material use [tonnes] – calculated in the stock model by multiplying additions to the charger stock by a profile of the materials used. The profiles vary per EPS and cable type (weight and material content), and over time (modelling the introduction of more efficient, lighter materials). Material use can be split into the most relevant materials.
- e-waste [tonnes] – calculated in the stock model as the weight of chargers disposed of each year. This is calculated by multiplying the number of units disposed by the material and weight composition of the charger component type. Sub-indicators on volumes of e-waste left untreated or recycled are also calculated.
- GHG emissions [tonnes] – are calculated in the stock model as life-cycle emissions (cradle-to-grave) per charger component type, accounted in the year of sale. Emissions are calculated on the basis of component specific emission profiles multiplied by additions to the charger stock.

Material use

To measure material use a bill of materials (BoM) was developed following a bottom-up approach, as there was little or no useful new data (compared to the 2019 study[148]) in the available literature concerning the material contents of EPS or cables. The BoM considers all of the components contained in a mobile phone charger which allowed us to identify the heaviest and largest components (e.g., transformer, electrolytic capacitors, and transistors), based on the datasheets published by the manufacturers. Once the key components of the

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[147] https://data.europa.eu/doi/10.2873/788086
[148] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/c6fadfea-4641-11ea-b81b-01aa75ed71a1

EPS were identified, desk research were conducted to determine the materials used in each of the components. Table 4.1 presents the standard material composition of a mobile charger and cable obtained as a result of this analysis. In preparing this composition the information about the materials used for most components is limited, as manufacturers generally do not include these details in the datasheets of the components.

Table 4.1. Standard material composition of a mobile charger and cable

Weight of components (g)	EPS	Cable
Plastic	36%	30%
Copper and copper alloys	13%	30%
Stainless steel (USB connectors)	6%	24%
Aluminium	7%	-
Others	37%	16%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

As indicated during an interview with a supplier of high-performance electronic components, it was estimated that the new technologies (e.g. GaN diodes, super-junction) would enable 40% less volume and 30% less weight for EPS, through improved energy efficiency and reduction in heat, and therefore a reduction in insulation and other materials. Therefore, the refined stock model assumes that the high-power and high-quality devices will become lighter than current models (per wattage) in the future. Table 4.2 below presents the total weight per component type at 5 years intervals used in the analysis.

Table 4.2. Modelled total weight per component type (2015-2030) based on input from experts

Component type		2015	2020	2025	2030
		Weight (g)			
EPS < 7.5 W	USB Type-A receptacle	28	28	28	28
	USB Type-C receptacle	28	28	28	28
	USB Type-A and Type-C receptacles (multi-port)	28	28	28	28
7.5W <= EPS <=27W	USB Type-A receptacle	50	50	45	40
	USB Type-C receptacle	60	60	54	48
	USB Type-A and Type-C receptacles (multi-port)	102	102	92	82
EPS > 27W	USB Type-A receptacle	94	94	80	66
	USB Type-C receptacle	117	117	99	82
	USB Type-A and Type-C receptacles (multi-port)	131	131	111	92
	Captive cable	113	113	96	79
Cable	USB Type-A - USB Micro B plugs	19	19	19	19
	USB Type-A – USB Type-C plugs	34	34	34	34
	USB Type-A – proprietary (Lightning) plugs	23	23	23	23

	USB Type -A – proprietary (Other device) plugs	23	23	23	23
	USB Type-C – USB Type-C plugs	45	45	45	45
	USB Type-C – proprietary (Lightning) plugs	37	37	37	37
	USB Type-C - proprietary (Other device) plugs	37	37	37	37
	USB Type-C plugs – wireless pad – Qi or other	37	37	37	37

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Taking all the above into consideration, key assumptions related to the materials contained in the EPS and cables were made. The modelling inputs are described in detail in the study mentioned above.

e-waste, treatment and recycling

It is estimated e-waste volumes and sub-indicators on waste treatment and recycling in the stock model based on the average material composition of the chargers, the recyclability of the materials, the volume of chargers disposed of, the method of disposal, and how disposed chargers are treated.

To estimate the volume of EPS and cables disposed of every year, average values based on the responses to the consumer survey were considered. These suggested that approximately 10% of the EPS and cables in stock are being disposed of each year. This assumption was applied in the model such that after 10 years all chargers purchased 10 years previously would be removed from the stock. A share of the EPS and cables in the stock would effectively be “in reserve”, i.e. functional, but stored and not in use. The consumer survey found that on average 1.32 EPS and 1.75 cables are reported to be held “in reserve”, whilst 1.75 EPS and 2.05 cables are ‘in-use’.

The volume of untreated and recycled EPS and cables was estimated considering WEEE disposal and treatment[149] studies which, despite many data gaps, predict increasing recycling rates over time. Based on analysis of the data for WEEE of small equipment and treatment in 2010 and 2018, an assumption for waste disposal and treatment was derived. This estimates for 2010 a rate of 41% of e-waste being sent for treatment, increasing to 65% by 2018. An annual increment of 1.5% improvement in this rate is applied per year based on this historic trend and an assumption that improvements will tail off somewhat

[149] Key studies used as sources for this estimation, are Balde et al (UNITAR) (2020) In-depth review of the WEEE collection rates and targets in the EU-28, Norway, Switzerland and Iceland; and Balde et al (UNITAR) (2020) The Dutch WEEE flows 2020, what happened between 2010 and 2018?

over time as the 'low hanging fruit' in increasing rates is used. By 2030, this increase increment sees 84% of charger disposals sent for treatment. As a result of these assumptions, the share of untreated waste decreases from 35% in 2018 to 16% in 2030. 4.3 below presents the modelled recycling rates at 5 years intervals used in the analysis (% recycled and %untreated waste). Additional key assumptions made related to the e-waste generated, treated and recycled are summarised in the consultant's study[150].

Table 1.3 Modelled recycling rates for EPS and cables (2015-2030)

Disposal method	2015	2020	2025	2030
Disposed to recycling	56%	69%	76%	84%
Incorrectly disposed (untreated waste)	44%	31%	24%	16%
Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)				

Concerning the treatment of different materials, the splits of materials use and specific recycling rates assumed in the stock model are mainly based on the input provided during the interviews with recycling experts.

Greenhouse Gas Emissions (GHG)

GHG emissions are released over the full lifecycle of the chargers, starting from material extraction, and through all the life-cycle steps of manufacturing, transport, use, and disposal. To consider the impact of these emissions, the first IA was mainly based on the results of the EU funded project SustainabilitySmart[151], and other studies[152] which focused on specific smartphone models and their accessories. The studies provided the Global Warming Potential (GWP) of each charger component (EPS and cable) and life-cycle phase (e.g. raw material acquisition, manufacturing, transport), which were then used to calculate an average CO2 emissions impact per unit (g) of weight for the component types.

It is to be noted that further review of available information finds only very limited additional published information on the environmental impact of chargers, it remains an issue not widely addressed by LCA practitioners nor where companies publish their own results. Therefore, to refine the GWP values considered in the first IA study, it was considered the data presented in the framework of the *Eco-design preparatory study on*

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[150] https://data.europa.eu/doi/10.2873/788086

[151] Sustainably SMART (2019) Regulation of Common Chargers for Smartphones and other Compatible Devices: Screening Life Cycle Assessment. Policy Brief No. 2.

[152] Ercan, M. (2013), Global Warming Potential of a Smartphone Using Life Cycle Assessment Methodology; Charles River Associates (2015) Harmonising chargers for mobile telephones Impact assessment of options to achieve the harmonisation of chargers for mobile phones

mobile phones, smartphones and tablets[153]. Table 4.4 and 4.5 below present the input values used by the updated stock model.

Table *4.4* - Average GWP (kg CO2e per g of weight of component)

	EPS	Cable
Raw material and manufacturing	0.035	0.012
Transport	0.031	0.023
End of life	0.0003	0.0002
Total	**0.066**	**0.035**
Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)		

Table 4.5 - Average GHG emissions per unit of component

Component type		Average GHG emissions (kg CO2e)
EPS < 7.5 W	USB Type-A receptacle	1.8
EPS < 7.5 W	USB Type-C receptacle	1.8
	USB Type-A and Type-C receptacles (multi-port)	1.8
7.5W <= EPS <=27W	USB Type-A receptacle	3.3
	USB Type-C receptacle	4.0
	USB Type-A and Type-C receptacles (multiport)	6.7
EPS > 27W [154]	USB Type-A receptacle	6.2
	USB Type-C receptacle	7.7
	USB Type-A and Type-C receptacles (multiport)	8.6
	Captive cable	7.4
Cable	USB Type-A - USB Micro B plugs	0.7
	USB Type-A – USB Type-C plugs	1.2
	USB Type-A – proprietary (Lightning) plugs	0.8
	USB Type -A – proprietary (Other device)plugs	0.8
	USB Type-C – USB Type-C plugs	1.6
	USB Type-C – proprietary (Lightning) plugs	1.3
	USB Type-C - proprietary (Other device) plugs	1.3
	USB Type-C plugs – wireless pad – Qi or other	1.3

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

[153] Regarding the end-of-life (EoL) emissions, a positive GWP is based on high recycling rates (of packaging material) and high rates of devices being reused. For this assessment, conservative approach was favoured and, therefore, did not consider the value suggested by Task 5 for the EoL phase. Nonetheless, given that the contribution of the EoL phase to the overall emissions is very small compared to the other phases (<1%), it does not have a major influence on the overall results.

[154] GHG emissions per unit of EPS>27W will slightly decrease between 2020-2030, as a consequence of the decrease in weight for EPS > 27W

During the scoping phase, potential additional impacts from unbundling were identified related to GHG emissions. For instance, not including an EPS and/or cable in the box could reduce the size of the packaging, impacting the environment in three main ways: firstly, it may reduce the materials used in packaging (fibre and plastic); secondly, it may allow for more devices to be shipped within the same space, hence reducing the environmental footprint of distribution, whilst the reduction in weight being shipped may also reduce the environmental impact; but, thirdly, shipping phones and EPS and/or cables separately may require additional distribution and delivery journeys, which would increase the footprint. An analysis of these factors indicated the likelihood that their impact is considerably lower compared to the other life-cycle phases considered, and additional that there are substantial uncertainties, for these reasons the impacts are not included in the main modelling and impact analysis.

In brief, the main stock model inputs related to the estimation of GHG emissions include:

- Material and weight composition of the EPS and cables added to the stock every year, based on average material content profiles (as explained above)
- Average CO2 eq emissions per weight of component (as presented in Table 4.4)

Based on these inputs, the GHG emissions (tonnes) are calculated in the stock model on the basis of component specific weight and emission profiles multiplied by additions to the EPS and cables stock. An extended explanation of the modelling inputs input values used is provided in the study.

2. Economic Assumptions And Calculations

The following types of impacts were identified as primary for this Impact Assessment: Operating costs and conduct of business; administrative burdens on businesses; competitiveness of businesses, innovation and research; and impacts on consumers and households. The initiative may give rise to non-tariff barriers (e.g. if manufacturers cannot sell mobile phones using proprietary charging solutions) and it may also affect regulatory convergence with third countries (e.g. if a third country regulates for the use of different charging technologies). However, all policy options are based on international standards, meaning these impacts (if any) are expected to remain limited. The position of SMEs was also considered of low relevance, since most economic operators in the sector are big companies located in third countries. A minority of European SMEs (those that supply charging solutions to phone manufacturers) could though be affected. This impact, although continues to be minor, is investigated in this study.

As a result, we focus the assessment on the following types of impacts:

- Competitiveness of businesses;
- Innovation and research;
- Costs for consumers;
- Operating costs and conduct of business;
- Costs to public authorities;

- Macroeconomic impacts (including impacts on SMEs).

Competitiveness of businesses

The policy options considered may affect competitiveness in several ways. For instance, some connectors are more expensive than others, and mandating USB Type-C may increase the cost of lower-end devices that still use USB micro-B connectors. The options that consider unbundling, on the other hand, would affect the overall cost of the product, and it is still unclear whether savings from not including chargers in the box will be passed on to consumers, or absorbed by the industry. Finally, some manufacturers receive income from the sale of proprietary charging solutions/accessories. Their income may be affected if standard solutions are mandated.

Therefore, this type of cost encompasses four different effects:

- Revenues and/or costs generated from the production and sale of chargers that have different characteristics than in the baseline scenario;
- Reduction in the number of chargers sold in the EU market;
- Changes to the distribution of revenue among competitors, due to harmonisation and/or unbundling of chargers;
- Variations in income from receiving/paying royalties.

Table 4.6 - Impact on businesses, per type of stakeholder

Stakeholder	Differences in costs	Fewer chargers sold	Changes in distribution of revenue among competitors	Variations in income from royalties
Manufacturers of System on a Chip (SoC)	Currently, manufacturers of SoC are already including USB PD in their chips. It may affect, however, the cost of SoC for lower-end devices.	Not applicable	The battery charging protocol is only a small component of the chip. It is not expected that any of the options would produce changes in the distribution of revenue.	The options considered allow the use of proprietary charging protocols, as long as USB PD is also included. Therefore, no losses of income from royalties are expected for SoC manufacturers.
Manufacturers of mobile phones and other portable devices	Differences in cost among different technologies are assumed to be passed on to consumers.	The unbundling options would generate savings for manufacturers, as they would not need to include EPS and/or cables in the box anymore. Some of these savings may be passed on to consumers through reductions in the price of the device, but some may be absorbed by manufacturers as additional income.	Some manufacturers argue that their proprietary fast charging technologies offer them a competitive advantage, and mandatory standardisation or unbundling would affect their competitive position.	Manufacturers of devices using proprietary connectors may lose incomes from royalties (e.g. sale of compatible accessories) if connectors are standardised.
Manufacturers of chargers	Differences in cost among different technologies are assumed to be passed on to consumers.	The unbundling options will likely reduce the total number of chargers sold in the EU, and therefore all manufacturers of chargers selling in the EU will be affected.	With unbundling options, firms who produce chargers to be sold in the box may lose market share if they are not able to adapt their distribution networks rapidly. This share would be won by manufacturers who distribute to retailers/consumers. Harmonisation options may also trigger a reduction of sales of proprietary chargers and cables that would benefit manufacturers of standard charging solutions.	Harmonisation options would lead to further adoption of USB PD / USB Type C than in the baseline, which may incentivise some firms to stop manufacturing proprietary solutions. This would lead to a reduction in royalty fees that charger manufacturers pay. As this is a very concentrated market, it is expected that marginal reductions in costs would be passed on to consumers, rather than producing gains for manufacturers.
Distributors, retailers, and wholesalers	No major impacts expected	Distributors may benefit from the increased sales of stand-alone chargers (if their revenue is higher than when sold in the box)	No major impacts expected	No major impacts expected
Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)				

These effects are summarised below, per type of stakeholder affected.

A key aspect when assessing economic impacts concerned the savings from not including chargers in the box (for options that consider unbundling) which could be reflected in the retail price of the devices or whether they will be absorbed as additional income by manufacturers.

In the online survey of stakeholders, two thirds of industry stakeholders (64%) answered that it is very unlikely or quite unlikely that the average retail price of mobile phones will decrease in the short term if the EPS is not included in the box, and the majority (57%) were of the same view when considering the effects in the long term.

Another key aspect is whether manufacturers will offer EPS out of the box at a reduced price if unbundling becomes mandatory. In the survey, just over half of respondents (54%) thought this is quite or very unlikely. However, in interviews, manufacturers who have started to unbundle commented that they have reduced the price of their stand-alone EPS.[155]

In the model, it has been assumed that the savings of selling mobile phones unbundled from the EPS/cable are passed on to consumers. In the premium segment of the market this might not be so obvious, as prices are not (only) determined by marginal costs but instead by market positioning strategies. However, evidence suggests that manufacturers are likely to offer other “accessories” instead (e.g. HMD is extending the guarantee of the device by one year). The price in medium and low tier phones is largely determined by the marginal price, and therefore it is to be expected that when savings are achieved from not including chargers in the box, these are passed on to consumers.

This impact has been quantified through the stock model. The following table presents an aggregate summary of the influences of each measure on the evolution of chargers sales split by EPS and cables. This shows the annual additions to the charger stock based on chargers provided with smartphones and chargers purchased standalone.

Table 4.7 - Standalone EPS sales projections [million units]

Measure	2023	2024	2025	2026	2027	2028	2029	2030	2030 difference with baseline
Baseline	129.2	129.8	130.0	130.2	130.3	130.5	130.6	130.2	
Harmonise device-end connectors	129.2	129.8	130.0	130.2	130.3	130.5	130.6	130.2	0%
Support of the relevant protocol on the end-device	130.3	125.7	125.9	126.1	126.2	126.4	126.5	126.2	-3%
Making available on the market at least unbundled solutions	129.2	154.7	154.2	153.7	153.3	152.8	152.4	151.5	16%
Informing consumers about charging performance	129.2	127.7	127.9	128.0	128.1	128.3	128.5	128.1	-2%

Source: Consultant calculations

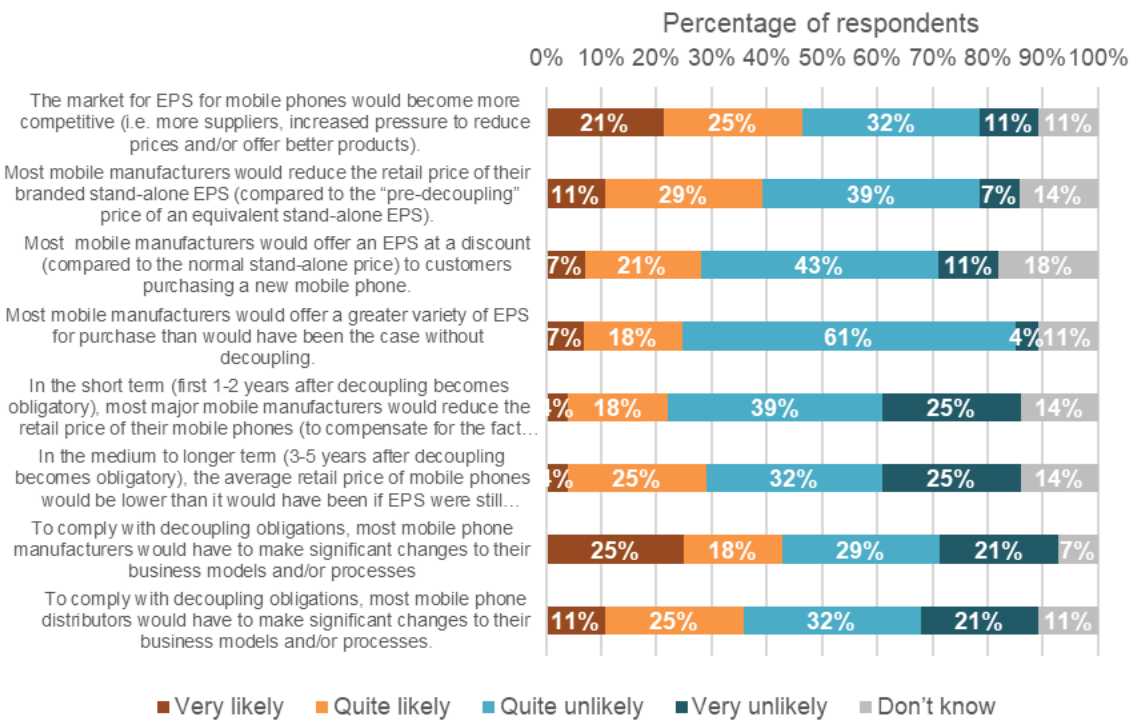
[155] As of 18 January 2021, customers purchasing an iPhone 12 from the Apple online shop in Spain (https://www.apple.com/es/shop/buy-iphone/iphone-12) were offered a 20W USB-C EPS as an optional accessory for €25. Similarly, customers pre-ordering a Galaxy S21 from the Samsung online shop in Spain (https://www.samsung.com/es/smartphones/galaxy-s21-5g/buy/) were offered a 25W USB-C EPS for €24.90. During interviews, both Apple and Samsung reported they had reduced the price of these EPS as part of their recent unbundled launches.

Table 4.8 - Standalone cable sales projections [million units]

Measure	2023	2024	2025	2026	2027	2028	2029	2030	2030 difference with baseline
Baseline	138.7	138.9	139.0	139.0	139.1	139.1	139.1	138.4	
Harmonise device-end connectors	138.7	132.7	132.8	132.9	132.9	132.9	133.0	132.3	-4%
Support of the relevant protocol on the end-device	138.7	135.8	135.9	136.0	136.0	136.1	136.1	135.4	-2%
Making available on the market at least unbundled solutions	138.7	138.9	139.0	139.0	139.1	139.1	139.1	138.4	0%
Informing consumers about charging performance	138.7	137.5	137.6	137.6	137.7	137.7	137.8	137.0	-1%

Source: Consultant calculations

Figure 1.1: Anticipated impacts of mandatory unbundling as perceived by industry stakeholders



Source: stakeholder survey. N=28, all private sector respondents

It is assumed that, when EPS and cables are sold bundled with mobile phones, they are sold at the wholesale price (industry representatives interviewed in this and the first IA assured that they do not obtain any profits for the sale of bundled EPS). When EPS/cables are not bundled to mobile phones, consumers save the wholesale price of the charger; however, if they buy an EPS/cable separately, they pay the retail price. That is why, even when there are fewer chargers in the market, consumers might not obtain any savings. Their capacity to obtain savings will depend on the effectiveness of unbundling (i.e. how many consumers would continue buying EPS).

The revenue for producers is assumed to be the difference between the price paid by consumers and the production cost. The stock model does not assign the revenue across the supply chain, but this is assessed qualitatively.

The gross profit generated via the sale of chargers (both in the box and stand-alone) for each policy option has been estimated, and it was compared to the gross profit in the baseline, using the following formula:

$$GPPOj = \sum(Pi \times Qi) + \sum(SPi \times SQi) - \sum(Ci \times Qi) - \sum(Ci \times SQi)$$

Where:

- GPPOj = Gross profit for manufacturers in Policy Option j
- Pi = Price of type of charger I (EPS/cable) when sold in the box
- Qi = Quantity of type of charger i (EPS/cable) sold in the box
- SPi = Price of type of charger i (EPS/cable) when sold as a standalone charger
- SQi = Quantity of standalone chargers sold of type i (EPS/cable)
- Ci = Production cost of manufacturing a charger of type i (EPS/cable)

Prices per type of product have been determined as follows: first, the study team conducted a mapping of all types of cables and EPS in retail websites. An average retail price was then calculated per product. A similar exercise was conducted for the wholesale prices. The estimate is that, on average, the wholesale price is 45% of the retail price. In other words, the retail price is 2.2 times the wholesale price. Estimating production costs required a different approach, as this is not public information. In interviews, it was asked manufacturers about the production costs or their products, and about differences in production cost between, e.g. USB Type-C interfaces and USB micro-B interfaces. The estimate is that the production cost is, approximately, 20% of the retail price. In other words, the retail price is 5 times the production cost. The table below details the prices used in the impact assessment. The quantities are derived from the stock model.

Table 4.9. Assumed costs and prices of chargers

Product	**Type of product**	**Production cost (€)**	**Price when in the box (€)**	**Stand-alone price (€)**
EPS <7.5W	USB Standard-A receptacle	3.3	5.8	16.7
	USB Type-C receptacle	3.0	5.3	15.0
	Multiport	3.0	5.3	15.0
EPS 7.5-27W	USB Standard-A receptacle	3.0	5.2	15.0
	USB Type-C receptacle	4.8	8.4	24.0
	Multiport	5.5	9.6	27.4
EPS >27W	USB Standard-A receptacle	6.0	10.5	30.0
	USB Type-C receptacle	6.4	11.2	32.0

	Multiport	7.6	13.3	38.1
	Captive cable	5.5	9.6	27.5
Cables (1m)	USB Standard-A - USB Micro-B	1.4	2.5	7.0
	USB Standard-A - USB Type-C	1.9	3.3	9.5
	USB Standard-A – proprietary (Lightning)	5.0	8.8	25.0
	USB Type-C - USB Type-C	2.8	4.9	14.0
	USB Type-C – proprietary (Lightning)	5.0	8.8	25.0

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

It should be noted that the prices have kept constant over time in the model. However, interviews with experts and industry representatives suggest that the cost and price of USB Type-C connectors will decrease over time, as more devices incorporate this connector and more economies of scale are achieved.

Other impacts on competitiveness, i.e. changes in distribution of revenue among competitors and loss of income from royalties, are explored qualitatively due to the lack of certain information in that respect.

Innovation and research

The initiative may affect innovation in charging technologies that are not compliant with the policy options (e.g. innovation in new connectors or fast charging technologies). Innovations may be pursued in a collaborative environment to develop new standards (e.g. the USB-IF), or by private companies individually to obtain new sources of comparative advantage. The new regulation or voluntary agreement on harmonisation could be updated to incorporate new standards, but not proprietary charging technologies.

Given the size of the EU market, a regulation that prohibits proprietary charging technologies to be placed in the EU market may preclude private companies from investing in this type of innovation (i.e. not cooperative). Under the voluntary agreement, companies would voluntarily commit, but not be obliged, to remove proprietary charging technologies from their phones, which means they would not be de-incentivised (or not to the same extent) from investing in new technologies.

The development of the USB Type-C connector may serve as an illustrative example. During the conducted interviews, it was widely recognised by the industry that the development of USB Type-C connectors was influenced (and to some extent facilitated) by the existence of Lightning. In particular, industry commented that some features of Lightning, including the fact that it is reversible, found their way into the USB Type-C connector. By extension, it appears plausible that the development of future USB technology could be negatively affected by the absence of any competing connector technologies whose features could eventually be incorporated.

Businesses' capacity to innovate, in this case, is also linked to their competitiveness. In fact, as explained in section 2 (problem definition), fast charging solutions are a source of competitive advantage for some companies.

The significance of this impact will depend on the chosen policy instrument, with higher negative impacts if the instrument is a regulation (as opposed to a voluntary agreement). It should be noted that companies innovating in charging solutions are not based in the EU. This impact is analysed qualitatively.

Impacts on consumers

Impacts on consumers are primarily assessed in the sections dedicated to "social impacts". As explained above when describing the impacts on competitiveness, the policy options may require the use of certain inputs (e.g. USB Type-C connectors) or unbundling the chargers, which would have an impact on the price consumers pay when acquiring a new mobile phone. This impact is quantified following the same approach as for impacts on competitiveness.

The price that consumers will pay for their chargers, whether included in the box or bought separately, will be affected by the policy options, in the same way that the options affect the gross profit that manufacturers receive. The formula to calculate the cost for consumers is as follows:

$$CPOj = \sum(Pi \times Qi) + \sum(SPi \times SQi)$$

Where:

- CPOj = Cost for consumers in Policy Option j
- Pi = Price of type of charger i when sold in the box
- Qi = Quantity of type of charger i sold in the box
- SPi = Price of type of charger i when sold as a standalone charger
- SQi = Quantity of standalone chargers sold of type i

Operating costs and conduct of business

Operating costs and conduct of business refer to additional adjustment, compliance or transaction costs on businesses derived from the policy options. It may affect, *inter alia*, the cost or availability of essential inputs, access to finance, the investment cycle, or entail the withdrawal of certain products from the market.

One of the costs considered is the cost of demonstrating compliance with the standard or regulation in question (conformity assessment). The costs vary substantially depending on the type of regulation (e.g. essential requirement, harmonised standard…) and on the option given to / chosen by manufacturers to demonstrate compliance (e.g. presumption of conformity, or other methods).[156] The impact will also depend on whether the policy options require full compliance with a standard, or compatibility (e.g. essential requirements).

The USB IF has a compliance programme to certify sinks (devices) and sources (EPS) that are compliant with the USB PD 3.0 specification. Manufacturers may also test whether their own products are USB PD compatible. There are products in the market that claim to perform this test, with a cost of circa 600 Euros before tax.[157]

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[156] More information on conformity assessment is available at: https://ec.europa.eu/growth/single-market/goods/building-blocks/conformity-assessment_en

[157] See, for instance: https://evision-webshop.de/USB-Power-Delivery-Tester/en

In addition, mandating certain standards may create market barriers and produce distortions (e.g. if other countries apply different requirements or standards), forcing manufacturers to have different models or designs for each market.

This impact is assessed qualitatively based on information provided by interviewees across all types of stakeholders, and on literature review.

Table 4.10 – information from stakeholders

Type of stakeholder	How they may be affected
Manufacturers of mobile phones	All the policy options considered require manufacturers making changes in their devices (e.g. to include USB Type C connectors and/or USB PD as the charging battery protocol), or changes in their packages (to remove the EPS and/or the cable, for those cases where accessories are still included). Manufacturers may also need to demonstrate compliance with standards (USB Type C and/or USB PD) in their devices and the EPS included in the box.
Distributors, retailers and wholesalers	The options that include unbundling may affect distributors, as they may have to look for new suppliers of stand-alone EPS and/or cables. They may also need to upskill their staff to be able to provide advice to consumers on which EPS/cable works with their devices.
Manufacturers of chargers (EPS and/or cables)	Manufacturers of chargers of portable devices would also be affected by unbundling and harmonisation initiatives. If unbundling is mandated, they may have to find new intermediaries to sell their EPS/cables. Firms that manufacture the chargers that are currently included in the box with mobile phones and other devices would be particularly affected. In interviews with the industry, it has become apparent that there are some charger manufacturers specialised in designing and producing tailor-made EPS and cables for specific portable devices. Chargers are produced and sold unbranded to manufacturers of portable devices, who incorporate their own brand to the final product. Harmonisation of EPS, on the other hand, would affect those firms that are currently manufacturing chargers with proprietary charging protocols, as they would need to adapt their processes to incorporate standard protocols (if not incorporated yet). Manufacturers of chargers may need to perform new tests or obtain new certifications on their EPS (e.g. on USB PD compliance).
Manufacturers of System-on-Chip (SoC)	A system on a chip (SoC) is an integrated circuit (also known as a "chip") that integrates all or most components of a computer or other electronic system. These components almost always include a central processing unit (CPU), memory, input/output ports and secondary storage, often alongside other components such as radio modems and a GPU – all on a single substrate or microchip. The SoC determines the battery charging protocol used by electronic devices. Manufacturers of SoC generally include USB PD along with other proprietary solutions.

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Costs to public authorities

Costs to public authorities may arise in two ways:

- Cost of adapting standards (e.g. IEC 63002) to the requirements of the EU regulation (e.g. defining minimum requirements that firms need to comply with, based on the standard). This cost is expected to be low / negligible, as existing standards would be used for any policy option.
- Increase in control costs for surveillance authorities to check an additional standard. Given that control and surveillance systems are already in place, the marginal cost for testing any additional requirement is expected to be very low or negligible.

This impact, which is considered to be very minor, is assessed qualitatively.

Macroeconomic impacts and impacts on SMEs

Most of the companies in the supply chain of mobile phones and their chargers are located out of the EU. There are very few manufacturers of mobile phones headquartered in the EU (notably, HMD, Fairphone as well as other small companies specialised on mobile phones for specific segments of the population), and their production lines are located overseas in most cases. The impacts for EU-based mobile phone manufacturers are assessed qualitatively. The market of chargers is more fragmented (i.e. formed by a larger number of companies), with some companies manufacturing chargers in the EU. There are around 10,000 companies manufacturing "other electrical equipment" in the EU (NACE 2790)[158], of which it is estimated that around 1% (100 firms) manufacture power supply units for telecommunication apparatus. Through the stock model, it is estimated that their turnover in 2020 was 154 million EUR (including only turnover from sales of chargers).[159] On average, between 2012 and 2018, there was one person employed in the EU in the manufacture of EPS per 186,177 Euros of turnover.[160] In other words, there were around 1,900 people in the EU employed in the production of chargers.

Regulations that affect the overall number of sales of EPS and cables in the EU would affect the firms' turnover and, therefore, may have wider macroeconomic implications on production and employment. These effects have been modelled in the stock model, where differences in revenues between the policy options and the baseline have been used as an input to estimate effects on EU employment.

Model assumptions of each measure

Measure 1: Harmonise device-end connectors

The following table presents an aggregate summary of the measure 1 scenario evolution of chargers split by EPS and cables. This shows the annual additions to the charger stock based on chargers provided with smartphones and chargers purchased standalone. The key impact of this option is that all smartphones must have USB Type-C connection ports, cables supplied with phones would alter to align with this

[158] Source: Structural Business Statistics (SBS), Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) [sbs_na_ind_r2]. Extracted on 8 March 2021 for NACE 2790 Manufacture of other electrical equipment.

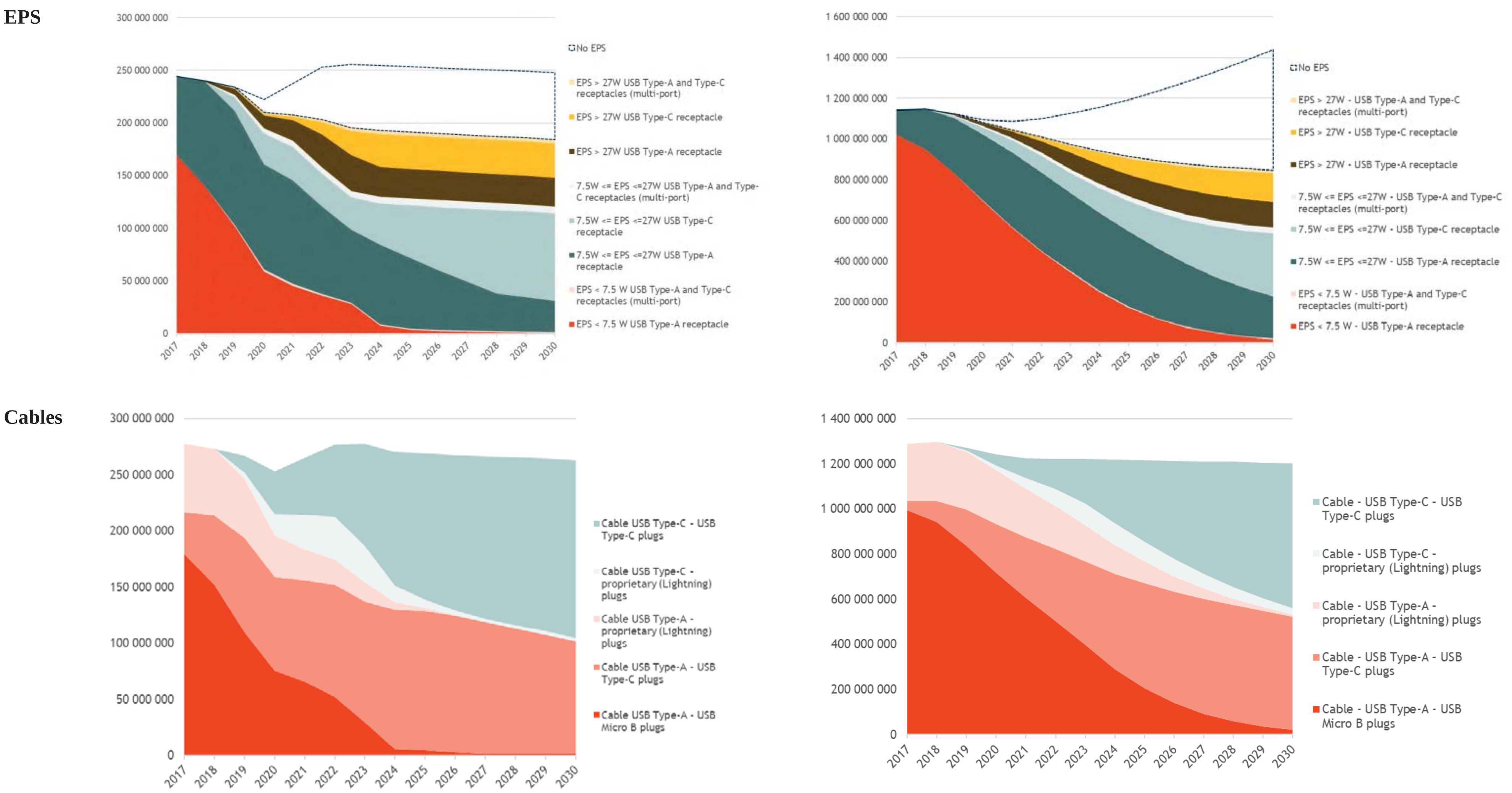
[159] Chargers' manufacturers' turnover is estimated by multiplying the amount of chargers in the baseline that are produced in the EU (26% of standalone chargers, according to PROCOM data) by the wholesale price of chargers.

[160] Source: Structural Business Statistics (SBS) Extract for NACE 2790 Manufacture of other electrical equipment.

change. In summary, the assumptions underlying this scenario are the same as the baseline except for the following variations:

- **With smartphones** there is no variation in total additions of EPS or cables compared to the baseline as these are directly linked to smartphone sales which remain unchanged across policy options. Changes in EPS and cables types supplied with smartphones do occur with the main variations from the baseline including:
    - **EPS – types:** The option requires a switch to USB Type-C on the phone, and the change to cables with USB Type-A to Type-C cables (see below), is expected to also indirectly lead to an increase in wattage of EPS to the 7.5W <= EPS <=27W bracket as manufacturers take advantage of the faster charging possibilities of USB Type-C compared to USB Micro-B. This is modelled by a reduction of the baseline share of EPS USB Type-A <7.5W to zero, with this share being redistributed to the EPS USB Type-A 7.5W <= EPS <=27W category from 2024 onwards.
    - **Cables - types:** both USB micro-B and Lightning (all Type-C in the baseline from 2021) cables are modelled to be reduced to zero in 2024 on introduction of the policy. In 2023 these cable types are already reduced by half compared to the baseline as manufacturers begin to adjust. The displaced market shares are allocated, first the Lightning cable share is all reallocated to USB Type-C – Type-C cables. Whilst the USB Type-A to Micro-B cable share is redistributed to USB Type-A – Type-C, and USB Type-C – Type-C cables, but predominantly the former given the configuration of the EPS still also supplied with smartphones, and the likelihood that for cost reasons manufacturers still producing USB Micro-B in 2024 will revert to USB Type-A – Type-C cables as the cheapest alternative. The C:C share of this displacement is around 12% in 2024, increasing to 29% by 2030.
- **Standalone charger** sales are modelled on the basis described above, and with variations in types compared to the baseline including:
    - **EPS - sales:** no change in totals compared to baseline.
    - **EPS – types:** Similar to the with smartphone sales, the move to USB Type-C connectors also leads to a faster reduction in <7.5W EPS than in the baseline, reducing from 6% of the total in 2024 (baseline 9%) to 0.5% by 2030 (baseline 5%). These displaced sales are split between EPS USB Type-A and USB Type-C on the basis of their share of cable sales with smartphones in the same year.
    - **Cables – sales:** the requirement for harmonised device-end connectors, will particularly impact the purchase of cables with proprietary connectors, namely the Lightning connectors of Apple. An impact on total cable sales is assumed due to the results of the consumer survey which show that Apple users have a higher propensity than average to purchase standalone cables, which would no longer be necessary under this policy option.

Figure 4.2: Measure 1 scenario evolution 2017-2030



Source: Consultant own stock model calculations.

Note: The No EPS area in the stock graph does not decline as there are no disposals assumed (unlike other EPS), the total accumulates for this reason.

- A reduction of 27% is applied to the share of the market of Apple (17.8%) to model this effect, this effectively reduces the 0.41 cables per person per year ratio to 0.39, which represents a 4.8% reduction in sales compared to the baseline.
- **Cables - types:** Significant reduction in all non USB Type-C cables from 2024 although some residual sales for older phones remain. USB Micro-B cables declining to 1% market share by 2027 (by 2030 in baseline). Lightning cables are reduced to 2% of the total by 2027. Displaced sales split in proportion to the smartphone market, i.e. 47:53 between Type-A-C and Type-C-C cables in 2024, increasing to 45:55 to C-C cables by 2030. In total by 2030 USB Type-A – Type-C cables account for 34% of the market, whilst USB Type-C – Type-C cables 63%, legacy Lightning and Micro-B cables the small remainder.

Measure 2: Require mobile phones to be compatible with USB PD

The following table presents an aggregate summary of the measure 2 scenario evolution of chargers split by EPS and cables. This shows the annual additions to the charger stock based on chargers provided with smartphones and chargers purchased standalone. The key assumptions underlying this scenario are the same as the baseline except for the following variations:

- **With smartphones** there is no variation in total additions of EPS or cables compared to the baseline as these are directly linked to smartphone sales which remain unchanged across policy options. Changes in EPS and cables types supplied with smartphones do occur with the main variations from the baseline including:
  - **EPS - types:** The same as for option 1, a requirement for USB-PD compatibility leads to a move away from low power (<7.5W) EPS, with these reduced to zero from 2024 as EPS are made more powerful to take advantage of the required USB Type-C charging.
  - **Cables - types:** The requirement for USB-PD compatibility results in all non-Apple phones that were still using USB Micro-B in the baseline (8.6% in 2024) switch to USB Type-C to ensure compatibility. In 2023 USB Micro-B cables are already reduced by half compared to the baseline as manufacturers begin to adjust. The displaced market share is allocated in the same way as Option 1 between USB Type-A–Type-C, and USB Type-C–Type-C cables.
- **Standalone charger** sales are modelled on the basis described above in Figure 4.2, and with variations in types compared to the baseline including:
  - **EPS – sales:** are reduced by the policy measure (-4% by 2030) compared to the baseline. This results from an assumed reduction in standalone sales to consumers that purchased a new EPS to acquire a faster charger, as the requirement for USB-PD compatibility, as described above, is expected to lead to a higher proportion of fast chargers supplied as standard with smartphones and/or that other standalone chargers are more likely to be able to fast-charge any phone. It is applied in the model through a reduction in the ratio of people assumed to purchase an EPS (0.31 per person/per year in the baseline), with a reduction of 5% applied to this ratio, reflecting the proportion of those in the consumer survey for the 2019 study that reported buying a standalone charger for the purpose of fast charging capabilities.
  - **EPS – types:** This options affects EPS types in exactly the same way as option 1, with a faster reduction in <7.5W EPS than baseline, reducing to 0.5% by 2030. Displaced sales split between EPS USB Type-A and USB Type-C.
  - **Cables – sales:** this option is not expected to directly influence standalone cable sales. However, as described above, they are expected to result in a reduction in standalone EPS sales of approximately 5%. This is also assumed to have an impact on cable sales as a share of EPS sales will be for EPS and cables bundled together. The consumer survey

provided information to estimate that 62% of EPS purchased standalone were purchased with cables. This ratio is applied to the 5% assumption on EPS reductions, resulting in a 3.1% reduction in cable sales compared to the baseline.

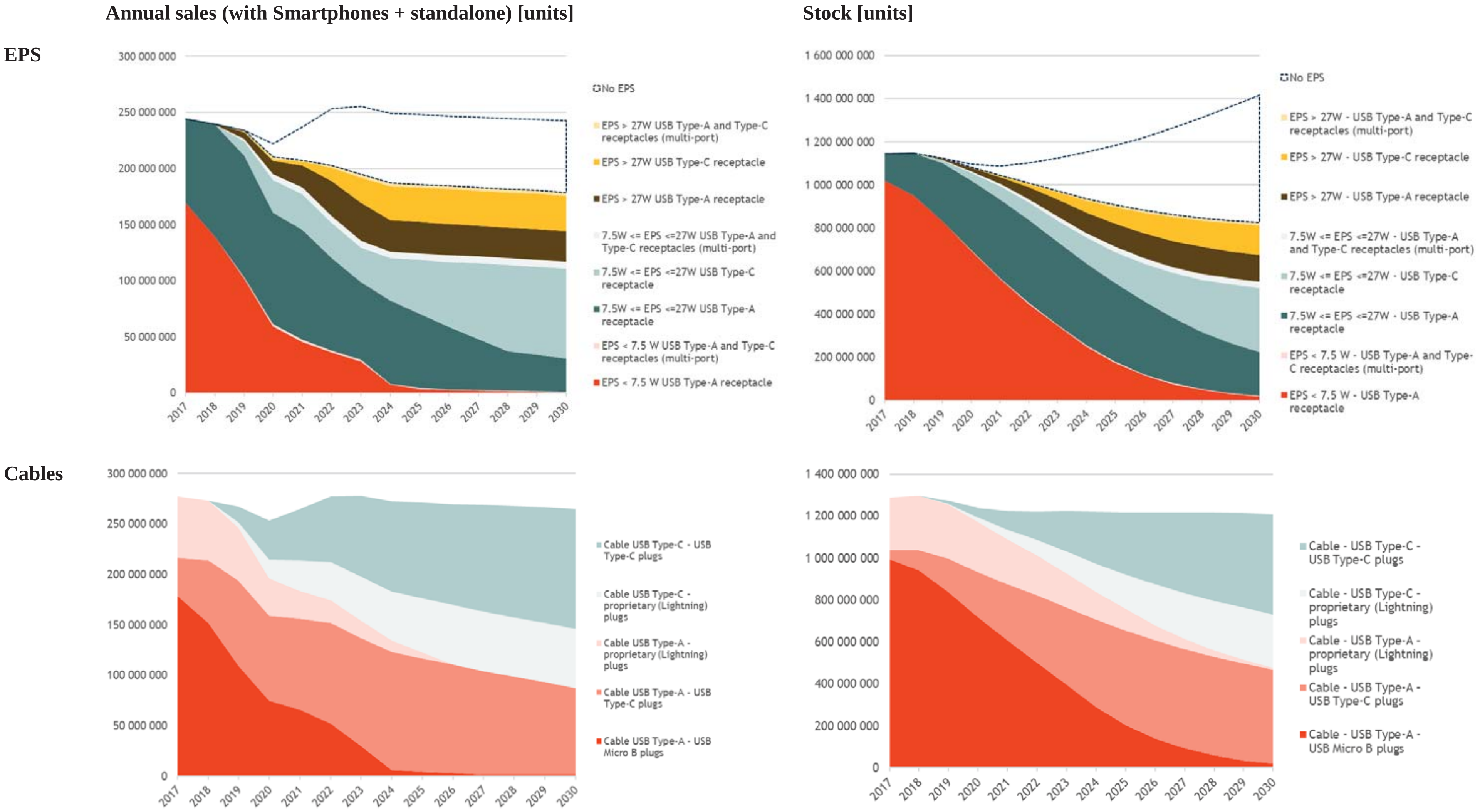
- **Cables - types:** Significant reduction in remaining USB Micro B cables from 2024. Some residual sales for older phones remain. USB Micro-B cables declining to 1% by 2027 (by 2030 in baseline). Micro-B displaced sales split in proportion to the smartphone market 47:53 between A-C and C-C cables in 2024, increasing to 45:55 to C-C cables by 2030. In total by 2030 USB Type-A – Type-C cables account for 24% of the standalone market by 2030, whilst USB Type-C – Type-C cables 50%.

Measure 3: Mandatory unbundling of EPS

The following table presents an aggregate summary of the measure 3 scenario evolution of chargers split by EPS and cables. This shows the annual additions to the charger stock based on chargers provided with smartphones and chargers purchased standalone. The key assumptions underlying this scenario are the same as the baseline except for the following variations:

- **With smartphones** there is a key variation in total additions of EPS or cables compared to the baseline, with EPS additions reduced to zero by this policy option. Purchases of EPS at the same time as a phone are added to standalone sales. No variations in cables additions are expected. For EPS and cable types:
    - **EPS – types:** All EPS unbundled from 2024 onwards, this results in around 60 million fewer EPS being supplied with smartphones each year.
    - **Cables – types:** No variation from baseline types.
- **Standalone charger** sales are modelled on the basis described above in Figure 4.2, and with variations in types compared to the baseline including:
    - **EPS - sales:** show a significant increase in this option of +16% or around 22 million per year by 2030. This is solely due to the mandatory unbundling of all smartphones, which creates a larger number of 'rebound' standalone purchases, added at the net ratio of 0.39 per unbundled phone as described previously for the baseline.
    - **EPS – types:** No changes compared to the baseline, EPS type splits remain the same, only the numbers of EPS are significantly increased.
    - **Cable – sales:** show an increase in this option of +7% by 2030. This is due to the indirect purchase of cables with EPS purchased as part of the rebound effect of unbundling. These are added at the net ratio of 0.21 per phone with unbundled EPS as described previously for the baseline.
    - **Cable – types:** No changes compared to the baseline.

Figure 4.3 Measure 2 scenario evolution 2017-2030



Source: Consultant own stock model calculations.

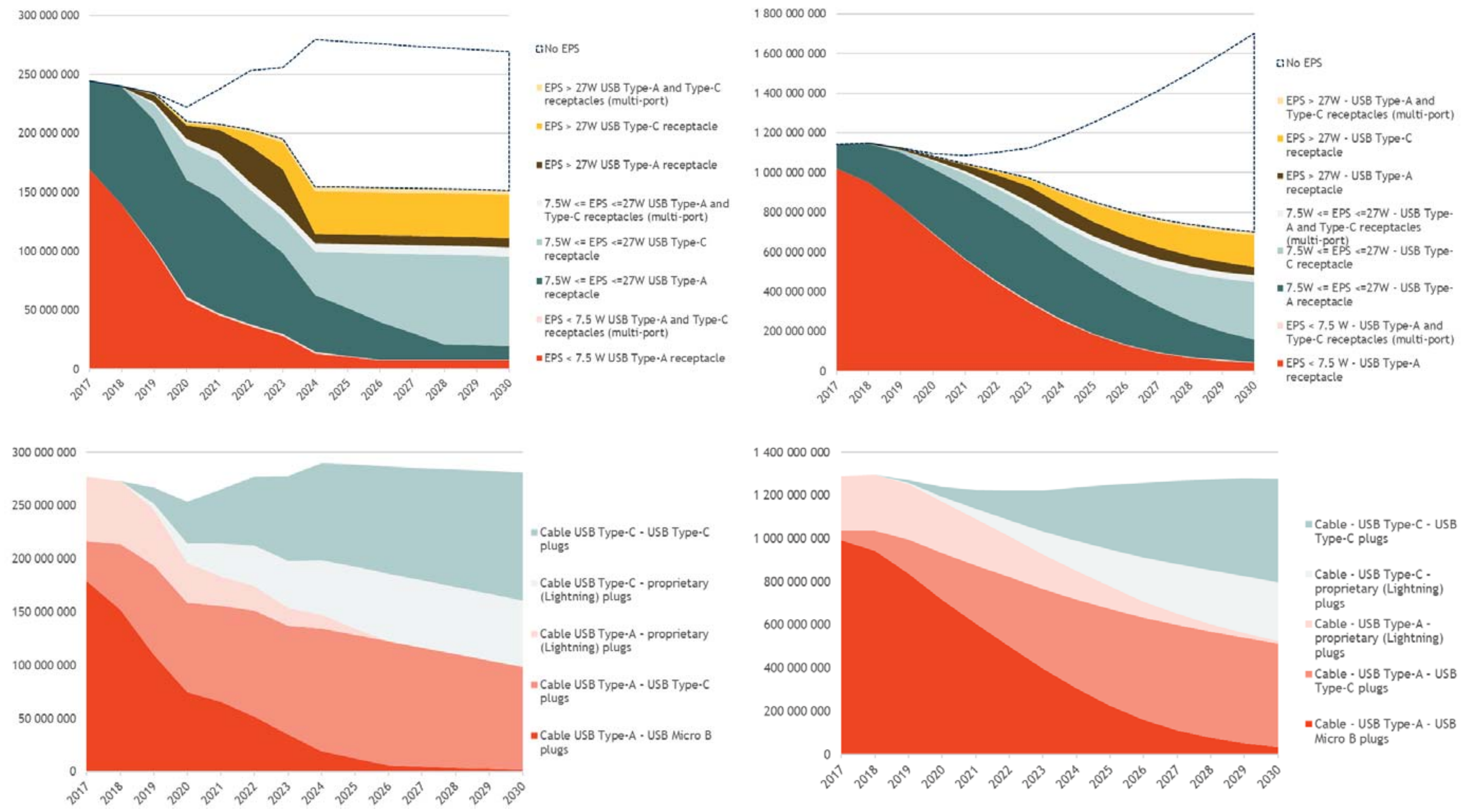
Note: The No EPS area in the stock graph does not decline as there are no disposals assumed (unlike other EPS), the total accumulates for this reason.

Figure 4.4 Measure 3 scenario evolution 2017-2030

Annual sales (with Smartphones + standalone) [units] **Stock [units]**

EPS

Cables



Source: Consultant own stock model calculations.

Note: The No EPS area in the stock graph does not decline as there are no disposals assumed (unlike other EPS), the total accumulates for this reason.

3. SCOPE OF THE IMPACT ASSESSMENT AND ASSUMPTIONS

During the inception phase, a mapping of 186 mobile phones and 192 other portable electronic devices was developped,[161] tracking their charging characteristics and market trends. Based on the mapping, devices were categorised into three priority groups using the following criteria[162]:

- The extent to which charging characteristics of other devices are similar to mobile phones, excluding from the analysis those for which the assumptions for mobile phone chargers could not be extrapolated;
- The extent to which unbundling already exists, de-prioritising those that are already sold unbundled;
- The trend of sales of the products, prioritising those devices with a high growth trend.

Based on the mapping and the analysis of market data, tablets and cameras were classified as the devices with the highest priority; earbuds and headphones/headsets and hand-held videogame consoles were classified as medium priority; and portable speakers, smartwatches and fitness trackers as low priority.[163]

The classification was used to prioritise the acquisition of market data for other portable devices. As a result, tablets, cameras and earbuds and headphones have been included in the stock model.[164] Impacts for other devices are assessed qualitatively.

Given that other portable devices have different charging characteristics to mobile phones and varied unbundling trends, not all of the policy options are relevant for all the devices.

Tablets

Of all the devices analysed, tablets are the most similar device to smartphones in terms of battery and charging characteristics. They use similar battery charging protocols, albeit with slightly higher wattage – especially on those tablets that are of bigger size or that incorporate features that are more typical of laptops (e.g. a keyboard). They also use the same types of connectors. In 2019, it is

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[161] The sample includes: 29 cameras (including action cameras), 10 handheld videogame consoles, 9 e-readers, 11 smartwatches / fitness trackers, 30 earsets and headsets, 14 laptops, 15 radio-controlled toys, 2 smartglasses, 26 portable speakers, 45 tablets.

[162] For more information on the prioritisation exercise conducted, see study on unbundling.

[163] Laptops and radio-controlled toys were also mapped and analysed, and excluded from further analysis. Laptops were excluded because they use significantly higher wattage than mobile phones, and therefore it would not be possible to extrapolate data and assumptions from smartphones to laptops (different impacts on safety and the environment). Radio-controlled toys were excluded because their charging characteristics also differ from mobile phones; they generally use lower current (0.1-1A vs 1-2A used in mobile phones) and, most importantly, use different types of batteries (Ni-MH / Ni-Cd, instead of Li-Ion or Li-Polymer used in mobile phones).

[164] Data for Tablets and earsets and headsetswas acquired from IDC; data for cameras has been retrieved from PRODCOM and CIPA.

estimated that 40% of tablets had USB micro-B receptacles, 33% USB Type-C, and 27% had proprietary connectors (23% Lightning and 4% other proprietary connectors).[165] All the tablets sold in the market nowadays are bundled with the EPS and cable.

All the policy options could apply to tablets. Currently, there are many tablets that are a hybrid between a tablet and a notebook or laptop, and therefore the scope of any legislation should be carefully defined. The impacts of the policy options on notebooks and laptops have not been analysed.

Digital photo cameras

All the cameras analysed in the mapping of devices (29) have USB connectors. In some cases the connector is only used for data transfer (7/29), whereas in most cases it can also be used to charge the camera (22/29).

There are two main types of digital cameras: cameras with built-in lenses (e.g. action cameras and compact cameras) and cameras with intercheangeable lenses (e.g. Reflex and mirrorless cameras). Cameras with built-in lenses are normally smaller and are charged via USB connectors (USB micro-B or USB Type-C). Larger cameras (Reflex and mirrorless) generally have removable (proprietary) batteries that are charged with external battery chargers. These chargers are proprietary and do not use USB cables or connectors. Only the newest and/or premium models of this type of cameras have a USB Type-C receptacle that allows not only data transfer, but also battery charging (i.e. some of these cameras can be charged either with a USB Type-C cable and EPS, or removing the battery and charging it separately using the proprietary charger). Out of the 29 cameras analysed:

- 20 were charged via a USB connection (either USB micro-B or USB Type-C);
- 7 could only be charged by removing the battery, using the proprietary charger;
- 2 could be charged either via USB Type-C charging, or via the proprietary charger (i.e. removing the battery).

Option 1 harmonises the receptacles to USB Type-C. This option could be applied to cameras, adding that the receptacle should provide both data transfer and charging via USB standards.

Cameras use significantly lower wattage than mobile phones. In the mapping of devices conducted, all the cameras analysed (29) required under 10W. The options to harmonise battery charging protocols considered in this impact assessment (measure 2) require minimum 7.5W; however, most cameras use less than that. In the few cases where the cameras require more power, the mapping indicates they already use USB Type-C charging. Therefore, measure 2 would not deliver the best

165 Estimates made based upon triangulation of mapping of devices and IDC data for Tablets.

technical option for cameras, as they would increase production costs and retail prices without producing any significant benefit for the consumers or the environment. Cameras that allow charging through the USB connector may already be charged safely with EPS that use USB PD and USB Type-C battery charging, as they provide backwards compatibility with other USB standards. A voluntary option for cameras requiring over 7.5W could be explored.

Out of the 29 cameras mapped, 12 included an EPS in the box, 9 included an external battery charger[166], and 26 included a cable. unbundling could therefore apply to cameras.

Earbuds and headphones: Certain types of connectors used by earbuds and headphones are similar to the ones used in mobile phones and tablets: Lightning (48% of the units sold in the EU in 2019), USB micro-B (41%) and USB Type-C (12%).[167] Common connector, therefore, could apply to earbuds and headphones. Some earbuds are charged wirelessly in their box, and the box connects to an EPS via a USB cable. For the purpose of this study, we have treated the earbuds' box as part of the product, and have mapped and analysed the connector in the box.

All the devices mapped (34) require less than 10W, and most require less than 5W. Therefore, similar to the case of cameras, measure 2 is not required to charge earbuds and headphones, as this would increase production costs and retail prices without producing any significant benefit for the consumers or the environment. A voluntary option for earbuds and headphonesrequiring over 7.5W could be explored.

Of the devices analysed, none of them included an EPS (hence making unbundling unnecessary for earbuds and headphones). However, almost all included a cable along with the hearing device. Unbundling could therefore apply to hearing devices.

Similar to the case of tablets, earbuds and headphones should be carefully defined so as to avoid including hearing aids and other potential devices that are different to those referred to in this study.

Hand-held videogame consoles

Nine consoles were mapped, of which five used USB micro-B connectors, three used USB Type-C connectors, and one used a proprietary connector (Sony PS Vita). The wattage used by consoles ranged from 4W (e.g. Nintendo 2DS) to 39W (e.g. Nintendo Switch). There were two devices using

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[166] The proprietary external charger to charge removable batteries is not considered an EPS. This type of charger is significantly different to mobile phone EPS and therefore it is not possible to use the same assumptions in estimations and the stock model.

[167] Estimate made based upon triangulation of mapping of devices with IDC data for earsets and headsets. It should be noted that IDC only includes premium categories of earsets and headsets, as it only includes devices that are considered "smart", i.e. include at least one of the following features: track health/fitness; modify audio beyond blanket noice cancellation; provide language translation; enable smart assistants. Non smart earsets and headsetsnormally use USB micro-B receptacles.

15W or more, of which one was USB PD enabled and the other used Quick Charge. All the devices except two (for which there was no information) were sold along with an EPS and cable.

Harmonisation of connector, and the unbundling measure could apply to hand-held videogame consoles. Harmonisation of charging protocol, which harmonise the use of battery charging protocols, may be applied to these devices. However, most devices use low wattage and harmonisation already exists for those using 15W or more.

Portable speakers

All of the 26 portable speakers mapped in the analysis used USB connectors (15 used USB micro-B and 11 used USB Type-C connectors). Most of the speakers required low wattage (under 10W), although the sample included six devices accepting 15W or more. All of these used USB Type-C connectors and either USB Type-C or USB PD battery charging protocols.

Given that there is no fragmentation of charging solutions in the market (proprietary solutions do not exist and USB micro-B connectors are naturally transitioning towards USB Type-C), harmonisation options are not strictly necesary.

Five out of 26 devices included an EPS along with the portable speaker and all of the devices included a cable. The unbundling measure could therefore apply to portable speakers.

E-readers

Most of the e-readers analysed (6 out of 8) use USB micro-B connectors and a minority (2 out of 8) use USB Type-C connectors. All of them are charged at 5W using the USB BC specification. As in the case of portable speakers, it is not proportionate to include e-readers within the scope of any regulatory harmonisation of connectors and charging protocol as it would not deliver any benefit to the consumer or the environment. Nonetheless, e-readers could of course also carry the interoperability labels.

None of the devices analysed included EPS along with the e-readers, but all included a cable.

Smartwatches and fitness trackers

All the devices analysed are charged via wireless and/or proprietary connectors. These wearables are often designed to be water resistant and support hard conditions, therefore USB connectors may not offer the best technical solution. The wattage accepted by the devices was below 10W in all cases. Applying the harmonisation of connector and charging protocol to smartwatches and fitness trackers would deliver sub-optimal charging solutions. Nonetheless, those devices that do use the relevant USB charging technologies could take part in the voluntary labelling scheme. However, given that wireless is the most common charging method for these devices, it may be more appropriate to use the labelling scheme to communicate wireless charging protocols instead.

Five out of the 11 devices analysed included an EPS. All included a cable, and most included a wireless charger. Unbundling measure could be applied to mandate unbundling of EPS. With regard to the cable, given that many of these devices use proprietary connectors (and USB Type-C do not offer the right technical option), mandating unbundling of the cable is not recommended.

Summary of policy options for other portable electronic devices

The table below summarises the devices for which each measure is relevant. 'Yes' indicates that the policy option could apply to that device, and the impact assessment in the remainder of this chapter explores the likely effects of this; 'No' indicates that, based on the information at disposal, it is recommended that the policy option does not apply to the device because it is not the best technical option (based on the charging characteristics of the portfolio of devices analysed) and/or the negative impacts would clearly overweight the positive impacts; 'Unnecessary' indicates that the option is feasible technically, but would not provide any benefits in relation to the baseline scenario.

Table 4.17 - Summary of scope of measures applied

Device	Harmonise connectors	Interoperability with common comm. protocol and providing information to consumer	Unbundling of EPS
Tablets	Yes	Yes	Yes
Cameras	Yes	Unnecessary	Yes
Earbuds and headphones/headsets	Yes	Yes for headphones/headsets, No for earbuds (or other hearing devices)	Unnecessary
Hand-held video game consoles	Yes	Yes	Yes
Portable speakers	Yes	Yes	Yes
E-readers	No	No	Unnecessary
Smartwatches & fitness trackers	No	No	Yes

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Model assumptions – other devices

The table below summarises the main assumptions that are built into the stock model for each policy option and other devices where data was available. It also includes the assumptions for the policy combination. In all policy options, the rebound effects (i.e. the percentage of consumers who would buy a standandalone EPS when acquiring a new unbundled phone) work in the same way as for smartphones.

(1) Harmonisation of the end-device connector	EPS – moved forward transition to 7.5W <= EPS <=27W by 1 year to 2024 Cable – USB Micro-B eliminated one year earlier than in the baseline, in 2024	EPS – not relevant Cables – all USB Micro-B and Lightning connectors are eliminated by 2024. Instead, cables use USB Type-C to C connectors, USB Type-A to C connectors, or USB Type-C to Lightning connectors.	EPS – no changes Cables – USB Micro-B and proprietary connectors are substituted by USB Type C. As a result, all cables sold are either USB Type A to C, or USB Type-C to C.
(2) Support of the relevant charging protocol on the end-device and informing consumers about charging performance	EPS – same as PO1 Cable – USB Micro-B eliminated one year earlier than in the baseline, in 2024	This policy option does not apply to earbuds.	The option has been modelled for cameras (although section 6.1 of the report recommends not to apply it in full). EPS – assume share with proprietary cables move to provide EPS and cables compatible with USB battery charging protocols. The splits between EPS with USB Type-A and C receptacles follows the same split as for mobile phones. Cables – Eliminate USB Micro-B cables 2 years earlier.
(3) Making available on the market at least unbundled solutions	EPS – all unbundled from 2024, already half in 2023 Cables – no change	EPS – already 100% unbundled Cables – no change	EPS – all unbundled from 2024, already half in 2023 Cables – no change
Policy Option 1	Same as measure 1	Same as measure 1	Same as measure 1
Policy Option 2	Same as measure 2	Same as measure 2	Same as measure 2
Policy Option 3	EPS – same as PO2 2020-2022, same as PO4a from 2023 Cables – same as PO2	EPS – same as PO2 2020-2022, same as PO4a from 2023 Cables – same as PO2	EPS – same as PO2 2020-2022, same as PO4a from 2023 Cables – same as PO2
Policy Option 4	Same as measure 1	Same as measure 1	Same as measure 1
Policy Option 5	EPS – same as PO1 2020-2022, same as PO4a from 2023 Cables – same as PO1	EPS – same as PO1 2020-2022, same as PO4a from 2023 Cables – same as PO1	EPS – same as PO1 2020-2022, same as PO4a from 2023 Cables – same as PO1

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

4. OTHER ASSUMPTIONS

Model assumptions – Combination of measures and synergy effects

The policy packages are modelled as the combined effect of the individual policy options. The underlying assumptions for the combination of options remain the same as the measures but with the following adjustments to account for how the policy options interact with each other:

- Policy Option 3 (measures 2 and 3): The effects of measures 2 and 3 are complementary. In addition, there is a synergy effect that enhances the effectiveness of unbundling (i.e. the addition of measure 2 reduces the number of consumers who decide to acquire an EPS when they buy a phone that is unbundled). It has been assumed that the combination of measures in this package will reduce the proportion of consumers who choose to purchase an EPS along with an unbundled new phone by 10%, i.e. from 57% under the baseline scenario (and all the measures individually) to 51%.

- Policy Option 4 (measures 1 and 2): The impacts of this package are slightly smaller than the sum of the impacts of measures 1 and 2 individually. This is because both of these measures entail the replacement of all remaining USB micro-B receptacles in phones with USB Type-C receptacles, and therefore this effect only accrues once if the options are combined.
- Policy Option 5 (measures 1, 2 and 3): In this case, measures 1 and 2 have overlapping impacts (as explained in package 1), and measure 3 complements the effects of 1 and 2. In addition, in there is a synergy effect similar to policy option 3, i.e. the proportion of consumers who choose to purchase an EPS along with an unbundled new phone falls from 57% to 51%.

Model assumptions – Sensitivity check

There are various uncertainties when projecting forward and assuming market and technological developments into the future, and also for the other assumptions that underpin the market model. Whilst some assumptions such as charger profiles, e.g. weight, price, etc; will see scaling effects proportional to the changes made, others can have more complex effects. The model was examined for variables for which sensitivity checks would be possible and where variance in the variable/assumption could have an important impact on the results. Also it was considered triangulation of data to validate model results, for example in terms of quantities of charger units, it provides good confidence that the model overall settings are robust as the number of EPS and cables in the stock, compared to the survey reported EPS and cables owned by consumers correspond closely.

One of the key sets of assumptions identified for checks was the rebound rates for EPS and cables, i.e. the proportion of consumers that would purchase these standalone in the case they were unbundled. In the model the rebound rates are:

- **EPS:** 57% of consumers buying an EPS standalone if this was unbundled, reduced by the 31% of those that would normally have purchased a standalone EPS in any case, a net rebound effect of 0.39 EPS purchased standalone for every EPS unbundled. This also has an indirect impact on cable purchases as 62% of standalone EPS purchases are bundled with a cable.
- **Cables:** a similar adjustment was made, on the basis of 75% of consumers purchasing a cable standalone if this was unbundled, reduced by the 41% that would have purchased a standalone cable anyway, for a net effect of 0.44 cable purchases for every cable unbundled.

Naturally, these assumptions are especially relevant for policy options 4a and 4b where unbundling is mandated.

Using a 35% rather than 57% assumption for consumers purchasing an EPS standalone in the case of unbundling results in a net effect of 0.24 EPS purchased for every EPS unbundled. Using 70% rather than 57% results in a net effect of 0.48. The impact of these changes is minimal on all policy options except the ones including unbundling. The following table compares these low and high assumptions for unbundling compared to the central 57% assumption used in the work. As expected, a lower rebound assumption results in greater environmental benefits compared to the baseline (i.e. higher reductions in emissions, etc), and vice-versa for a higher assumption. The overall impact of the assumption is quite significant in the results, so that if in reality the rebound effect is lower, then the beneficial impact of these policy options would also be higher.

Table 4.16 - 41 Results of sensitivity check of rebound effect assumption on unbundling

	PO4a average annual difference with baseline			PO4b average annual difference with baseline		
	LOW	CENTRAL	HIGH	LOW	CENTRAL	HIGH
CO_2 emissions	-13.4%	-9.0%	-6.6%	-26.2%	-19.9%	-16.4%
Material use	-9.8%	-6.1%	-4.1%	-28.3%	-21.8%	-18.3%
E-waste	-4.4%	-2.7%	-1.8%	-12.8%	-10.0%	-8.4%
Untreated	-4.1%	-2.6%	-1.7%	-11.9%	-9.4%	-7.9%
Recycled	-3.9%	-2.3%	-1.4%	-13.6%	-10.7%	-9.1%
Cost to consumers	-0.1%	4.2%	6.6%	-4.9%	2.4%	6.4%
Benefit for manufacturers and wholesalers [NPV million EUR]	-10.6%	-6.8%	-4.7%	-27.4%	-20.9%	-17.3%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

5. IMPACTS OF THE DIFFERENT MEASURES

Following the methods in the previous two sections, the following impacts can be estimated on the different measures for mobile phones and for the broader scope of devices.

Table 4.18 Summary of environmental impacts per measure for mobile phones

		Baseline	**Harmonise device-end connectors**	**Support of the relevant protocol on the end-device and Informing consumers about charging performance**	**Making available on the market at least unbundled solutions**
GHG emissions [ktCO2e]	**Cumulative 2024-2030**	**7 838**	**7 963**	**7 767**	**7 139**
	Difference with baseline		125	-71	-699
	Annual average	1 120	1 138	1 110	1 020
	Difference with baseline		18	-10	-100
	As %		1.6%	-0.9%	-8.9%
Material Use [tonnes]	**Cumulative 2024-2030**	**152 806**	**155 110**	**151 597**	**143 710**
	Difference with baseline		2 304	-1 209	-9 096
	Annual average	21 829	22 159	21 657	20 530
	Difference with baseline		329	-173	-1 299

	As %		1.5%	-0.8%	-6.0%
e-waste [tonnes]	**Cumulative 2024-2030**	**133 196**	**134 283**	**132 846**	**129 650**
	Difference with baseline		1 088	-350	-3 546
	Annual average	19 028	19 183	18 978	18 521
	Difference with baseline		155	-50	-507
	As %		0.8%	-0.3%	-2.7%
Of which Untreated [tonnes]	**Cumulative 2024-2030**	**27 365**	**27 580**	**27 302**	**26 677**
	Difference with baseline		215	-63	-688
	Annual average	3 909	3 940	3 900	3 811
	Difference with baseline		31	-9	-98
	As %		0.8%	-0.2%	-2.5%
Of which Recycled [tonnes]	**Cumulative 2024-2030**	**70 685**	**71 330**	**70 556**	**69 087**
	Difference with baseline		645	-129	-1 597
	Annual average	10 098	10 190	10 079	9 870
	Difference with baseline		92	-18	-228
	As %		0.9%	-0.2%	-2.3%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.19: Summary of economic and social impacts for mobile phones

	Baseline	**Harmonise device-end connectors**	**Support of the relevant protocol on the end-device and Informing consumers about charging performance**	**Making available on the market at least unbundled solutions**
Benefits to consumers (NPV million EUR)				
Cumulative 2024-2030	**45,982**	**42,143**	**44,807**	**48,019**
Difference with baseline		-3,840	-1,175	2,036
Annual average	6,569	6,020	6,401	6,860
Difference with baseline		-549	-168	291
As %		-8.4%	-2.6%	4.4%
Competitiveness of businesses				
	Of which impact manufacturers and wholesalers (NPV million EUR)			
Cumulative 2024-2030	**11 903**	**10 932**	**11 682**	**11 110**
Difference with baseline		-970	-221	-793
Annual average	1 700	1 562	1 669	1 587
Difference with baseline		-139	-32	-113
As %		-8.20%	-1.90%	-6.70%
	Of which impact EU manufacturers (NPV million EUR)			
Cumulative 2024-2030	**1 519**	**1 389**	**1 471**	**1 725**
Difference with baseline		-129	-48	207
Annual average	217	198	210	246
Difference with baseline		-18	-7	30
As %		-8.50%	-3.10%	13.60%
	Of which impact distributors and retailers until point of sale (NPV million EUR)			
Cumulative 2024-2030	**22 177**	**20 278**	**21 444**	**25 799**

Difference with baseline		-1 899	-733	3 621
Annual average	3 168	2 897	3 063	3 686
Difference with baseline		-271	-105	517
As %		-9%	-3%	16%
Other costs/impacts		Negligible	Negligible	Negligible

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.20 Summary of environmental impacts per measure for the broader scope

		Baseline	Harmonise device-end connectors	Support of the relevant protocol on the end-device and Informing consumers about charging performance	Making available on the market at least unbundled solutions
GHG emissions [$ktCO_2e$]	**Cumulative 2024-2030**	**9 052**	**9 226**	**8 995**	**8 047**
	Difference with baseline		174	-57	-1 005
	Annual average	1 293	1 318	1 285	1 150
	Difference with baseline		25	-8	-144
	As %		1.90%	-0.60%	-11.10%
Material Use [tonnes]	**Cumulative 2024-2030**	**179 371**	**183 033**	**178 459**	**165 619**
	Difference with baseline		3 662	-913	-13 752
	Annual average	25 624	26 148	25 494	23 660
	Difference with baseline		523	-130	-1 965
	As %		2.00%	-0.50%	-7.70%
e-waste [tonnes]	**Cumulative 2024-2030**	**155 463**	**157 419**	**155 382**	**149 645**
	Difference with baseline		1 957	-81	-5 817
	Annual average	22 209	22 488	22 197	21 378
	Difference with baseline		280	-12	-831
	As %		1.30%	-0.10%	-3.70%
Of which Untreated [tonnes]	**Cumulative 2024-2030**	**31 914**	**32 301**	**31 905**	**30 782**
	Difference with baseline		388	-8	-1 132
	Annual average	4 559	4 614	4 558	4 397
	Difference with baseline		55	-1	-162
	As %		1.20%	0.00%	-3.50%
Of which Recycled [tonnes]	**Cumulative 2024-2030**	**82 899**	**84 103**	**82 929**	**80 180**
	Difference with baseline		1 204	30	-2 719
	Annual average	11 843	12 015	11 847	11 454
	Difference with baseline		172	4	-388
	As %		1.50%	0.00%	-3.30%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.21: Summary of economic and social impacts for the broader scope

	Baseline	Harmonise device-end connectors	Support of the relevant protocol	Making available on the market at least

			on the end-device and Informing consumers about charging performance	unbundled solutions
Benefits to consumers (NPV million EUR)				
Cumulative 2024-2030	**49 960**	**45 619**	**48 795**	**52 247**
Difference with baseline		-4 341	-1 165	2 287
Annual average	7 137	6 517	6 971	7 464
Difference with baseline		-620	-166	327
As %		-8.70%	-2.30%	4.60%
Competitiveness of businesses				
	Of which impact manufacturers and wholesalers (NPV million EUR)			
Cumulative 2024-2030	**14 176**	**12 919**	**13 960**	**12 890**
Difference with baseline		-1 257	-215	-1 285
Annual average	2 025	1 846	1 994	1 841
Difference with baseline		-180	-31	-184
As %		-8.89%	-1.53%	-9.09%
	Of which impact EU manufacturers (NPV million EUR)			
Cumulative 2024-2030	**1 519**	**1 389**	**1 471**	**1 793**
Difference with baseline		-129	-48	274
Annual average	217	198	210	256
Difference with baseline		-18	-7	39
As %		-8.29%	-3.23%	17.97%
	Of which impact distributors and retailers until point of sale (NPV million EUR)			
Cumulative 2024-2030	**21 609**	**19 781**	**20 874**	**26 466**
Difference with baseline		-1 828	-735	4 857
Annual average	3 087	2 826	2 982	3 781
Difference with baseline		-261	-105	694
As %		-8%	-3%	22%
Other costs/impacts		Negligible	Negligible	Negligible

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

6. IMPACTS OF THE AGGREGATED MEASURES

Starting from the impacts of the single measures, it is possible to estimate the impacts of the options as in the four tables below. In a first assumption the costs can be estimated as the sum of the measures. In some cases, however, synergies are present.

Table 4.22 Aggregated summary of environmental impacts for mobile phones

		Option 1	Option 2	Option 3	Option 4	Option 5
GHG emissions [ktCO₂e]	**Cumulative 2024-2030**	**7 963**	**7 767**	**6 887**	**7 783**	**6 810**
	Difference with baseline	125	-71	-951	-55	-1 028
	Annual average	1 138	1 110	984	1 112	973
	Difference with baseline	18	-10	-136	-8	-147

	As %	1.60%	-0.90%	-12.10%	-0.70%	-13.10%
Material Use [tonnes]	**Cumulative 2024-2030**	**155 110**	**151 597**	**139 452**	**151 831**	**137 862**
	Difference with baseline	2 304	-1 209	-13 354	-975	-14 944
	Annual average	22 159	21 657	19 922	21 690	19 695
	Difference with baseline	329	-173	-1 908	-139	-2 135
	As %	1.50%	-0.80%	-8.70%	-0.60%	-9.80%
e-waste [tonnes]	**Cumulative 2024-2030**	**134 283**	**132 846**	**128 094**	**133 010**	**127 549**
	Difference with baseline	1 088	-350	-5 102	-186	-5 647
	Annual average	19 183	18 978	18 299	19 001	18 221
	Difference with baseline	155	-50	-729	-27	-807
	As %	0.80%	-0.30%	-3.80%	-0.10%	-4.20%
Of which Untreated [tonnes]	**Cumulative 2024-2030**	**27 580**	**27 302**	**26 381**	**27 335**	**26 277**
	Difference with baseline	215	-63	-985	-30	-1 088
	Annual average	**3 940**	**3 900**	**3 769**	**3 905**	**3 754**
	Difference with baseline	31	-9	-141	-4	-155
	As %	0.80%	-0.20%	-3.60%	-0.10%	-4.00%
Of which Recycled [tonnes]	**Cumulative 2024-2030**	**71 330**	**70 556**	**68 325**	**70 645**	**68 005**
	Difference with baseline	645	-129	-2 359	-40	-2 680
	Annual average	10 190	10 079	9 761	10 092	9 715
	Difference with baseline	92	-18	-337	-6	-383
	As %	0.90%	-0.20%	-3.30%	-0.10%	-3.80%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.23 Aggregated summary of economic and social impacts for mobile phones

	Option 1	Option 2	Option 3	Option 4	Option 5
Benefits to consumers (NPV million EUR)					
Cumulative 2024-2030	**42 143**	**44 807**	**45 966**	**40 944**	**44 505**
Difference with baseline	-3 840	-1 175	-16	-5 038	-1 478
Annual average	6 020	6 401	6 567	5 849	6 358
Difference with baseline	-549	-168	-2	-720	-211
As %	-8.40%	-2.60%	0.00%	-11.00%	-3.20%
Competitiveness of businesses					
	Of which impact manufacturers and wholesalers (NPV million EUR)				
Cumulative 2024-2030	**10 932**	**11 682**	**10 725**	**10 693**	**10 216**
Difference with baseline	-970	-221	-1 178	-1 210	-1 686
Annual average	1 562	1 669	1 532	1 528	1 459
Difference with baseline	-139	-32	-168	-173	-241
As %	-8.20%	-1.90%	-9.90%	-10.20%	-14.20%
	Of which impact EU manufacturers (NPV million EUR)				
Cumulative 2024-2030	**1 389**	**1 471**	**1 642**	**1 342**	**1 608**

Difference with baseline	-129	-48	123	-176	89
Annual average	198	210	235	192	230
Difference with baseline	-18	-7	18	-25	13
As %	-8.50%	-3.10%	8.10%	-11.60%	5.90%
	Of which impact distributors and retailer until point of sale (NPV million EUR)				
Cumulative 2024-2030	**20 278**	**21 444**	**24 517**	**19 559**	**24 072**
Difference with baseline	-1 899	-733	2 339	-2 618	1 895
Annual average	2 897	3 063	3 502	2 794	3 439
Difference with baseline	-271	-105	334	-374	271
As %	-9%	-3%	10.5%	-11.8%	8.5%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.24 Aggregated summary of environmental impacts for broader scope of devices

		Option 1	Option 2	Option 3	Option 4	Option 5
GHG emissions [ktCO$_2$e]	**Cumulative 2024-2030**	**9 226**	**8 995**	**7 799**	**9 046**	**7 767**
	Difference with baseline	174	-57	-1 253	-6	-1 286
	Annual average	1 318	1 285	1 114	1 292	1 110
	Difference with baseline	25	-8	-179	-1	-184
	As %	1.93%	-0.60%	-13.80%	-0.10%	-14.20%
Material Use [tonnes]	**Cumulative 2024-2030**	**183 033**	**178 459**	**161 409**	**179 754**	**161 130**
	Difference with baseline	3662	-913	-17 962	383	-18 242
	Annual average	26 148	25 494	23 058	25 679	23 019
	Difference with baseline	524	-130	-2 566	55	-2 606
	As %	2.04%	-0.50%	-10.00%	0.20%	-10.20%
e-waste [tonnes]	**Cumulative 2024-2030**	**157 420**	**155 382**	**148 127**	**156 146**	**148 604**
	Difference with baseline	1957	-81	-7 336	683	-6 859
	Annual average	22 489	22 197	21 161	22 307	21 229
	Difference with baseline	280	-12	-1 048	98	-980
	As %	1.26%	-0.10%	-4.70%	0.40%	-4.40%
Of which Untreated [tonnes]	**Cumulative 2024-2030**	**32 302**	**31 905**	**30 493**	**32 056**	**30 594**
	Difference with baseline	388	-8	-1 421	143	-1 320
	Annual average	4 615	4 558	4 356	4 579	4 371
	Difference with baseline	56	-1	-203	20	-189
	As %	1.22%	0.00%	-4.50%	0.40%	-4.10%
Of which Recycled [tonnes]	**Cumulative 2024-2030**	**84 103**	**82 929**	**79 437**	**83 418**	**79 750**
	Difference with baseline	1204	30	-3 462	519	-3 149
	Annual average	12 015	11 847	11 348	11 917	11 393
	Difference with baseline	172	4	-495	74	-450
	As %	1.45%	0.00%	-4.20%	0.60%	-3.80%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

Table 4.25 Aggregated summary of economic and social impacts for broader scope of devices

	Option 1	Option 2	Option 3	Option 4	Option 5
Benefits to consumers (NPV million EUR)					
Cumulative 2024-2030	**45 619**	**48 795**	**50 202**	**44 421**	**48 236**
Difference with baseline	-4 341	-1 165	242	-5 540	-1 724
Annual average	6 517	6 971	7 172	6 346	6 891
Difference with baseline	-620	-166	35	-791	-246
As %	-8.69%	-2.30%	0.50%	-11.10%	-3.50%
Competitiveness of businesses					
	Of which impact manufacturers and wholesalers (NPV million EUR)				
Cumulative 2024-2030	**12 919**	**13 960**	**12 507**	**12 679**	**11 713**
Difference with baseline	-1 257	-215	-1 669	-1 497	-2 463
Annual average	1 846	1 994	1 787	1 811	1 673
Difference with baseline	-179	-31	-238	-214	-352
As %	-8.86%	-1.53%	-11.80%	-10.60%	-17.40%
	Of which impact EU producers: (NPV million EUR)				
Cumulative 2024-2030	**1 390**	**1 471**	**1 710**	**1 342**	**1 675**
Difference with baseline	-129	-48	191	-176	156
Annual average	199	210	244	192	239
Difference with baseline	-18	-7	27	-25	22
As %	-8.49%	-3.23%	12.60%	-11.60%	10.30%
	Of which impact distributors and retailers until point of sale (NPV million EUR)				
Cumulative 2024-2030	**19 781**	**20 874**	**25 189**	**19 062**	**24 811**
Difference with baseline	-1 828	-735	3 580	-2 546	3 202
Annual average	2 826	2 982	3 598	2 723	3 544
Difference with baseline	-261	-105	511	-364	457
As %	-8%	-3%	16.6%	-11.8%	14.8%

Source: Impact assessment study on Unbundling of mobile phones and similar electronic devices (2021)

ANNEX 5: STATE-OF-PLAY OF CHARGING TECHNOLOGIES

This section provides an overview of the chargers for mobile phones and the main features that influence interoperability, including the main components of chargers, and the status of fast and wireless charging.

A charging solution is formed by three main elements:

1. The External Power Supply (EPS)

   This is the device that is typically plugged into the sockets at home, which are connected to the electrical wiring and, in turn, to the electric grid. It typically has a USB type A or USB type C interface so to allow cables to be connected to it, for the purposes of charging the devices.

2. A cable assembly allowing power transfer from the EPS to the device. At the termination that goes into the EPS, cables mirror the relevant interface of the EPS (i.e. USB type A or USB type C).

   a. For wired charging solutions at the mobile end, cables can have a USB type C, a micro USB type B or a proprietary interface. In the past, and still occasionally today, they could not be detachable, i.e. the end that goes into the EPS is fused with the EPS itself.

   b. For wireless charging solutions, the cable terminates with, or can be connected to, a pad which allows wireless charging.

   For the purposes of this Impact Assessment, the combination of an EPS as in point 1 and a cable as in point 2a is intended to be a "charger". The combination of an EPS as in point 1 and a pad as in point 2b is intended to be a "wireless charger".

3. The device's battery

   This is a part of the device, which has an appropriate interface (and internal circuitry) to receive the power from the charger.

For a device to charge, these three elements need to be interoperable and the EPS has to provide an appropriate level of electric current (or voltage) that the battery needs. In the last years, most of chargers have become able to support different levels of electric current (or voltage), so it is frequent that the charger and the mobile phone communicate through a specific protocol to establish the best charging profile that both can support.

The following sections 1, 2 and 3 describe, respectively, points 1 and 2a and 2b above in more detail.

1. The EPS

After the first MoU, EPS were typically providing 7.5W (5V at 1.5A). With the increase of the dimension of the phones, bigger batteries with higher capacities were placed on the market. These requested EPS to delivery of increased power levels to keep the charging speed at least in line with the old new technologies. The USB Implementers Forum (USB-IF)[168], formed by 100+ members developed in cooperation with IEC the standard series 62680. This standard series set the specifications for USB Power Delivery and USB Type-C. The USB Power Delivery (PD) specification describes the architecture and protocols to connect the battery charger and the device to be charged (e.g. a mobile phone). During this communication, the optimum charging voltage and current are determined to deliver power up to 100W through the USB connector. Some mobile phone manufacturers have since incorporated USB PD in their devices. On 8 January 2018, USB-IF announced the "Certified USB Fast Charger" which certifies chargers that use the feature “Programmable Power Supply” (PPS) of the USB PD specification. The interoperability of the “USB PD family” is defined by the standard EN 63002, which allows the device and EPS to communicate with each other, so that the EPS provides only the power that the device requires, avoiding damaging the battery and maximising performance. Specific manufacturers developed specific technology, e.g. Qualcomm’s Quick Charge, which are nevertheless compatible with the USB PD.

In summary, EPS today can be classified into four main typologies, as described in the table below.

Table 5.1: Typology of EPS for mobile phones

Type of EPS	Specifications applicable	Interoperability with low-end and old phones	Interoperability with high end phones
Common EPS, as defined in 2009 MoU	IEC 62684	Yes	Can charge high-end phones at a normal speed
USB PD	EN 62680-1-2 EN 62680-1-3 EN 63002	Yes	Yes
Quick Charge v1, v2, v3	None	Yes, although safety (for user and device) is not guaranteed	Only phones including Quick Charge
Quick Charge v4, v4+	Programmable Power Supply Compatible with USB PD and USB C specifications	Yes	Yes

Source: Commission’s contractor

[168] https://www.usb.org/

As regard the interfaces on the EPS, the following applies:

Table 5.2: Maximum power and speed for data transfer supported by USB connectors – EPS side

Type of connector	Latest specification it supports (power)	Latest specification it supports (data transfer)	Max Power	Max data transfer
USB Type-A	USB PD (EN 62680-2)	USB 3.2	100W	20 Gbps
USB Type-C	USB PD (EN 62680-2)	USB 4	100W	40 Gbps

When consulted for this study, phone manufacturers were asked about compliance of their products (mobile phones and chargers included in the box) with these standards. All manufacturers confirmed that their chargers and mobile phones with charging capacity of up to 5W comply with 62684. Only two companies provided information on devices using more than 5W. In one case, all devices are compliant with IEC 62680 series and IEC 63002, whereas in another case there is a mix of devices compliant with 62680 series and 63002, and devices with proprietary fast charging solutions.

The study team conducted a review of phones available in the market in 2018. The contractor estimated that in 2018, 71% of phones sold in the EU included an EPS in the box that is compatible with IEC 62684, 11% included an EPS compliant with USB PD specifications, and 18% included an EPS using a proprietary solution. Among the latter, it should be noted that some proprietary solutions (Quick Charge v4 and v4+) are compatible with USB PD and USB Type-C specifications, and therefore interoperable with other devices. The contractor also estimated that a large proportion of these devices incorporated the latest Quick Charge solutions (v4 and v4+).

2. The cable, in the case of wired charger

The cable assembly is another element that determines interoperability. When the first MoU was signed in 2009, signatories committed to use USB micro-B connectors at the phone end. The MoU, however, also allowed the use of proprietary connectors. The shape of the connector at the EPS end was not directly covered by the 2009 MoU. However, the standard that defined "*the common charger*" (EN 62684) indicated that EPS need to be "*provided with a detachable cable and equipped with a USB Standard A receptacle to connect to the EPS*".

To date, the majority, if not all, of mobile phone manufacturers complied with the requirement of providing an EPS with a detachable cable and USB A sockets and plugs. Similarly, most mobile phone manufacturers adopted USB micro-B at the phone end, and this has been the mainstream solution until the irruption of USB Type-C. USB Type-C is a 24-pin USB connector system, which is distinguished by its two-fold rotationally-symmetrical connector. The specification was finalised in 2014, and published shortly after. The EN 62680-1-3 sets specifications for connectors, cables, adapters, supporting charge of up to 15W. However, it can also support USB PD (up to 100W). Since then, USB C has started to gradually replace USB micro-B as the connector of choice at the device end (starting in higher-end phones).

The exception is one manufacturer with an approximate market share in the last years of 20%, who has kept a proprietary interface at the mobile end, but includes USB Type-C in other products, e.g. laptops. According to this manufacturers, an important difference is that the proprietary interface occupies less space inside the phone than the USB Type-C.

3. **The assembly for wireless charging**

Wireless charging is an incipient technology to charge portable devices. It requires a pad which can be connected directly to the EPS or through a cable ending with a USB Type C interface. Compared to the energy transfer of a wired charger, its energy efficiency is around 60%[169].

The physical operation principle refers to the way in which the transmitter sends energy into the receiver (or *coupling*). The following technologies can be differentiated based on that criteria:

- **Inductive coupling.** Inductive coupling uses induction as a transmission method. Basically the transmitter coil, through which high frequency AC current flows, generates a changing magnetic flux that induces then a current in the receiver coil, if put close enough. This placing becomes a crucial factor for inductive coupling, since its frequency level only allows proper power transfer in very close ranges (few millimetres).

- **Magnetic resonance coupling.** Magnetic resonance is based in RLC circuits in which current is fed, causing the capacitor and inductor to exchange energy periodically (Développement, Yole, 2018). When working at resonant frequency, the amount of energy stored increases with time, escalating the voltage and current level in the transmitter and thus generating a more powerful magnetic field, allowing looser coupling than the inductive method.

- **Capacitive coupling.** Capacitive coupling uses capacitors (or induced capacitance between circuits) to transmit energy through an electric field. Since it requires large areas it is not used in electronics charging applications (Lu, Wang, Niyato, In Kim, & Han, 2016).

- **RF radiation.** This technique uses diffuse RF/microwave radiation in order to send energy (Lu, Wang, Niyato, In Kim, & Han, 2016). It works in very high frequency

[169] https://data.europa.eu/doi/10.2873/537546

ranges and can transmit energy to a distance up to kilometres, although it is not widely used due to safety reasons.

- **Distributed laser charging.** Another emergent technology identified is distributed laser charging, which could potentially impact the wireless charging landscape greatly (Liu, et al., 2016). This technology is based energy transmission through photons than are then re-converted to electricity through a small PV panel in the receiver. This technology could offer free positioning and long distance charging to several devices simultaneously as well as further safety, since charging is automatically stopped when an object is placed in the line of sight of the device being charged (Zhang, Pang, Georgiadis, & Cecati, 2019). The main limitations currently seem to be the low efficiency and power output of these systems, being in the range of around 20% and 5-10 W respectively. This does however place this emergent method in the same application range of current wireless charging technologies (i.e. mobile phones and other small electronic devices).

- **Acoustic energy transfer (AET).** Another existing wireless energy transmission method is acoustic energy transfer (AET). As the name suggests, electric energy is transmitted in form of sound (i.e. mechanical vibration). As explained in (Awal et al., 2016), AET systems usually consist on a transmitting side which converts electricity in vibration, a medium area (which can be any solid, liquid or air) and a receiver consisting mainly in a transducer converting vibration back to electric pulses. AET's main advantages compared to the aforementioned means of energy transfer are its safety (as no electromagnetic wave or laser is being used) and it's friendliness to otherwise problematic transfer mediums like metals. Its main potential applications according to (Awal et al., 2016) would be mainly through wall and in-body power transfer. The earlier has actually been devoted the most attention to, with reported peaks of 1 kW power transfer at around 88% conversion efficiency. Over-the-air energy transmission seems however to be rather challenging for AET, with a handful of tests having been made using ultrasonic transducers. With those, the maximum power rate achieved was in the level of μW. It is therefore, highly unlikely that this technology will be seen in consumer electronic charging anytime soon.

The first three technologies are also known as *near field* technologies because they transfer power over short distance, while the rest are *far field* technologies. It is also to be noted that in general; inductive, resonant and Radio Frequency technologies work over similar principles but at different frequencies, which in turn affects the charging distance and the interoperability between the systems. The rest do use different physical means to transmit energy. Although all these ways of transferring energy are well known, their application to powering electronic devices is fairly recent (even in its infancy for many of them).

In this Impact Assessment high power Wireless Power Transfer (e.g. for charging electric vehicles) is not considered, as the related equipment is out of scope of the initiative.

There are three main technologies for wireless charging portable electronics of interest of this initiative: Airfuel, Qi and PMA, which are all being developed by consortia of major market players. Qi and PMA seem to have been the preferred technologies by mobile manufacturers to date. Most smartphones use the Qi technology, although some devices are also compatible with PMA. Qi was released in 2008, and by February 2019 there were over 220 devices which had Qi built-in[170]. Wireless chargers only work with compatible devices. Specific standards reflect the specifications of these technologies, e.g. EN 63028 (AirFuel Wireless Power Transfer System Baseline System Specification) and IEC PAS 63095 (The Qi wireless power transfer system power class 0 specification).

Interoperability of the External Power Supply (EPS)

Traditionally, the EPS sold to charge mobile phones and other portable devices followed the standard IEC 62684, published in 2011 and updated in 2018. This standard specifies the interoperability of common EPS for use with data-enabled mobile telephones. It defines the common charging capability and specifies interface requirements for the EPS. The maximum power allowed by this standard is 7.5W (5V at 1.5A). This standard nowadays would be insufficient to power certain devices (e.g. high-end mobile phones and tablets) or would charge them at a very low speed.

Since then, new technologies using higher current and/or voltage have emerged. Table 5.3 offers a summary of standard solutions, and Table 5.4 of proprietary charging solutions. Battery charging protocols are discussed more in depth in sections 4.1.1 and 4.2.2.

Table 5.3: Standard battery charging protocols

<table>
<tr><th>Charging technology</th><th>Battery charging specifications applicable</th><th>Applicable interface[171]</th><th>Voltage</th><th>Current</th><th>Power</th></tr>
<tr><td>Common EPS, as defined in 2009 MoU[172]</td><td>IEC 62684</td><td rowspan="2">USB Standard-A (source), USB Micro-B (sink), USB Type-C (source or sink)</td><td rowspan="2">5V</td><td rowspan="2">Up to 1.5A</td><td rowspan="2">Up to 7.5W</td></tr>
<tr><td>USB Battery Charging 1.2</td><td>EN-IEC 62680-1-1</td></tr>
</table>

[170] Source: https://qi-wireless-charging.net/qi-enabled-phones/

[171] Source refers to the EPS, and sink to the device that is charged. It should be noted that devices can be both source and sink (e.g. when a laptop is charged it would be a sink, and when it is used to charge other devices it would be a source).

[172] Following the MoU signed in 2009, CENELEC received a mandate from the European Commission to develop a harmonised standard for mobile phone chargers. In response, CENELEC created a task force to develop the interoperability specifications of a common EPS, and work was transferred into the IEC. The IEC published the standard IEC 62684 in 2011 and updated it in 2018.

USB Type-C	EN-IEC 62680-1-3	USB Type-C (source or sink)	5V	1.5A, 3A	7.5W or 15W
USB PD 2.0 (superseded)	EN-IEC 62680-1-2	USB Standard-A (source), USB Type-C (source or sink)	5V, 9V, 15V, 20V	Configurable up to 5A[173]	Up to 100W[174]
USB PD 3.0	EN-IEC 62680-1-2	USB Type-C (source or sink)	5V, 9V, 15V, 20V	Configurable up to 5A	Up to 100W
USB PD 3.0 + PPS (Programmable Power Supply)	EN-IEC 62680-1-2	USB Type-C (source or sink)	5V Prog, 9V Prog, 15V Prog and 20V. PPS adds 3V to 21 V in 20mV increments	Configurable up to 5A	Up to 100W

Source: Commission's contractor

Table 5.4: Main proprietary battery charging protocols[175]

Charging technology	Battery charging specifications applicable	Interface	Voltage	Current	Power
Quick Charge 1.0	None	USB Standard-A (source), USB Micro-B (sink)	5V	2A	10W
Quick Charge 2.0	None	USB Standard-A (source), USB Micro-B (sink)	5V, 9V, 12V	3A	18W
Quick Charge 3.0	None	USB Standard-A (source), USB Micro-B (sink), USB Type-C (sink)	3.6-20V (200mV increments)	2.5A, 4.6A	18W
Quick Charge 4 and 4+	None (QC mode)	USB Type-C (source or sink)	3.6-20V (200mV increments)	2.5A, 4.6A	100W
	USB PD mode		5V, 9V	3A	27W

[173] Power transfer over 3A requires use of an electronically marked 5A cable
[174] Power over 60W requires the use of USB Type-C at the source
[175] Only proprietary charging protocols that are relevant for the EU market are listed. The table does not aim to be comprehensive of all existing proprietary charging protocols.

	USB PD 3.0 PPS mode		3 V - 21 V (20 mV steps increments)	3A	27W
Quick Charge 5	N/A	USB Type-C (source or sink)	N/A	N/A	+100W
Huawei SuperCharge	None	USB Standard-A (source), USB Type-C (sink)	10V, 5V, 4.5V	2.25A, 4.5A, 5A	20W
			10V, 5V, 20V	4A, 8A, 3.25A	40W
			11V	6A	66W
VOOC	None	USB Standard-A (source), USB Type-C (sink), USB micro-B (sink)	5V	4A	20W
			5V	5A	25W
			10V	5A	50W
			5V	6A	30W
			10V	6.5A	65W

Source: Ipsos MORI, based on multiple sources: literature review (e.g. technical standards and other technical documentation), interviews with manufacturers, mapping of portable electronic devices.

Standard charging solutions for EPS

Evolution of USB charging protocols

Universal Serial Bus (USB) is a set of specifications developed for serial data transmission by the USB Implementers Forum (USB-IF). The objective of the first specification developed, USB 1.0, was to allow an easy and high speed connection between PC and peripherals. The speed of data transmission of USB 1.0 was between 1.5 and 12 Mbits/s, the voltage was 5V, and the maximum current was 100 mA (0.5 W). Several connectors' shapes were adopted to implement this protocol.

USB 2.0 was released in 2001, increasing the speed of data transmission to 480 Mbits/s, and the current to 500mA (2.5W). USB 3.0, released in 2008, increased the data transfer rate to 5 Gbits/s and the current to 0.9 A (delivering up to 4.5W of power). These protocols, however, were not oriented to charging devices, and interoperability was not guaranteed as there were no clear specifications or standards for USB-based charging products.

In order to facilitate interoperability, the USB-IF created a specification for battery charge and/or power delivery: "Battery Charging Specification – BC 1.0, BC 1.1, and BC 1.2", released in 2007, 2009 and 2010, respectively (IEC 62680-1-1). The latest revision of BC 1.2 was published in 2015. The power flow of the USB BC is unidirectional, from the EPS to the connected device, and limited to 7.5W. This protocol has a wider scope than IEC 62684, which is specific to mobile phones.

USB Type-C is a standard designed to increment the amount of power flowing from the the EPS to the device, hencereducing duration of the charge. The standard extended the power capabilities to 15 W, with current being dinamically managed in the interval of 0.5A to 3A. The connectors are symetric and reversable. With this standard, data transmision speed was also increased to 10 Gbits

USB Power Delivery 1.0, released in 2012, allowed power delivery of up to 100W over a single USB. In 2014 an updated version, USB PD 2.0, was released together with the specification for the USB Type-C connector (IEC 62680-1-3). In 2015, a third version of the protocol, USB PD 3.0, was published (reviewed in 2019). The protocol defines all the elements of a USB system: hosts, devices, hubs, chargers and cable assemblies, as well as the architecture, protocols, power supply behaviour, connectors and cabling required when using USB PD.

USB PD 2.0 can be used with USB Type-A, Type-B and Type-C connectors. USB PD 3.0, however, can only be used with USB Type-C connectors.

USB Type-C main characteristics are:

- Power delivery up to 100W.
- Symmetry (it can connect both the EPS and the device).
- Simultaneous data transmission and power delivery.

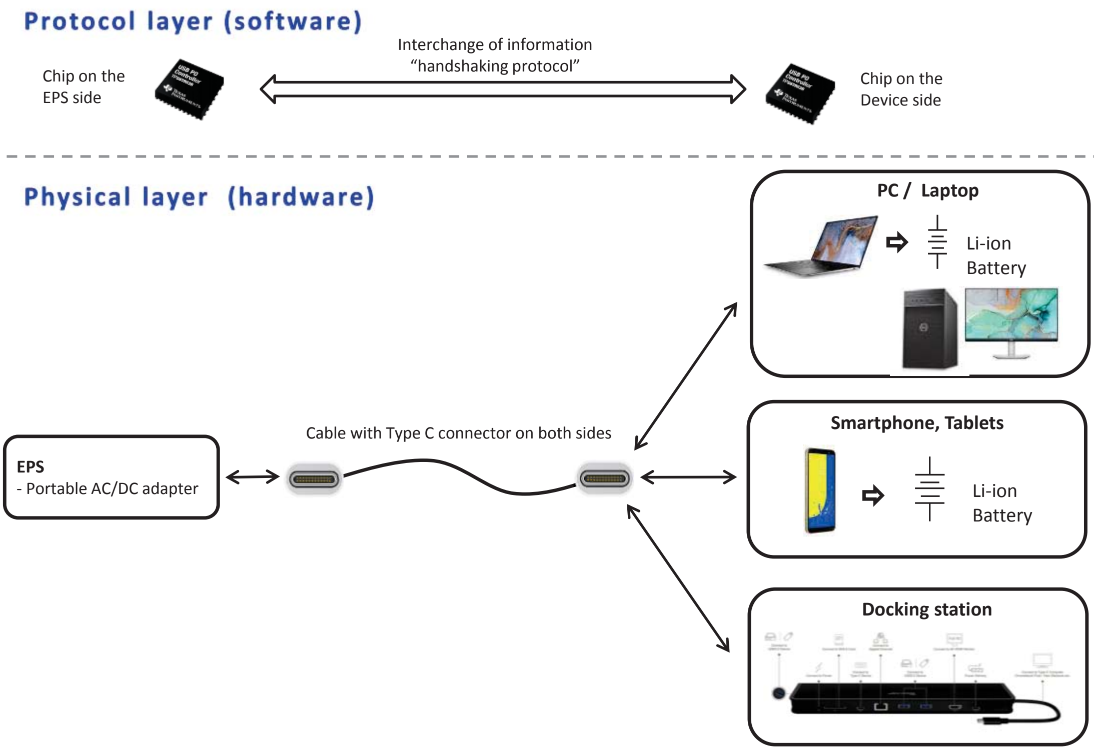
USB Power Delivery (USB PD)

The Universal Serial Bus Power Delivery (USB PD) is a technical specification (EN-IEC 62680-1-2) that, combined with a Type-C connector (EN-IEC 62680-1-3), allows an increment of the power that can be delivered to electrical devices.

USB PD can be divided into physical and protocol layers. The physical layer (i.e. the hardware) is composed by the EPS, the cable or cord with a USB Type-C connector and the downstream unit. The protocol layer (i.e. the software) defines the communication protocol and the content of the communication. Devoted chips (SoC), USB compliant, are required for the implementation of the communication protocol.

Downstream devices can be divided into those that can store energy, such as mobile phones, tablets, or laptops; and those that cannot store energy, such as desktop computers, docking stations and monitors.

Figure 5.1. Characteristics of the USB PD



The power transmission can be implemented in two different modes, following the standard IEC 62680-1-2:

- Fixed Supply Operation. The EPS identifies a set of fixed voltages (5 V, 9 V, 15 V and 20 V) and current (maximum of 5 A).

- Programmable Power Supply Operation (PPS). The voltage and the current can be individually controlled. The voltage varies between 3.3V and 21 V while the current can increase up to 5 A. This power topology allows a better control of the thermal rise of the battery during a high power charge.

How does the EPS "know" how much power it should deliver?

When an EPS and a downstream device are connected, they exchange information. The standard IEC 62680-1-2 states that USB PD compliant EPS shall be able to charge non-compliant devices. During the smart talk, or handshake, the EPS identifies if the device downstream is a USB PD type and determines whether it should apply fast, or regular charge. It also provides information about device protections (overcurrent, overtemperature, overvoltage, etc.) during information exchange.

The standard also defines five basic power levels and requires that each power level shall be able to deliver previous lower levels. This means that if an EPS can deliver up to 100W (20V/5A), it should also be able to safely charge other devices that require less power (e.g. 27W or 15W).

USB PD Certification

On 8 January 2018, USB-IF announced the "Certified USB Fast Charger" which certifies chargers that use the feature "Programmable Power Supply" (PPS) of the USB PD specification. The certification allows manufacturers to use the USB-IF logo in their products, which are also included in the USB-IF website[176].

According to interviewees, many manufacturers decide not to certify their products, even if they are compliant with the USB PD specification, due to a variety of reasons, e.g.: certification costs, administrative burden, low perception of advantages of certification, or the need to test the products in external laboratories (which can give rise to concerns about IP leakage).

On the other hand, products that include add-ons beyond USB PD (e.g. EPS providing power via USB PD or a proprietary solution, depending on the device that the user connects) cannot be certified.

Proprietary charging solutions for EPS

In the smartphone ecosystem, many models use in-house technologies rather than the more ubiquitous USB PD standard or Quick Charge. However, only a few of these technologies are truly proprietary. Many are just USB PD or Quick Charge repackaged under a different brand name, such as MediaTek’s PumpExpress, which uses USB PD.

This sub-section explores the main fast charging technologies that are truly proprietary: Qualcomm’s Quick Charge, Huawei SuperCharge, and Oppo VOOC.

Quick Charge

Quick Charge (QC) is a proprietary Qualcomm battery charging protocol used for managing power delivered over USB cables and connectors, mainly by communicating to the EPS and negotiating a voltage. QC is an optional feature available with Qualcomm’s Snapdragon SoC.

The first fast charging technology available on the market was Qualcomm’s Quick Charge 1.0, released in 2013 and providing up to 10W. In 2014, Qualcomm released Quick Charge 2.0, which provided maximum power of 18W.

Quick Charge 3.0, released in 2016, introduced the feature INOV (Intelligent Negotiation for Optimum Voltage), which allowed for a fined tuned power output and a more optimized charging cycle. Instead of providing a fixed voltage, Quick Charge 3.0’s INOV communicated with the device to request any voltage between 3.2V and 20V at 200mV increments, allowing for a wider selection of voltages.

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[176] The USB-IF website (https://www.usb.org/products) includes a list of products that have passed the USB-IF compliance programme.

INOV is able to dynamically adjust the charging voltage over the battery charging cycle. As a battery charges up, it slowly draws less and less current, slowing down the charging speed. Qualcomm stated that INOV allows the phone to request just enough voltage to reach the desired charge current, thereby maximising efficiency.

Quick Charge 4 was announced in December 2016 alongside the Snapdragon 835 SoC. Quick Charge 4 introduces two charging modes: QC and USB PD. This means that the device would charge with USB PD if either the device or the EPS are not QC compatible. It also featured additional safety measures to protect against over-voltage, over-current and overheating, as well as cable quality detection. QC 4.0 was not compatible with previous QC versions. Qualcomm announced Quick Charge 4+ in 2017, including some additional safety features, as well as compatibility with QC 2.0 and QC 3.0 devices.

Quick Charge 5 was announced in July 2020. Qualcomm states that this standard is compatible with USB PD PPS (although it could not be certified as it includes add-ons beyond USB PD).

Quick Charge comes as an option with Snapdragon SoC and it has been adopted by a large number of mobile phone manufacturers, such as Samsung, BQ, Lenovo, LG, Redmi, Xiaomi, HTC, Nokia, or Sony. As of November 2020, no devices featured QC 5 yet.[177] It should be noted that not all devices that include Snapdragon SoC use QC. For instance, Google Pixel phones use Snapdragon chips, but their battery charging protocol is USB PD. Other manufacturers that were early adopters of Quick Charge, such as Samsung, continue using Snapdragon chips but have moved to USB PD.

According to interviewees, QC has also been adopted by manufacturers of other devices, including tablets, drones, wireless speakers, powerbanks, and mobile 4G routers. EPS that use QC bring USB Type-A or USB Type-C sockets, or both if they are multi-port.

Huawei SuperCharge

Huawei, through its affiliated company HiSilicon, produces their own SoC, known as Kirin. This SoC incorporates Huawei's proprietary charging solution, SuperCharge. There are two main versions of SuperCharge: 20W and 40W, and Huawei also manufacturers EPS that are able to deliver over 60W. HiSilicon does not produce SoC for other OEMs, and therefore only Huawei devices use Huawei SuperCharge.

Huawei’s devices adjust the charging voltage and current automatically depending on the type of charger and cable that the consumer uses. The devices also disable SuperCharge automatically when plugging in a cable that does not support SuperCharge.

[177] See list of devices featuring QC, as reported by Qualcomm, here: https://www.qualcomm.com/media/documents/files/quick-charge-device-list.pdf (updated November 2020)

Huawei SuperCharge delivers fast charging by increasing the current (up to 8A), and therefore it needs a cable that can transmit high current. Android Authority conducted the test using a OnePlus cable, which also delivers fast charging by increasing the current. Had Android Authority used a different third-party cable, it would have probably failed to deliver 20W.

Huawei's EPS use the proprietary SuperCharge protocol and can also charge devices via the USB Battery Charge protocol (EN-IEC 62680-1-1). However, unlike the devices, the EPS do not support USB PD.

According to information provided by interviewees, all Huawei EPS use USB Type-A sockets and they have no plans yet to move to USB Type-C at the EPS end.

Oppo VOOC

Oppo VOOC (Voltage Open Loop Multi-step Constant-Current Charging), also known as Dash Charge (20W), Warp Charge (30W) or Dart Charge (65W), is a proprietary technology created by BBK Electronics. BBK Electronics Corporation markets smartphones under the Oppo, Vivo, OnePlus, Realme and iQOO (a sub-brand of Vivo) brands. In contrast to other fast charging technologies (e.g. USB PD), which increase the voltage during fast charging, VOOC uses low voltage and a higher current than the "common" charger.

As of 2020, VOOC comes in five variations: (i) VOOC 2.0, which operates at 5 V/4 A, (ii) VOOC 3.0 (2019), which appears to operate at 5 V/5 A, (iii) SuperVOOC (2018), a successor of VOOC 2.0 with 10 V/5 A (50W), (iv) VOOC 4.0 (2020), a successor of VOOC 3.0, which operates at 5 V/6 A (30 W), (v) SuperVOOC 2.0 (2020), a successor of Super VOOC with 10 V/6.5 A (65 W). **All versions of VOOC require a proprietary cable to work**. In addition to electrical requirements like thickness (low electrical resistance) to handle the high currents without overheating, the VOOC 2.0 protocol requires a fifth pin on the (USB-A to USB-C) cable to communicate through. Without such communication, the charger runs at a limit of 5 V/1.5 A. **Mobile devices using VOOC cannot be charged at a fast speed using non-proprietary EPS**. A Fast Charging Accessory test conducted by Android Authority revealed that One Plus and Realme devices charged at around 7W-13W when using Quick Charge or USB PD EPS, compared to 26W of power when charging with the original EPS and cable. According to IDC data, sales of VOOC-enabled smartphones in 2018 represented less than 1% of total sales of mobile phones in the EU. The mapping of devices suggests that the sockets of Oppo VOOC EPS are USB Type-A.

Summary of interoperability between EPS and device

In summary, most devices can be charged with a USB PD EPS (provided the right cables are connected) at a reasonable speed. This includes USB PD EPS, as well as QC 4+ and QC 5 EPS, since they can provide power using the USB PD mode in addition to their proprietary charging protocol.

Phone manufacturers are including either (a) USB PD as the only battery charging protocol in their devices, or (b) USB PD in combination with another proprietary solution. This makes these devices interoperable with any USB PD compliant EPS. Oppo devices (e.g. OnePlus, Realme) are the least interoperable, and they can only be charged at high speed when using proprietary accessories (though tests show that USB PD can charge these phones at around 13W).

As shown in Figure 5.2, in some instances (e.g. Huawei and Oppo devices) the power provided by USB PD EPS is lower than their proprietary charging solution. This may be because the USB PD protocol included in these devices use a low voltage (e.g. 5V or 9V at 3A), whereas the proprietary solutions can accept higher wattage. USB PD is backwards compatible, which means that low-end devices which still use the standard BC protocol (EN-IEC 62680-1-1) can be charged safely (up to 7.5W).

Figure 5.2. Summary of interoperability between the most common types of EPS and devices

		Type of EPS						
		Common EPS	USB PD	QC 1, 2, 3	QC 4	QC 4+, 5	Huawei SuperCharge	OPPO
Type of device	Standard	Standard charge	Standard charge	Standard charge	Standard charge	Standard charge	Standard charge	Standard charge
	USB PD	Standard charge	Fast charge (optimum)	Standard charge	Fast charge (optimum)	Fast charge (optimum)	(1) Standard charge	Standard charge
	QC 1, 2, 3	Standard charge	Fast charge (below max)	Fast charge (optimum)	Not guaranteed	Fast charge (optimum)	No information	No information
	QC 4, 4+, 5	Standard charge	Fast charge (optimum)	Fast charge (below max)	Fast charge (below max)	Fast charge (optimum)	No information	No information
	Huawei	Standard charge	Fast charge (below max)	Fast charge (below max)	Fast charge (below max)	Fast charge (below max)	Fast charge (optimum)	Standard charge
	OPPO	Standard charge	Fast charge (below max)	Standard charge	Standard charge	No information	Standard charge	Fast charge (optimum)

Legend:

[orange]	Interoperability is not guaranteed
[yellow]	Standard charge (up to 7.5W) guaranteed
[light green]	Fast charge (10-15W, but below maximum capability of device)
[dark green]	Fast charge (optimum charge)
[white]	No information available

Source: Ipsos MORI

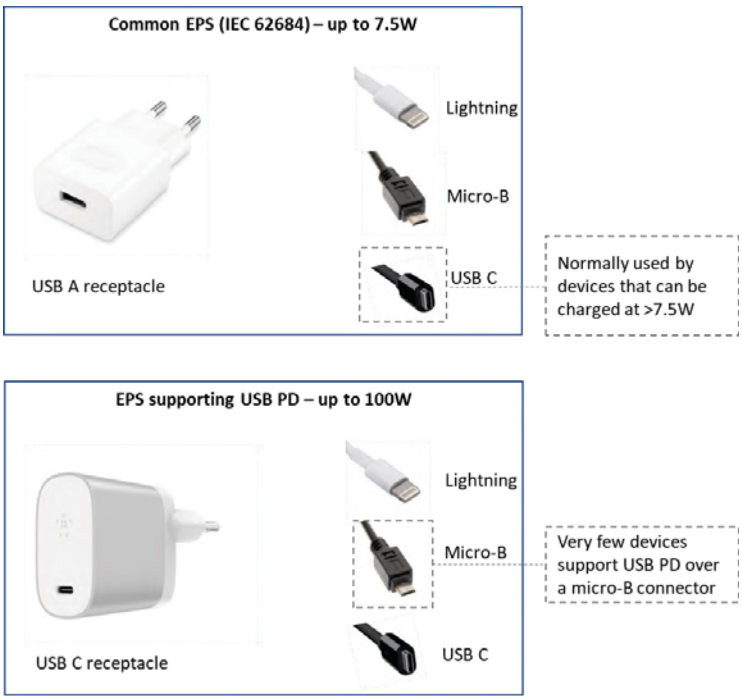
(1) According to information provided by interviewees, Huawei EPS and cables can charge other mobile phones at 10W. However, tests conducted by Android Authority showed that the proprietary cable is not interoperable with Google Pixel 4. This is most probably because Google Pixel 4 blocks any cables that do not fully comply with the USB Type-C specification, or that have some add-ons.

Interoperability of connectors at the device end

Finally, the cables connecting the device and the EPS also affect the interoperability. At the device end, the most common connectors are USB micro-B and USB Type-C. The latter is gradually superseding the former in smartphones and tablets; however, USB micro-B continues to be the mainstream solution for devices that require less power (e.g. e-Readers, earbuds and headphones). For more information on the connectors used by different types of devices, see section 2.3.1. Apple has a proprietary connector, Lightning, which has been incorporated in all iPhones and some other Apple products since 2012 and continues to be used in the last generation of iPhones launched in 2020. Recent iPads and MacBook have USB Type-C. Apple has not published the Lightning specifications; however, it should be able to carry, at least, up to 20W, which is the power accepted by iPhone 12. Apple devices (smartphones, tablets and laptops) are USB PD enabled and can be charged with any EPS that supports USB PD.

In summary, interoperability is determined by the EPS and the cable *separately*. This means, the same EPS could be used to charge several devices even if the devices use different cables/connectors, and the same cable could be used for several devices, even if they use different EPS (e.g. because they have different charging requirements). The figure 5.3 below summarises the most common charging solutions available in the market.

Figure 5.3. Summary of charging solutions

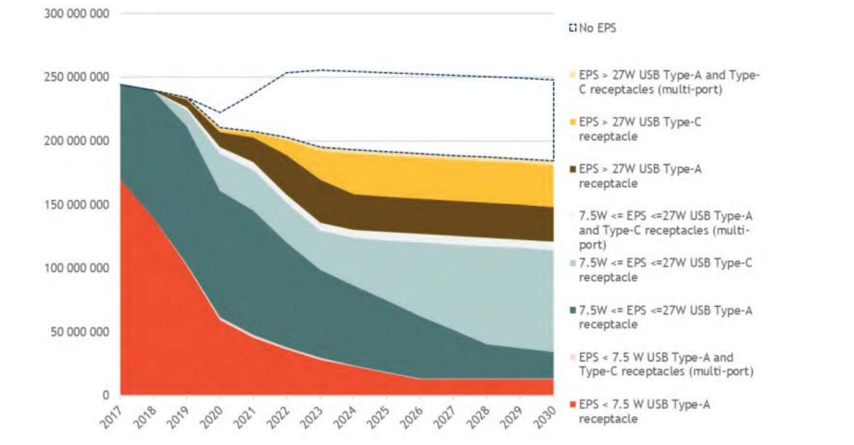
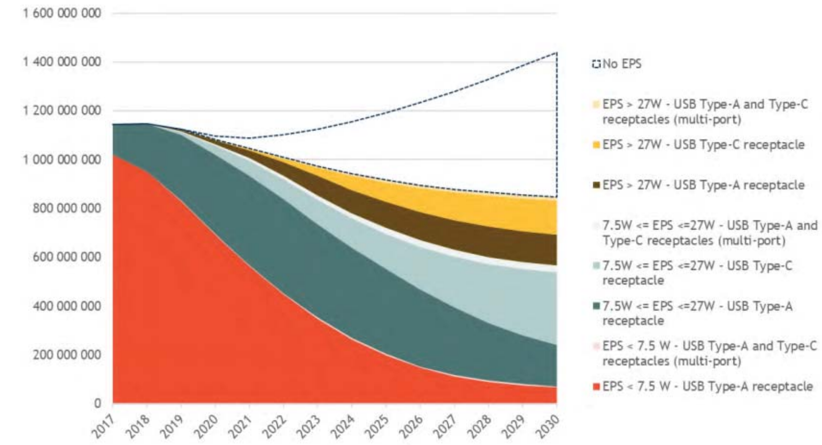


Source: Commission's contractor

Market share of the USB technologies

Figure 5.4 shows the expected trends of EPS and cables in the absence of actions.

Figure 5.4: estimated stock of EPS and charger cables

<table>
<tr><td></td><td>Annual sales (with Smartphones + standalone) [units]</td><td>Stock [units]</td></tr>
<tr><td>EPS</td><td>
</td><td>
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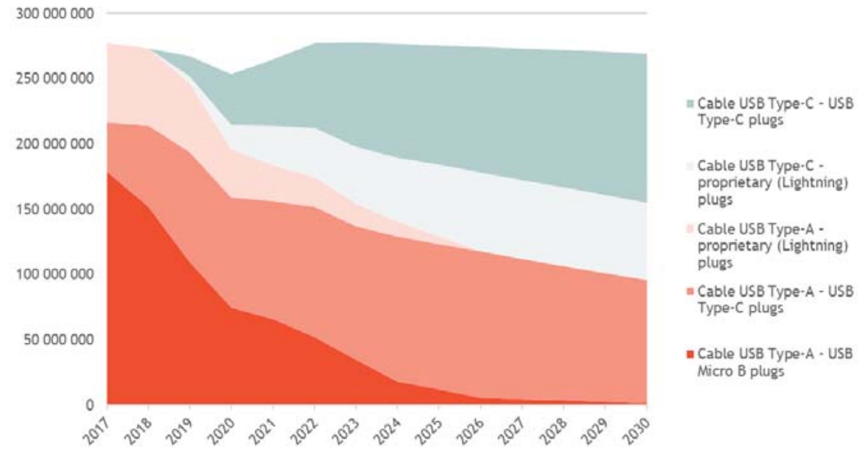
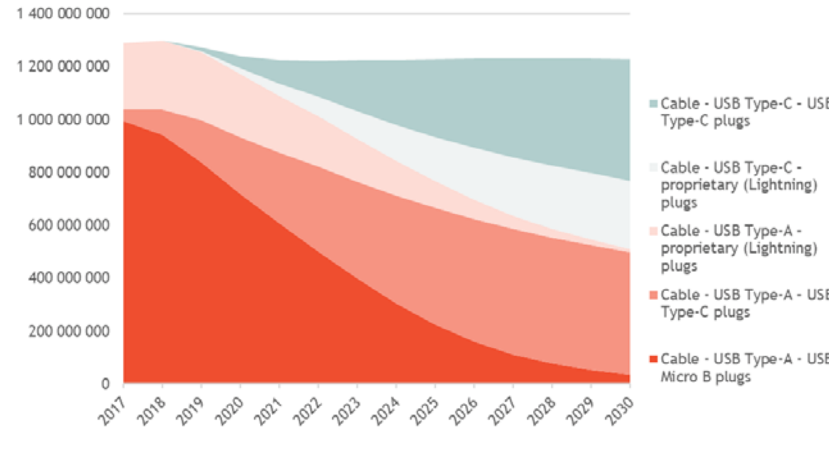
<tr><td>Cables</td><td>
</td><td>
</td></tr>
</table>

Source: Commission's contractor

ANNEX 6: COHERENCY MAPPING – RELATED PIECES OF EU LAW

In March 2020, the Commission adopted a new **Circular Economy Action Plan**. It announces initiatives along the entire life cycle of products, targeting for example their design, promoting circular economy processes, fostering sustainable consumption, and aiming to ensure that the resources used are kept in the EU economy for as long as possible.

The plan presents a set of interrelated initiatives among which the **Circular Electronics Initiative** that includes, among others, the following sets of actions:

- Adopting regulatory measures for electronics and ICT including mobile phones, tablets and laptops under the Ecodesign Directive so that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling;

- Adopting regulatory measures on chargers for mobile phones and similar devices, including the introduction of a common charger, improving the durability of charging cables, and incentives to decouple the purchase of chargers from the purchase of new devices.

- Improving the collection and treatment of waste electrical and electronic equipment[178] including by exploring options for an EU-wide take back scheme to return or sell back old mobile phones, tablets and chargers.

Ultimately, the CEI's main objectives are to:

- reduce e-waste and carbon/environmental footprints;

- keep valuable resources in the EU through circular models;

- create economic opportunities and incentives and enable consumers to make more sustainable choices;

- ensure a harmonized approach across the single market.

When developing the approach for the common charging and unbundling initiative the above mentioned objectives should be taken into account.

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[178] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE), OJ L 197, 24.7.2012, p. 38.

Related to the first two sets of actions, three concurrent initiatives on **Ecodesign and Energy labelling** analyse in depth environmental impacts of spare parts, repair and maintenance information, disassembly requirements, preparation for re-use, design for reliability, design for recyclability, environmental impacts, battery requirements, and energy labelling for mobile phones, tablets and laptops. The specific sub-actions are:

1. **Designing mobile phones and tablets to be sustainable – ecodesign**[179]

This initiative was planned under the Circular Economy Action Plan 2020 and is in line with European Green Deal objectives on efficient use of resources. It aims to ensure that:

- Mobile phones and tablets are designed to be energy efficient and durable
- Consumers can easily repair (incl. access to spare parts), upgrade and maintain them
- It is possible to reuse and recycle the devices.

2. **Energy labelling of mobile phones and tablets – informing consumers about environmental impact**[180]

This initiative complements the parallel implementing Regulation on ecodesign. It aims to introduce, when relevant, labelling requirements that support ecodesign by giving consumers better information regarding product sustainability.

3. **Review ecodesign requirements for computers and computer servers**[181]

This initiative aims to reduce the energy consumption of computers and computer servers by establishing minimum efficiency requirements and other performance criteria. This will result in a decrease of CO2 emissions and deliver financial savings for European consumers.

Related to the third set of actions under the Circular Electronics Initiative, the Commission is working on the **management of waste of electrical and electronic equipment (WEEE)**.

The Initiative will take stock of ongoing actions to increase the circularity of electronics value chains, taking into account the developments on the Sustainable Products Initiative

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179 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Designing-mobile-phones-and-tablets-to-be-sustainable-ecodesign
180 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12798-Environmental-impact-of-mobile-phones-and-tablets-Energy-Labelling
181 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1581-Review-of-ecodesign-requirements-for-computers-and-computer-servers

(SPI)[182], which will be adopted at the end of the year, and will set out the Commission's vision for the way forward, in particular addressing both the supply side (eco-design requirements) and demand side (establishing a right to repair).

The Initiative will also highlight elements focused on other phases of electronic product lifecycles. In this regard, the Commission is currently undertaking actions which include:

- Improving the collection and treatment e-waste, including exploring options for strengthening incentives for take-back and return of small EEE (stored in households including cables and chargers) with a focus on mobile phones, tablets and laptops ; (Q2 2021)

- In the context of SPI, introducing a digital product passport to increase the information on product characteristics along the value chain and to consumers and facilitate product repair, upgrading, component recovery and reuse, and ultimately recycling.

- A review of EU rules on restrictions of hazardous substances in electrical and electronic equipment;

An exploratory study is being run on options for strengthening incentives for take-back and return of small EEE (stored in households including cables and chargers) with a focus on mobile phones, tablets and laptops. The consultants have been tasked with assessing the possible options at EU level that could be taken to strengthen the incentives to return both used EEE and waste EEE. This means that both measures which extend the lifetime of devices through reuse or other times of reverse supply chains *and* measures which improve the collection of waste EEE are being considered. However, at this stage it still not decided which kind of instrument and follow-up the Commission will take.

Concurrently, the Commission will also increase the effectiveness of the current Ecodesign framework for energy-related products by adopting and implementing the **Ecodesign and Energy Labelling Working Plan 2020-2024 (EELWP)**. This will be the first 5-year plan to combine formally the future priorities for the implementation of the Ecodesign Directive 2009/125/EC and Energy Labelling Regulation (EU) 2017/1369.

The EELLWP contains, among others, a specific item being investigated for possible regulation about the "**universal EPS**". It is estimated that more than 2 billion External Power Supplies (EPSs), in the range from 0-120 Watts, are present on the European market today[183]. This is partly due to a fragmentation of EPS. However, it is also caused by

[182] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative
[183] EIA overview report 2017

business practice, where it is common to supply an EPS with each electronic device to make sure that the sold product is charged and supplied with the right power supply. Typically, only lower priced electronic products such as mobile phones and wireless speakers may be sold without an EPS. A potential for material efficiency exists if an EPS could be used during a longer lifetime than just for the lifetime of the product it is delivered with.

On the evolution of technologies, the industry consortium USB-IF[184], has developed a full set of specifications to support a number of features ranging from delivering direct current at various voltages and with different, modulable intensity, but also including transmission of digital data such as images and audio over a single cable and using a single, harmonised interface. These developments by USB-IF turned into a set of standards by IEC that were endorsed by ESOs[185].

Finally, a revision of the **EPS regulation** is foreseen in 2022. EPSs are regulated by Commission Regulation (EU) 2019/1782[186] , which define an EPS as a device that meets the following criteria:

- it is designed to convert alternating current (AC) power input from the mains power source input into one or more lower voltage direct current (DC) or AC outputs;
- it is used with one or more separate devices that constitute the primary load;
- it is contained in a physical enclosure separate from the device or devices that constitute the primary load;
- it is connected to the device or devices that constitute the primary load with removable or hard-wired male/female electrical connections, cables, cords or other wirings;
- it has nameplate output power not exceeding 250 watts; and
- it is used with electrical and electronic household and office equipment included in its Annex I;

184 www.usb.org
185 EN IEC 62680-1-2 :2020 ; EN IEC 62680-1-3 :2018 ; EN IEC 62680-1-4 :2018 ; EN IEC 62680-1-5 :2019 ; EN IEC 62680-1-6 :2019 ; EN IEC 62680-1-7 :2019 ; EN IEC 62680-1-8 :2019 ; EN 62680-1-1 :2015 : EN 62680-2-2 :2015 ; EN 62680-2-3 :2015.
186 Commission Regulation (EU) 2019/1782 of 1 October 2019 laying down ecodesign requirements for external power supplies pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulation (EC) No 278/2009

The regulation excludes the certain power supplies (voltage converters, uninterruptible power supplies, battery chargers without power supply function, lighting converters, external power supplies for medical devices, active power over Ethernet injectors, docking stations for autonomous appliances, external power supplies placed on the market before 1 April 2025 solely as a service part or spare part for replacing an identical external power supply placed on the market before 1 April 2020, under the condition that the service part or spare part, or its packaging, clearly indicate 'External power supply to be used exclusively as spare part for' and the primary load product(s) it is intended to be used with).

GLOSSARY

Term or acronym	*Meaning or definition*
CEAP	Circular Economy Action Plan
CEI	Circular Electronics Initiative
Connector	electrical termination which is built according to a specific blueprint and interface
Decoupling	Re-design a part or component by separating two previously joint parts, such as splitting an external power supply (EPS) with a non-detachable, soldered cable into two independent parts and using a receptacle + plug connection to connect the EPS with the cable
EELWP	Ecodesign and Energy Labelling Working Plan 2020-2024
e-waste	Waste from electronic and electrical equipment
External Power Supply (EPS) 	Device converting alternating current (AC) power input from the mains into direct current (DC) to power a product as defined in Regulation (EU) 2019/1782 on eco-design
Fast charging	Term commonly used to indicate an EPS supporting one of more power delivery protocols for optimising the speed of charge of battery-powered products whilst ensuring safety and durability of the batteries via interaction with the battery management module in the powered products. USB PD include different features for powering at 4 discrete voltage level (5, 9, 15 and 20 volt) PPS defines small voltages increases between 3 volt and 21 volt.
GaN	Gallium Nitride
GHG	Green House Gas
Interface	Common word to define the receptacle (Female connector)
kt	Kilo tonnes
Lightning 	Proprietary connector created by Apple Inc. introduced in 2012 to replace its predecessor, the 30-pin dock connector and used in a few products such as smartphones and pencils. Devices with a Lightning receptacle can interoperate with any USB products as fully compatible at signal and electrical level. Cables with a lightning plug generally have a standard USB Type-A or Type-C plug on the other end. As Type-C, it is fully reversible.
MEP	Member of the European Parliament
MoU	Memorandum of Understanding
MS	Member States
NLF	Legislative Framework
Plug	Male connector
Proprietary charging solution	Charging solution adopted by a single organization or individual. Ownership by a single organization gives the owner the ability to place restrictions on the use of the solution and to change it unilaterally. Specifications for proprietary solutions may or may not be published, and implementations are not freely distributed.
Receptacle	Female connector
RED	Radio Equipment Directive 2014/53/EU
SoC	System on a Chip
SPI	Sustainable Products Initiative
Unbundling	Selling a product or service separately when previously it had been sold together with others. In the context of this IA, it means selling an electronic device without a cable and/or external power supply.

USB	USB (Universal Serial Bus specification) is a set of specifications developed by the USB implementer Forum (USB-IF) for that establishes specifications for cables and connectors and protocols for connection, communication and power supply of electronic products. The USB specifications have been standardised in IEC EN 62680 family of standards
USB PD	In July 2012, USB-IF announced the finalization of the USB Power Delivery (PD) specification (USB PD rev. 1), an extension that specifies using certified PD aware USB cables with standard USB Type-A and Type-B connectors to deliver increased power (more than 7.5 W) to devices with larger power demand. The USB Power Delivery specification revision 2.0 (USB PD rev. 2) was released as part of the USB 3.1 suite. It covers the Type-C cable and connector with four power/ground pairs and a separate configuration channel. Revision 3.0 was released in 2017.
USB Type-A 	It has been the first USB connector and still widely available in many products for backward compatibility. Most of the EPSs currently on the market for use with phones have a Type-A receptacle for plugging the cable to power the product.
USB Type-B 	A connector (B-Plug and B-Receptacle) defined to overcome limitations of the previous type-A connector and having a number of variants. The most common variant, called “Micro-B” is generally used in cheap products such as low-end mobile phones.
USB Type C 	24-pin USB connector system, which is distinguished by its two-fold rotationally-symmetrical connector. A device with a Type-C connector does not necessarily implement USB 3.1, USB Power Delivery, or any Alternate Mode: The Type-C connector is common to several technologies.
WEEE	Waste of electrical and electronic equipment (WEEE) such as computers, TV sets, fridges and cell phones, which is the subject of Directive 2012/19/EU.
Wireless charging	Inductive charging (also known as cordless charging) uses an electromagnetic field to transfer energy between two objects through electromagnetic induction. This is usually done with an inductive pad. Power is sent through an inductive coupling to an electrical device, which can then use that energy to charge batteries or run the device.